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TECHNICAL MEMORANDUM

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Subject: ***Groundwater Pathway Analysis & DCGL Derivation for KMTC***

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ENDORSEMENT: This document contains the results of research and technical analysis which have been reviewed and approved for publication by the Technical Director, NEXTEP Environmental, Inc.

H Newman 4/4/01

Harry J. Newman, CHP, Technical Director — Date

Introduction:

This memorandum summarizes the methodology of NUREG/CR-5512 and, to a lesser extent, RESRAD, for determining the potential dose to an individual due to natural uranium contamination in groundwater. The calculations initially assume a concentration of 1 pCi/L of natural uranium in groundwater. The contamination is carried through the various potential pathways to humans, and the resulting dose from the unit contamination is calculated for each pathway. Finally, the results for each potential pathway are summed, and the total potential dose per pCi/L of natural U in groundwater is obtained. The Derived Concentration Guideline Level (DCGL) for natural U in groundwater is then derived based upon the regulatory limit of 25 mrem per year to the average member of the critical population. In this case, the exposure pathway scenario assumes that the resident farmer is the average member of the critical population.

The following groundwater related pathways are analyzed:

- Ingestion of Groundwater
- Ingestion of Soil
- External Exposure
- Ingestion of Vegetables
- Ingestion of Meat

- Ingestion of Milk
- Resuspension and Inhalation of Soil
- Ingestion of fish

The spreadsheets containing the parameters and calculations are located in Attachments 1-4. In Attachments 1-4, the reference used for a given parameter is cited at the right hand side of each row.

Calculations:

The basic equations for dose for each pathway are presented in this section.

Groundwater Ingestion

The average member of the critical population consumes 1.4 liters of water per day[1]. The formula for calculating the drinking water dose is as follows:

Equation 1

$$Dose_{dw} = \frac{C_w}{27} * Q_w * DCF * 10^5$$

Where:

- $Dose_{dw}$ = Committed effective dose from drinking water (mrem/year)
- C_w = Contaminant groundwater concentration (pCi/l)
- Q_w = Intake rate of water (l/year)
- DCF = 50 year committed effective dose conversion factor for ingestion of contaminants (Sv/Bq)[2]
- 10^5 = Converts Sieverts (Sv) to mrem
- 27 = Converts Bq to pCi

The detailed calculations for groundwater ingestion are presented in Attachment 1.

Inadvertent Soil Ingestion

Ingestion of contaminated soil is possible as a result of transfer to vegetables, fruits, and hands [Kennedy and Strenge, 1992]. Although the amount ingested depends upon the activities performed and personal habits, a default value of 18.25 g/y is assumed. The equation for calculating the ingestion dose is as follows [Kennedy and Strenge, 1992]:

[1] 1.4 liters/day is the mean value for consumption based upon the EPA *Exposure Factors Handbook* [U.S. EPA, 1997].
[2] For this analysis, the adult dose estimates are calculated using ICRP 72 methodology

Equation 2

$$Dose_{soiling} = C_{soil} * IR * ED * DCF * \frac{100{,}000}{27}$$

Where:

- $Dose_{soiling}$ = Committed effective dose from the ingestion of soil
- C_{soil} = Concentration of soil (Bq/g)
- IR = Ingestion rate of soil (g/day)
- ED = Exposure duration (d/year)
- DCF = Committed effective dose conversion factor for ingestion (Sv/Bq)
- 100,000/27 = Conversion from Sv to mrem and pCi to Bq

The detailed calculations for soil ingestion are presented in Attachment 1.

External Exposure to Soil

The general formula used for calculating the external effective dose equivalent for outdoor exposure is as follows:

Equation 3

$$ExternalDose = C * DCF * ED * 3600$$

Where:

- External dose = Dose in Sieverts (multiply by 100,000 to obtain dose in mrem)
- C = Concentration ($Bq*m^{-3}$)
- DCF = Dose conversion factor, nuclide specific ($Sv*s^{-1}*Bq^{-1}*m^3$)
- ED = Exposure duration (hours/year)
- 3600 = Conversion from hours to seconds

The detailed calculations for soil ingestion are presented in Attachment 1.

Ingestion of Fruit and Vegetable Products Contaminated by Overhead Irrigation Spray

The calculation of the concentration on the plant from overhead irrigation involves two separate stages. The first stage is determining the amount retained on plants after being sprayed by irrigation water. The second stage is the calculation of the additional contamination as a result of root uptake and resuspension of contaminated soil onto the plant. The two stages are then added to obtain a combined contaminant concentration on edible plant surfaces. The plant concentration is then consumed according to each plant

type, and a dose conversion factor is applied to the total intake to calculate the final dose from ingestion of produce.

In order to calculate the concentration on the plant following the initial deposition, an estimate must first be made of the deposition rate [Kennedy and Strenge, 1992]:

Equation 4

$$R = \{IR * r_v * T_v * C_w \} / Y_v$$

Where:

- R = Average deposition rate to edible parts of plant from application of irrigation water (pCi/kg*d)
- IR = Application rate of irrigation water (L/m²*d)
- r_v = Fraction of initial deposition retained on plant (dimensionless)
- T_v = Translocation factor for transfer of radionuclides from plant surfaces to edible parts (dimensionless)
- C_w = Average concentration in irrigation water (assumed constant) (pCi/L)
- Y_v = Plant yield (kg wet weight/m²)

Following the estimate of the deposition rate, a calculation of the contribution from direct deposition is an ordinary, first order, linear differential equation. The solution to the equation is as follows:

Equation 5

$$C_{plant} = (R/\lambda) \{1 - e^{-\lambda t} \}$$

Where:

- C_{plant} = The radionuclide concentration in the plant from deposition onto plant surfaces (pCi/kg)
- λ = Effective weathering and decay constant (d-1)
- t = growth period for plant (d)

For simplicity, losses from radiological decay during the holdup period[3] and consumption period are neglected. This conservative assumption has no significant impact on the dose contribution, as the radionuclides of interest have long half-lives.

The second stage of the calculation is the estimate of the concentration in plants resulting from resuspension and root uptake. In order to estimate this contribution, the average soil concentration must first be calculated. This linear differential equation is similar to equation 5, with the exception of the loss term.

[3] The holdup period is the time between produce harvest and consumption.

The loss of contaminants from soil is due to leaching by infiltrating water. This infiltration rate is different from the estimated infiltration rate of buried waste, as the area of interest for plants is the first 15 centimeters of soil.

Equations 6 through 9 are necessary in order to determine the loss of contaminants due to leaching [Yu, et al, 1993]. Equation 21 utilizes default data to obtain an estimated infiltration rate.

Equation 6

$$I = \{1 - C_e\}\{\{1 - C_r\}P_r + I_{rr}\}$$

Where:

- I = Infiltration rate (m/year)
- C_e = Evapotranspiration coefficient (dimensionless)
- C_r = Runoff coefficient (dimensionless)
- P_r = Precipitation rate (m/year)
- I_{rr} = Irrigation rate (m/year)

In order to determine the retardation factor, it is first necessary to calculate the saturation ratio in equation 7.

Equation 7

$$R_s = \{I / K_{sat}\}^{1/\{2b+3\}}$$

Where:

- R_s = Saturation Ratio
- K_{sat} = Hydraulic conductivity (m/year)
- b = soil specific exponential parameter [Yu, et al, 1993][4] (dimensionless)

The retardation factor in equation 8 [Yu, et al, 1993] is the ratio of the pore water velocity to the radionuclide transport velocity.

Equation 8

$$R_d = 1 + \{\rho_b * K_d\} / \{p_t * R_s\}$$

Where:

- R_d = Retardation factor (dimensionless)
- ρ_b = Soil density (g/cm^3)
- p_t = Soil porosity (dimensionless)

[4] The soil-specific b parameter is an empirical parameter used to evaluate the saturation ratio of the soil.

- K_d = Distribution coefficient (cm^3/g)

Equation 9 [Yu, 1993] is used to obtain a time independent estimate of the leach rate in the top 15 centimeters of soil as a result of the application of irrigation water and local precipitation.

Equation 9

$$L = I / \{\theta * T * R_d\}$$

Where:

- L = Leach rate (y^{-1})
- θ = Volumetric water content (dimensionless)
- T = Thickness of contaminated zone (m)

Having obtained the information necessary to calculate the loss term in the soil, equation 10 [Kennedy and Strenge, 1992] calculates the radionuclide deposition rate onto the soil.

Equation 10

$$R_{soil} = \{C_w * IR\} / P_s$$

Where:

- R_{soil} = Average deposition rate onto soil (pCi/kg*d)
- P_s = Aerial soil density (kg/m^2)
- C_w and IR are as defined in Equation 4.

The final concentration at the end of the growing period is shown in equation 11. In order to account for continued deposition over time, equation 11 was modified by taking the time for plant growth to infinity. The resulting equilibrium concentration is simply the deposition rate divided by the leach rate.

Equation 11

$$C_{soil} = R_{soil} / (L * 365) * \{1 - e^{-Lt}\}$$

Where:

- C_{soil} = Radionuclide soil concentration at end of growing period (pCi/kg)

Finally, equation 12 calculates the concentration in the plant due to uptake and resuspension [Kennedy and Strenge, 1992].

Equation 12

$$C_{plant} = \{ML + B\} * W_{d-w} * C_{soil}$$

Where:

- C_{plant} = Radionuclide concentration in plant (pCi/kg)
- ML = Mass loading factor for resuspension of soil to edible portions of plant (dry weight)
- B = Concentration factor for uptake of soil to plant (dry weight basis)
- W_{d-w} = Conversion factor for plants from dry weight to wet weight

The total contaminant concentration in plants, C_{plants}, is the sum of equations 5 and 12. The resulting formula for dose from ingesting contaminated vegetation is as follows:

Equation 13

$$Dose_{plants} = \frac{C_{plants}}{27} * Q_{plants} * DCF * F * 10^8$$

Where:

- $Dose_{plants}$ = Committed effective dose from ingesting contaminated vegetation (mrem/year)
- C_{plants} = Contaminant concentration in plants (pCi/g)
- Q_{plants} = Intake rate of vegetation (kg/year)
- DCF = 50 year committed effective dose conversion factor for ingestion of contaminants (Sv/Bq)
- F = Fraction of contaminated material that is grown
- 10^8 = Converts Sieverts (Sv) to mrem and grams to kilograms
- 27 = Converts pCi to Bq

The fraction of contaminated material that is assumed grown in a particular location is 50% for the resident farmer.

Detailed calculations for dose due to consumption of fruit and vegetables are presented in Attachment 1.

Ingestion of Meat and Dairy Products

The following pathways are considered in the analysis of animal ingestion:

- Ingestion of beef cattle
- Ingestion of milk (dairy cattle)
- Ingestion of poultry

The detailed calculations for each of these livestock groups are presented in Attachment 2.

The animals, in turn, are exposed to contamination via a number of mechanisms. The mechanisms considered are:

- Direct Ingestion of Well Water by Animals
- Animal Ingestion of Plants Contaminated Directly from Irrigation Spray and from Root Uptake and Resuspension of Soil Contamination[5]
- Direct Ingestion of Contaminated Soil

Direct Ingestion of Well Water by Animals

A transfer factor is then utilized to estimate the contaminant concentration in the edible portion of the animal as a result of ingesting contaminated well water. The formula for estimating the concentration in the animal product is as follows:

Equation 14

$$C_{animals,water} = C_W * Q_w * TF$$

Where:

- $C_{animals, water}$ = Concentration in animals due to water intake (pCi/kg)
- C_w = Groundwater concentration (pCi/l)
- Q_w = Intake rate of water by animals (l/d)
- TF = Transfer factor that takes into account the concentration in the edible portion of the animal to the concentration in the water (pCi/kg/pCi/d)

Ingestion of Plants Contaminated Directly from Irrigation Spray and from Root Uptake and Resuspension of Soil Contamination

The plants irrigated for the animals include fresh forage, stored hay, and stored grain. The specific intake of each fraction for an animal generally depends upon the season. However, an average ingestion amount for each animal per food group is utilized for these calculations [Kennedy and Strenge, 1992]. Specific values for each parameter are located in Attachment 1. The methodology for the animal ingestion pathway closely follows that of direct plant ingestion (by humans). The main difference is that humans consume plant material at the end of the growing season, whereas animals consume the plants continuously.

The calculation of the concentration on the plant involves two separate stages. The first stage is the calculation of the contamination on the plant as a result of directly deposited material. The second stage is the calculation of the additional contamination as a result of root uptake and resuspension. The two stages are then added to obtain a combined contaminant concentration on edible plant surfaces.

[5] Animal contamination as a result of direct contamination of waste is not considered, due to the limited contribution potential via this pathway.

The first stage in the calculation of the concentration of the plant is an estimate of the deposition rate. The formula for the deposition rate [Kennedy and Strenge, 1992] is:

Equation 15

$$R = \frac{I_{rr} * r_v * T_v * C_w}{Y_v}$$

Where:

- R = Average deposition rate to edible parts of plant from application of irrigation water (pCi/kg*d)
- I_{rr} = Application rate of irrigation water (L/m²*d)
- r_v = Fraction of initial deposition retained on plant (dimensionless)
- T_v = Translocation factor for transfer of radionuclides from plant surfaces to edible parts (dimensionless)
- C_w = Average concentration in irrigation water (assumed constant) (pCi/l)
- Y_v = Plant yield (kg wet weight/m²)

Following the estimate of the deposition rate, a calculation of the contribution from direct deposition is a first-order linear differential equation. Equation 16 applies to stored grain and hay, as the formula takes into account the accumulation of contamination over the entire growing season. The solution to the equation is as follows:

Equation 16

$$C_{plant,stored} = R / \lambda \left\{1 - e^{-\lambda t}\right\}$$

Where:

- $C_{plant,\ stored}$ = The radionuclide concentration in the plant from deposition onto plant surfaces (pCi/kg)
- λ = Effective weathering and decay constant (d-1)
- t = growth period for plant (d)

For simplicity, losses during the holdup period[6] and consumption period are neglected. This conservative assumption has no significant impact on the dose contribution, as the three radionuclides of interest have long half-lives.

The calculation of the contribution from direct deposition for grasses (fresh forage) takes into account the fact that animals ingest the contaminated grass during the entire growing period. As a result, the amount of contamination ingested is an average of the entire growing period.[7] The solution for this equation is as follows:

[6] The holdup period is the time between produce harvest and consumption.
[7] Equation 15 is derived by integrating equation 14 with respect to time, to yield an average value.

Equation 17

$$C_{plant,direct,avg} = \frac{(\frac{R*t}{\lambda}) - (\frac{R}{\lambda^2} * (1 - e^{(-\lambda*t)}))}{t}$$

Where:

- $C_{plant,direct,avg.}$ = Average plant concentration for fresh forage (pCi/kg)

The second stage of the calculation is the estimate of the concentration in plants resulting from resuspension and root uptake. In order to estimate this contribution, the average soil concentration must first be calculated. This linear differential equation is similar to equation 16, with the exception of the loss term.

Prior to calculating the average soil concentration, the loss due to leaching must be estimated. The loss of contaminants from soil is due to leaching by infiltrating water.

Equations 6 through 9 are used to determine the loss of contaminants due to leaching [Yu, et al, 1993]. Equation 33 [Kennedy and Strenge, 1992] calculates the radionuclide deposition rate onto the soil.

Equation 18

$$R_{soil} = \frac{C_w * I_{rr}}{P_s}$$

Where:

- R_{soil} = Average deposition rate onto soil (pCi/kg*d)
- P_s = Aerial soil density (kg/m²)
- Cw and I_{rr} are as defined in Equation 15.

The final concentration at the end of the growing period is shown in equation 19. In order to account for continued deposition over time, equation 19 was modified by taking the time for plant growth to infinity. The resulting equilibrium concentration is simply the deposition rate divided by the leach rate.

Equation 19

$$C_{soil} = \frac{R_{soil}}{L}\left\{1 - e^{-Lt}\right\}$$

Where:

- C_{soil} = Radionuclide soil concentration at end of growing period (pCi/kg)
- L = Leach Rate (y^{-1})

Finally, equation 20 calculates the concentration in the plant due to uptake and resuspension [Kennedy and Strenge, 1992]:

Equation 20

$$C_{plant,uptake+resuspension} = \{ML + B\} * W_{d-w} * C_{soil}$$

Where:

- $C_{plant, uptake + resuspension}$ = Radionuclide plant concentration (pCi/kg)
- ML = Mass loading factor for resuspension of soil to edible portions of plant
- B = Concentration factor for uptake of soil to plant (dry weight basis)
- W_{d-w} = Conversion factor for plants from dry weight to wet weight

Once the estimated animal feed concentrations have been calculated (equations 16, 17, and 20), the concentration in the edible portion of the animal may then be estimated. The formula for estimating the contribution in the animal due to deposition and uptake from fresh forage is:

Equation 21

$$C_{Animals,forage} = (TF * Q_{a,forage} * f_w) * (C_{plant,direct} + C_{plant,uptake+resuspension})$$

Where:

- $C_{Animals, forage}$ = Concentration in animals as a result of ingesting contaminated fresh forage
- TF = Transfer factor relating the concentration in the edible portion of the animal to the intake concentration (pCi/kg/pCi/d)
- $Q_{a, forage}$ = Consumption rate of fresh forage by animals (Kg/d)
- f_w= Fraction of forage that is contaminated (unitless, 1)

The formula for estimating the concentration in the edible portion of the animal as a result of ingesting stored feed is as follows:

Equation 22

$$C_{Animal,storedfeed} = TF * ((f_w * C_{grain} * Q_{a,grain}) + (f_w * C_{storedhay} * Q_{a,storedhay}))$$

Where:

- $C_{animal, stored feed}$ = Concentration in animals as a result of ingesting stored feed (pCi/kg)
- C_{grain} = Concentration in the grain (pCi/kg)
- $C_{stored hay}$ = Concentration in the stored hay (pCi/kg)

- $Q_{a,\ grain}$ = Consumption rate of grain by the animal (kg/d)
- $Q_{a,\ stored\ hay}$ = Consumption rate of stored hay by the animal (kg/d)

Ingestion of Soil by Animals

Animals inadvertently ingest soil in the process of consuming feed. For this process, the animals are presumed to only ingest soil while consuming fresh forage. The amount of soil ingested is taken to be a fraction of the amount of forage consumed. The formula for the concentration in the edible portion of the animal as a result of ingesting contaminated soil is [Kennedy and Strenge, 1992]:

Equation 23

$$C_{Animals,soil} = TF * f_w * Q_{a,forage} * IF * W_{D-W} * C_{Soil,avg}$$

Where:

- $C_{animals,\ soil}$ = Concentration in animals due to the ingestion of soil (pCi/kg)
- $Q_{a,\ forage}$ = Consumption rate of vegetation by animals (kg/d)
- IF = Intake fraction of soil (unitless)
- $W_{D\text{-}W}$ = Dry to wet weight conversion factor (unitless)
- $C_{soil,\ ave}$ = Average contaminant concentration in soil (pCi/kg)

Overall Contribution from the Animal Pathway

Equations 14, 21, 22, and 23 are combined to obtain an overall contribution for the animal pathway from the ingestion of groundwater well, plants, and soil. The resulting estimated dose is:[8]

Equation 24

$$D_{Animalpathway}^{Humans} = DCF * 365d/y * Q_{h,animalproduct} * \frac{10^5}{27} * (C_{Water}^{Animals} + C_{stored}^{Animals} + C_{forage}^{Animals} + C_{Soil}^{Animals})$$

Where:

- D^{humans} = Dose to humans from the animal ingestion pathway (mrem/year)
- DCF = Dose conversion factor (Sv/Bq)
- $\frac{10^5}{27}$ = Factors to convert Sv to mrem and pCi to Bq
- $Q_{h,\ animal\ product}$ = Consumption rate of specific animal product by humans (kg/d)

[8] Note that the equation is simplified by assuming that no decay occurs during the period of time between harvest and consumption. This assumption is valid, as the radionuclides of interest for the groundwater pathway are very long lived.

Soil Resuspension and Inhalation

Contaminated soil may also result in exposure due to resuspension and subsequent inhalation. This exposure may occur from soil contaminated through irrigation water.

The resuspension factor does depend upon the activities that are being performed by the intruder. The highest dust loading is related to gardening activities, while the lowest is equated to time spent indoors. The equation for calculating the committed effective dose from inhalation is as follows [Kennedy and Strenge, 1992]:

Equation 25

$$Dose_{Inhalation} = [(V_x * t_x * CDO * C_{soil} * DCF) + (V_r * t_i * (CDI + P_d * RF_r) * C_{soil} * DCF)] * 10^5$$

Where:

- V_x = Breathing rate for time spent outdoors (m^3/h)
- t_x = Time spent outdoors during a year (hours)
- CDO = Dust loading for outdoor activities (g/m^3)
- V_r = Breathing rate for time spent indoors (m^3/h)
- t_i = Time spent indoors during a year (hours)
- CDI = Dust loading for indoor activities (g/m^3)
- P_d = Indoor dust loading on floors (g/m^2)
- RF_r = Indoor resuspension factor (per meter)
- DCF = Inhalation committed effective dose, nuclide and age specific (Sv/Bq)
- 10^5 = Conversion from Sv to mrem

The indoor portion of the above equation differs slightly from the outdoor portion, as it includes contributions from materials blown and soil tracked into the house and resuspended [Kennedy and Strenge, 1992]. Detailed calculations for this pathway are presented in Attachment 3.

Ingestion of Fish

The ingestion of fish is included in the groundwater modeling analysis. The scenario assumes that the groundwater contamination leaches into a surface water source and is accumulated in the fish. Calculations for this pathway are presented in Attachment 4.

Equation 26

$$Dose_{fish} = C_w * DF * biofac * U_f * DCF * \frac{100{,}000}{27}$$

Where:

- $Dose_{fish}$ = Dose from fish ingestion

- DF= Dilution factor from groundwater source to surface water source[9] (unitless)
- Biofac = Bioaccumulation factor for uranium in fish (pCi/kg/pCi/L)
- U_f= = Human ingestion of fish (kg/y)
- DCF = Ingestion committed effective dose, nuclide and age specific (Sv/Bq)
- $10^5/27$ = conversion from Sv/Bq to mrem/pCi

Summary:

The following Table summarizes the potential dose to the average member of the critical population from goundwater containing natural U at a concentration of 1 pCi/L. The pathways and parameters chosen for the analysis represent those associated with the resident farmer in accordance with NUREG 5512.

Table 1
Summary of Dose from Groundwater Pathways
Resident Farmer
Groundwater Contamination-Total U 1 pCi/L

Pathway	Dose (mrem/y)
Ingestion of groundwater	8.90 E-02
Ingestion of soil	4.78 E-05
External exposure	9.42 E-05
Ingestion of vegetables	1.68 E-02
Ingestion of meat	2.64 E-03
Ingestion of milk	2.67 E-05
Resuspension/Inhalation of soil	1.51 E-04
Ingestion of fish	1.74 E-03
ALL PATHWAYS	1.11 E-01

The DCGL is calculated by dividing the dose limit of 25 mrem/y by the DCF for all pathways determined above. This results in a DCGL for natural U in groundwater of 226 pCi/L.

Conclusion:

The DCGL for natural U in groundwater is determined to be 226 pCi/L. The determination was made under conservative exposure scenarios. The exposure scenario assumed that the average member of the critically exposed population was the resident farmer. Assumptions and parameters for the calculations are based upon NUREG 5512.

[9] The dilution factor is conservatively assumed to be 10. In reality the dilution factor would be significantly larger than this as the surface water volume large enough to permit the harvest of 10 kg of fish per year would dilute the concentration of the incoming seep or spring by greater than a factor of 10.

This Table Supports Calculations for Ingestion of Fruit, Vegetables, Groundwater, and Soil

Consumption of Fruits and Vegetables													
Parameters	**Uranium 235**				**Uranium 238**				**Uranium 234**				
Intake of:	leafy veg	Other veg	Fruits	grain	leafy veg	Other veg	Fruits	grain	leafy veg	Other veg	Fruits	grain	Reference
Groundwater Concentration (pCi/l)	0.0225	0.0225	0.0225	0.0225	0.489	0.489	0.489	0.489	0.489	0.489	0.489	0.489	
Irrigation Rate (L/m²d)	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	[USNRC, 1994]
isotope decay content (per day)	2.70E-12	2.70E-12	2.70E-12	2.70E-12	4.24E-13	4.24E-13	4.24E-13	4.24E-13	7.71E-09	7.71E-09	7.71E-09	7.71E-09	
weathering constant (per day)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	[USNRC, 1977]
Translocation factor for leafy vegetables	1	1	1	1	1	1	1	1	1	1	1	1	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Translocation factor for other vegetables, fruits, grains	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Fraction of deposited activity initially retained on plant surfaces	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Plant Yield - leafy (kg/m²)	2	2	2	2	2	2	2	2	2	2	2	2	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Plant Yield - other veg	4	4	4	4	4	4	4	4	4	4	4	4	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Plant Yield fruit	2	2	2	2	2	2	2	2	2	2	2	2	
Crop growing period - all fruits, veg, grain (days)	90	90	90	90	90	90	90	90	90	90	90	90	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Plant Yield - grain	1	1	1	1	1	1	1	1	1	1	1	1	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Avg. deposition onto Plants (pCi/kg-d)	0.00585	0.000293	0.000585	0.00117	0.12714	0.006357	0.012714	0.025428	0.12714	0.006357	0.012714	0.025428	Calculated, See Text
Concentration at time of harvest - (pCi/kg)	0.115700247	0.005785	0.011570025	0.02314	2.514552044	0.125728	0.251455	0.50291	2.514552044	0.125728	0.251455	0.50291	Calculated, See Text
Areal soil density (kg/m²)	240	240	240	240	240	240	240	240	240	240	240	240	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Deposition rate onto soil (pCi/kgd)	0.000195	0.000195	0.000195	0.000195	0.004238	0.004238	0.004238	0.004238	0.004238	0.004238	0.004238	0.004238	Calculated, See Text
Evapotranspiration coefficient	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	[USNRC, 1994]
runoff coefficient	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	[USNRC, 1994]
Rainfall (m/y)	1	1	1	1	1	1	1	1	1	1	1	1	[USNRC, 1994]
Irrigation rate (m/y)	0.7592	0.7592	0.7592	0.7592	0.7592	0.7592	0.7592	0.7592	0.7592	0.7592	0.7592	0.7592	[USNRC, 1994]
Infiltration rate (m/y)	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	Calculated, See Text
Total soil porosity	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	[USNRC, 1994]
hydraulic conductivity (m/y)	10	10	10	10	10	10	10	10	10	10	10	10	[USNRC, 1994]
Saturation ratio	0.81927082	0.819271	0.81927082	0.819271	0.81927082	0.819271	0.819271	0.819271	0.81927082	0.819271	0.819271	0.819271	Calculated, See Text
Volumetric water content	0.245781246	0.245781	0.245781246	0.245781	0.245781246	0.245781	0.245781	0.245781	0.245781246	0.245781	0.245781	0.245781	Calculated, See Text
soil density (g/cm^3)	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	[USNRC, 1994]
distribution coefficient (cm^3/g)	15	15	15	15	15	15	15	15	15	15	15	15	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Retardation factor	100.4787048	100.4787	100.4787048	100.4787	100.4787048	100.4787	100.4787	100.4787	100.4787048	100.4787	100.4787	100.4787	Calculated, See Text
Zone thickness (m)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	[USNRC, 1994]
Leach rate (per day)	0.000576587	0.000577	0.000576587	0.000577	0.000576587	0.000577	0.000577	0.000577	0.000576587	0.000577	0.000577	0.000577	Calculated, See Text
Soil Contamination at end of growing season (pCi/kg)	0.33819694	0.338197	0.33819694	0.338197	7.350146832	7.350147	7.350147	7.350147	7.350146832	7.350147	7.350147	7.350147	Calculated, See Text
Plant to soil concentration factor (dry weight)	1.70E-02	1.40E-02	0.004	1.30E-03	1.70E-02	1.40E-02	0.004	0.0013	1.70E-02	1.40E-02	0.004	0.0013	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
mass loading factor for resuspension to edible portions	0.1	0.1	0.01	0	0.1	0.1	0.01	0	0.1	0.1	0.01	0	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Wet to dry conversion factor	0.2	0.25	0.18	0.91	0.2	0.25	0.18	0.91	0.2	0.25	0.18	0.91	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Plant concentration as a result of uptake and resuspension (pCi/kg)	0.007913808	0.009639	0.000852256	0.0004	0.171993436	0.209479	0.018522	0.008695	0.171993436	0.209479	0.018522	0.008695	Calculated, See Text
total plant concentration (pCi/kg)	0.123614056	0.015424	0.012422281	0.02354	2.686545479	0.335207	0.269978	0.511606	2.686545479	0.335207	0.269978	0.511606	Calculated, See Text
Consumption rate of: (kg/y)	11	51	46	69	11	51	46	69	11	51	46	69	[USNRC, 1994]
fraction of diet from garden -considered in consumption rate	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	[USNRC, 1994]
Uptake fraction	1	1	1	1	1	1	1	1	1	1	1	1	
Uptake per year (Bq/y)	0.025180641	0.014567	0.010581943	0.030079	0.547259264	0.316584	0.229981	0.653718	0.547259264	0.316584	0.229981	0.653718	
Dose conversion factor (Sv/Bq)	4.70E-08	4.70E-08	4.70E-08	4.70E-08	4.50E-08	4.50E-08	4.50E-08	4.50E-08	4.90E-08	4.90E-08	4.90E-08	4.90E-08	[ICRP, 1995]
Committed dose (mrem/y)	0.000118349	6.85E-05	4.97351E-05	0.000141	0.002462667	0.001425	0.001035	0.002942	0.00268157	0.001551	0.001127	0.003203	Calculated, See Text
Total Dose (mrem/y)	0.00037792				0.007863942				0.008562959				
Ingestion of Drinking Water	U-235				U-238				U-234				
Groundwater Concentration (pCi/l)	0.0225				0.489				0.489				
DW Intake rate (l/d)	1.4				1.4				1.4				[U.S. EPA, 1997]
Intake Frequency (d/y)	365				365				365				
Uptake per Year (Bq/y)	0.425833333				9.254778				9.254777778				
Dose conversion factor (Sv/Bq)	4.70E-08				4.50E-08				4.90E-08				[ICRP, 1995]
Committed dose (mrem/y)	0.002001417				0.0416465				0.045348411				
Soil Ingestion Contribution													
	U-235				U-238				U-234				
Soil ingestion rate - gardening (mg/hr)	18.25				18.25				18.25				[USNRC, 1994]
Dose conversion factor (Sv/Bq)	4.70E-08				4.50E-08				4.90E-08				
Soil concentration at eqlb (pCi/kg)	3.38E-01				7.35E+00				7.35E+00				
Dose (mrem/y)	**1.0744E-06**				**2.23567E-05**				**2.4344E-05**				
Direct Radiation Contribution													
Dose Coefficient (Sv*m^3/Bq*s)	3.75E-18				5.52E-22				2.14E-21				
Exposure time (s)	6.62E+06				6.62E+06				6620000				[USNRC, 1994]
Indoor Soil Shielding factor	0.33				0.33				0.33				[USNRC, 1994]
Exposure time indoors (s)	1.73E+07				1.73E+07				1.73E+07				[USNRC, 1994]
Direct Radiation Dose (mrem/y)	**9.2715E-05**				**2.966E-07**				**1.1499E-06**				
Total Dose (mrem/y)	U-235 **0.00257555**				U-238 **0.051662823**				U-234 **0.05626379**				
Release limit for a resident farmer (pCi/l)	226												

REFERENCES

ICRP, Age-Dependent Doses to Members of the Public From Intake of Radionuclides: Part 5 Compilation of Ingestion and Inhalation Dose Coefficients, ICRP Publication 72, Oxford, Pergamon Press, 1995.
Kennedy, W.E., Jr. and D.L. Strenge, Residual Radioactive Contamination from Decommissioning: Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent, NUREG/CR-5512, PNL-7994, Washington, D.C., 1992
U.S. EPA, Exposure Factors Handbook, U.S. EPA/600/P-95/002, Washington, D.C., 1997.
U.S. NRC, Policy and Guidance Directive PG-8-08, Scenarios for assessing potential doses associated with residual radioactivity, May 1994.
U.S. NRC (U.S. Nuclear Regulatory Commission), Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Regulatory Guide 1.109, Rev.1, U.S. NRC, Washington, D.C., 1977.
Yu, C., Zielen, A.J., Cheng, J.J., Yuan, Y.C., Jones, L.G., LePoire, D.J., Wang, Y.Y., Loureiro, C.O., Gnanapragasam, E., Faillace, E., Wallo III, A., Williams, W.A., and Peterson, H.

Attachment 2
Rural Residential Irrigation Analysis

This table supports calculations for beef cattle
Direct Plant Contamination from Irrigation Spray and Indirect via root uptake (and rainsplash)

Parameters	Uranium 235			Uranium 238			Uranium 234			
Intake of:	grasses/forage	stored hay	grain	grasses/forage	stored hay	grain	grasses/forage	stored hay	grain	Reference
Groundwater Concentration (pCi/l)	0.0225	0.0225	0.0225	0.489	0.489	0.489	0.489	0.489	0.489	
Irrigation Rate (L/m²d)	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	
isotope decay content (per day)	2.70E-12	2.70E-12	2.70E-12	4.24E-13	4.24E-13	4.24E-13	7.71E-09	7.71E-09	7.71E-09	
weathering constant (per day)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Translocation factor	1	0.1	0.1	1	0.1	0.1	1	0.1	0.1	
Fraction of deposited activity retained on plant surfaces	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
Plant Yield (kg/m²)	1.5	1	1	1.5	1	1	1.5	1	1	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Crop growing period - (days)	30	45	90	30	45	90	30	45	90	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Avg. deposition onto Plants (pCi/kg-d)	0.0078	0.00117	0.00117	0.16952	0.025428	0.025428	0.16952	0.025428	0.025428	
Concentration at time of harvest - (pCi/kg)	0.1211917	0.0209337	0.02314005	2.6338995	0.45495817	0.5029104	2.63389951	0.45495817	0.502910409	
Average concentration from direct deposition for animal consumption (pCi/kg)*	**0.0752055**	**0.0209337**	**0.02314005**	**1.634467**	**0.45495817**	**0.5029104**	**1.634467**	**0.45495817**	**0.502910409**	
Areal soil density (kg/m²)	240	240	240	240	240	240	240	240	240	
Deposition rate onto soil (pCi/kg*d)	0.000195	0.000195	0.000195	0.004238	0.004238	0.004238	0.004238	0.004238	0.004238	
Evapotranspiration coefficient	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
runoff coefficient	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
Rainfall (m/y)	1	1	1	1	1	1	1	1	1	
Irrigation rate (m/y)	0.7592	0.7592	0.7592	0.7592	0.7592	0.7592	0.7592	0.7592	0.7592	
Infiltration rate	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	
Total soil porosity	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
hydraulic conductivity (m/y)	10	10	10	10	10	10	10	10	10	
Saturation ratio	0.8192708	0.8192708	0.81927082	0.8192708	0.81927082	0.8192708	0.81927082	0.81927082	0.81927082	
Volumetric water content	0.2457812	0.2457812	0.24578125	0.2457812	0.24578125	0.2457812	0.24578125	0.24578125	0.245781246	
soil density (g/cm^3)	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	
distribution coefficient (cm^3/g)	15	15	15	15	15	15	15	15	15	
Retardation factor	100.4787	100.4787	100.478705	100.4787	100.478705	100.4787	100.478705	100.478705	100.4787048	
Zone thickness (m)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	
Leach rate (per day)	0.0005766	0.0005766	0.00057659	0.0005766	0.00057659	0.0005766	0.00057659	0.00057659	0.000576587	
Soil Contamination at eqlb (pCi/kg)	0.3381969	0.3381969	0.33819694	7.3501468	7.35014683	7.3501468	7.35014683	7.35014683	7.350146832	
Plant to soil concentration factor (dry weight)	1.70E-02	1.70E-02	1.30E-03	1.70E-02	1.70E-02	0.0013	1.70E-02	1.70E-02	0.0013	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
mass loading factor for resuspension to edible portions	0.1	0.1	0	0.1	0.1	0	0.1	0.1	0	
Wet to dry conversion factor	0.22	0.22	0.91	0.22	0.22	0.91	0.22	0.22	0.91	
Plant concentration as a result of uptake and resuspension (pCi/kg)	**0.0087052**	**0.0087052**	**0.00040009**	**0.1891928**	**0.18919278**	**0.0086952**	**0.18919278**	**0.18919278**	**0.008695224**	
total plant concentration (pCi/kg)	0.0839107	0.0296388	0.02354014	1.8236598	0.64415095	0.5116056	1.82365978	0.64415095	0.511605632	
Consumption rate of: (kg/d)	41.72	21.6	4.63	41.72	21.6	4.63	41.72	21.6	4.63	[USNRC, 1994] based upon fraction contribution from NUREG 5512
Contamination fraction	1	1	1	1	1	1	1	1	1	
Animal product transfer factor	0.0002	0.0002	0.0002	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	2.00E-04	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Animal Ingestion of Soil (from fresh forage)										
Deposition rate onto soil (pCi/kg*d)	0.000195			0.004238			0.004238			
Soil intake fractions (of forage diet, dry wt)	0.02			0.02			0.02			
Average concentration in soil consumed by animals (pCi/kg*d)	**0.3381969**			**7.3501468**			**7.35014683**			
transfer factor relating concentration in edible portion of animal to intake concentration	0.0002			2.00E-04			2.00E-04			
consumption rate of fresh forage (kg/d)	41.72			41.72			41.72			
fraction of forage contaminated	1			1			1			
Avg. concentration at time of forage intake by animal (pCi/kg)	0.0007126			0.0154865			0.01548647			
Concentration in edible portion of animal at time of intake for stored food (pCi/kg)	0.0001498			0.0032565			0.00325648			
Ingestion of Water	Uranium 235			Uranium 238			Uranium 234			
Groundwater Concentration (pCi/l)	0.0225			0.489			0.489			
Intake rate (l/d)	50			50			50			[USNRC, 1994]
Intake Frequency (d/y)	365.25			365.25			365.25			
Concentration in edible portion of animal due to water intake (pCi/kg)	0.000225			0.00489			0.00489			
Total concentration in edible portion of animal (pCi/kg)	0.0010874			0.0236329			0.02363295			
Consumption rate by humans (kg/d)	0.162			0.162			0.162			[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Total intake (Bq/y)	**0.002383**			**0.0517916**			**0.0517916**			
Dose conversion factor (Sv/Bq)	4.70E-08			4.50E-08			4.90E-08			
Committed Effective Dose (mrem)	**1.12E-05**			**0.0002331**			**0.00025378**			

Attachment 2
Rural Residential Irrigation Analysis

This table supports calculations for dairy cattle

Direct Plant Contamination from Irrigation Spray and Indirect via root uptake (and rainsplash)

Parameters	Uranium 235			Uranium 238			Uranium 234		
Intake of:	grasses/for	stored hay	grain	grasses/for	stored hay	grain	grasses/for	stored hay	grain
Groundwater Concentration (pCi/l)	0.0225	0.0225	0.0225	0.489	0.489	0.489	0.489	0.489	0.489
Irrigation Rate (L/m²d)	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08
isotope decay content (per day)	2.70E-12	2.70E-12	2.70E-12	4.24E-13	4.24E-13	4.24E-13	7.71E-09	7.71E-09	7.71E-09
weathering constant (per day)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Translocation factor	1	0.1	0.1	1	0.1	0.1	1	0.1	0.1
Fraction of deposited activity retained on plant surfaces	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Plant Yield (kg/m²)	1.5	1	1	1.5	1	1	1.5	1	1
Crop growing period - (days)	30	45	90	30	45	90	30	45	90
Avg. deposition onto Plants (pCi/kg-d)	0.0078	0.00117	0.00117	0.16952	0.025428	0.025428	0.16952	0.025428	0.025428
Concentration at time of harvest - (pCi/kg)	0.1211917	0.0209337	0.02314005	2.6338995	0.45495817	0.5029104	2.63389951	0.45495817	0.502910409
Average concentration from direct deposition for animal consumption (pCi/kg)*	0.0752055	0.0209337	0.02314005	1.634467	0.45495817	0.5029104	1.634467	0.45495817	0.502910409
Areal soil density (kg/m²)	240	240	240	240	240	240	240	240	240
Deposition rate onto soil (pCi/kg*d)	0.000195	0.000195	0.000195	0.004238	0.004238	0.004238	0.004238	0.004238	0.004238
Evapotranspiration coefficient	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
runoff coefficient	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Rainfall (m/y)	1	1	1	1	1	1	1	1	1
Irrigation rate (m/y)	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796
Infiltration rate	0.7898	0.7898	0.7898	0.7898	0.7898	0.7898	0.7898	0.7898	0.7898
Total soil porosity	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
hydraulic conductivity (m/y)	10	10	10	10	10	10	10	10	10
Saturation ratio	0.8201032	0.8201032	0.82010324	0.8201032	0.82010324	0.8201032	0.82010324	0.82010324	0.820103236
Volumetric water content	0.246031	0.246031	0.24603097	0.246031	0.24603097	0.246031	0.24603097	0.24603097	0.246030971
soil density (g/cm^3)	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
distribution coefficient (cm^3/g)	15	15	15	15	15	15	15	15	15
Retardation factor	100.37773	100.37773	100.377732	100.37773	100.377732	100.37773	100.377732	100.377732	100.3777324
Zone thickness (m)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Leach rate (per day)	0.0005841	0.0005841	0.00058413	0.0005841	0.00058413	0.0005841	0.00058413	0.00058413	0.000584125
Soil Contamination at eqlb (pCi/kg)	0.3338326	0.3338326	0.33383262	7.2552955	7.25529554	7.2552955	7.25529554	7.25529554	7.255295536
Plant to soil concentration factor (dry weight)	0.017	0.017	0.0013	0.017	0.017	0.0013	0.017	0.017	0.0013
mass loading factor for resuspension to edible portions	0.1	0.1	0	0.1	0.1	0	0.1	0.1	0
Wet to dry conversion factor	0.22	0.22	0.91	0.22	0.22	0.91	0.22	0.22	0.91
Plant concentration as a result of uptake and resuspension (pCi/kg)	0.0085929	0.0085929	0.00039492	0.1867513	0.18675131	0.008583	0.18675131	0.18675131	0.008583015
total plant concentration (pCi/kg)	0.0837984	0.0295265	0.02353497	1.8212183	0.64170948	0.5114934	1.8212183	0.64170948	0.511493423
Consumption rate of: (kg/d)	29.6	23.8	1.64	29.6	23.8	1.64	29.6	23.8	1.64
Uptake fraction	1	1	1	1	1	1	1	1	1
Animal product transfer factor	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06	5.00E-06
Animal Ingestion of Soil (from fresh forage)									
Deposition rate onto soil (pCi/kg*d)	0.000195			0.004238			0.004238		
Soil intake fractions (of forage diet, dry wt)	0.02			0.02			0.02		
Average concentration in soil consumed by animals (pCi/kg*d)	0.3338326			7.2552955			7.25529554		
transfer factor relating concentration in edible portion of animal to intake concentration	0.000005			5.00E-06			5.00E-06		
consumption rate of fresh forage (kg/d)	29.6			29.6			29.6		
fraction of forage contaminated	1			1			1		
Avg. concentration at time of forage intake by animal (pCi/kg)	**1.262E-05**			**0.0002743**			**0.00027426**		
Concentration in edible portion of animal at time of intake for stored food (pCi/kg)	3.707E-06			8.056E-05			8.0558E-05		
Ingestion of Water	Uranium 235			Uranium 238			Uranium 234		
Groundwater Concentration (pCi/l)	0.0225			0.489			0.489		
Intake rate (l/d)	160			160			160		
Intake Frequency (d/y)	365.25			365.25			365.25		
Concentration in edible portion of animal due to water intake (pCi/kg)	0.000018			0.0003912			0.0003912		
Total concentration in edible portion of animal (milk) (pCi/kg)	3.433E-05			0.000746			0.00074602		
Consumption rate by humans (of milk) (l/d)	0.273973			0.273973			0.273973		
Total Intake (Bq/y)	**0.0001272**			**0.0027649**			**0.00276494**		
Dose conversion factor (Sv/Bq ICRP 72)	4.70E-08			4.50E-08			4.90E-08		
Committed Effective Dose (mrem)	**5.979E-07**			**1.244E-05**			**1.3548E-05**		

Attachment 2
Rural Residential Irrigation Analysis

This table supports calculations for Poultry

Direct Plant Contamination from Irrigation Spray and Indirect via root uptake (and rainsplash)

Parameters	Uranium 235			Uranium 238			Uranium 234		
Intake of:	grasses/for	stored hay	grain	grasses/fo	stored hay	grain	grasses/for	stored hay	grain
Groundwater Concentration (pCi/l)	0.0225	0.0225	0.0225	0.489	0.489	0.489	0.489	0.489	0.489
Irrigation Rate (L/m²d)	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08	2.08
isotope decay content (per day)	2.695E-12	2.695E-12	2.6951E-12	4.245E-13	4.2446E-13	4.245E-13	7.7127E-09	7.7127E-09	7.71273E-09
weathering constant (per day)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Translocation factor	1	0.1	0.1	1	0.1	0.1	1	0.1	0.1
Fraction of deposited activity retained on plant surfaces	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Plant Yield (kg/m²)	1	1	1	1	1	1	1	1	1
Crop growing period - (days)	30	45	90	30	45	90	30	45	90
Avg. deposition onto Plants (pCi/kg-d)	0.0117	0.00117	0.00117	0.25428	0.025428	0.025428	0.25428	0.025428	0.025428
Concentration at time of harvest - (pCi/kg)	0.1817875	0.0209337	0.02314005	3.9508493	0.45495817	0.5029104	3.95084926	0.45495817	0.502910409
Average concentration from direct deposition for animal consumption (pCi/kg)*	0.1128083	0.0209337	0.02314005	2.4517005	0.45495817	0.5029104	2.45170049	0.45495817	0.502910409
Areal soil density (kg/m²)	240	240	240	240	240	240	240	240	240
Deposition rate onto soil (pCi/kg*d)	0.000195	0.000195	0.000195	0.004238	0.004238	0.004238	0.004238	0.004238	0.004238
Evapotranspiration coefficient	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
runoff coefficient	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Rainfall (m/y)	1	1	1	1	1	1	1	1	1
Irrigation rate (m/y)	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796	0.7796
Infiltration rate	0.7898	0.7898	0.7898	0.7898	0.7898	0.7898	0.7898	0.7898	0.7898
Total soil porosity	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
hydraulic conductivity (m/y)	10	10	10	10	10	10	10	10	10
Saturation ratio	0.8201032	0.8201032	0.82010324	0.8201032	0.82010324	0.8201032	0.82010324	0.82010324	0.820103236
Volumetric water content	0.246031	0.246031	0.24603097	0.246031	0.24603097	0.246031	0.24603097	0.24603097	0.246030971
soil density (g/cm^3)	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
distribution coefficient (cm^3/g)	15	15	15	15	15	15	15	15	15
Retardation factor	100.37773	100.37773	100.377732	100.37773	100.377732	100.37773	100.377732	100.377732	100.3777324
Zone thickness (m)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Leach rate (per day)	0.0005841	0.0005841	0.00058413	0.0005841	0.00058413	0.0005841	0.00058413	0.00058413	0.000584125
Soil Contamination at eqlb (pCi/kg)	0.3338326	0.3338326	0.33383262	7.2552955	7.25529554	7.2552955	7.25529554	7.25529554	7.255295536
Plant to soil concentration factor (dry weight)	0.017	0.017	0.0013	0.017	0.017	0.0013	0.017	0.017	0.0013
mass loading factor for resuspension to edible portions	0.1	0.1	0	0.1	0.1	0	0.1	0.1	0
Wet to dry conversion factor	0.22	0.22	0.91	0.22	0.22	0.91	0.22	0.22	0.91
Plant concentration as a result of uptake and resuspension (pCi/kg)	0.0085929	0.0085929	0.00039492	0.1867513	0.18675131	0.008583	0.18675131	0.18675131	0.008583015
total plant concentration (pCi/kg)	0.1214012	0.0295265	0.02353497	2.6384518	0.64170948	0.5114934	2.6384518	0.64170948	0.511493423
Consumption rate of: (kg/d)	0.13	0	0.09	0.13	0	0.09	0.13	0	0.09
Uptake fraction	1		1	1	1	1	1	1	1
Animal product transfer factor	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Animal Ingestion of Soil (from fresh forage)									
Deposition rate onto soil (pCi/kg*d)	0.000195			0.004238			0.004238		
Soil intake fractions (of forage diet, dry wt)	0.1			0.1			0.1		
Average concentration in soil consumed by animals (pCi/kg*d)	0.3338326			7.2552955			7.25529554		
transfer factor relating concentration in edible portion of animal to intake concentration	1.2			1.2			1.2		
consumption rate of fresh forage (kg/d)	0.13			0.13			0.13		
fraction of forage contaminated	1			1			1		
Avg. concentration at time of forage intake by animal (pCi/kg)	0.0200843			0.4364987			0.43649866		
Concentration in edible portion of animal at time of intake for stored food (pCi/kg)	0.0025418			0.0552413			0.05524129		
Ingestion of Water	Uranium 235			Uranium 238			Uranium 234		
Groundwater Concentration (pCi/l)	0.0225			0.489			0.489		
Intake rate (l/d)	0.3			0.3			0.3		
Intake Frequency (d/y)	365.25			365.25			365.25		
Concentration in edible portion of animal due to water intake (pCi/kg)	0.0081			0.17604			0.17604		
Total concentration in edible portion of animal (pCi/kg)	0.0307261			0.6677799			0.66777995		
Consumption rate by humans (kg/d)	0.024658			0.024658			0.024658		
Total Intake (Bq/y)	**0.0102492**			**0.22275**			**0.22274998**		
Dose conversion factor (Sv/Bq ICRP 72)	4.70E-08			4.50E-08			4.90E-08		
Committed Effective Dose (mrem)	**4.817E-05**			**0.0010024**			**0.00109147**		
Effective Dose per Isotope	**5.997E-05**			**0.0012479**			**0.0013588**		

Attachment 3
Inhalation

Inhalation dose estimates as a result of irrigated soil contamination dispersed over an area on site												
Isotope	Concentration (pCi/g)	Concentration (Bq/g)	Dose conversion factor (Sv/Bq)	Time spent indoors (d/y)	Time spent outdoors (d/y)	Breathing rate for time indoors or out (m^3/hr)	Dust loading indoors (g/m^3)	Dust Loading Outdoors (g/m^3)	Indoor dust loading on floors (g/m²)	Indoor resuspension factor (per meter)	Dose Estimate (CED) (Sv/y)	Dose Estimate (CED) (mrem/y)
U-235	0.000338197	1.25258E-05	3.10E-06	200.88	76.7	1.2	0.00005	0.0002	0.4	0.00005	3.29E-11	3.28799E-06
U-238	0.007350147	0.000272228	2.90E-06	200.88	76.7	1.2	0.00005	0.0002	0.4	0.00005	6.68E-10	6.68488E-05
U-234	0.007350147	0.000272228	3.50E-06	200.88	76.7	1.2	0.00005	0.0002	0.4	0.00005	8.07E-10	8.06796E-05
Reference			[ICRP, 1995]	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]	[USNRC, 1994]	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]	[USNRC, 1994]	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]		

NOTE: THE TIME ESTIMATES ARE FOR THE RESIDENT FARMER

Attachment 4
Fish

Ingestion of fish for the resident farmer				
Parameter	**U-235**	**U-238**	**U-234**	**Reference**
Groundwater Concentration (pCi/l)	0.0225	0.489	0.489	
Dilution factor	10	10	10	Conservative Value based on Professional Judgment
Biofactor (pCi/kg/pCi/L)	10	10	10	[Yu, C., et.al.., 1993]
Ingestion rate of fish (kg/y)	10	10	10	[Kennedy, W.E.Jr., and Strenge, D.L., 1992]
Dose conversion factor (Sv/Bq)	4.70E-08	4.50E-08	4.90E-08	ICRP72
Committed dose (mrem/y)	3.92E-05	8.15E-04	8.87E-04	

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TECHNICAL MEMORANDUM

April 3, 2001

Originator: Harry J. Newman, CHP, Technical Director

Subject: Subsurface Uranium DCGLw for KMTC Test Pit Area

Revision: 1

ENDORSEMENT: This document contains the results of research and technical analysis which have been reviewed and approved for publication by the Technical Director, NEXTEP Environmental, Inc.

H Newman 4/4/01

Harry J. Newman, CHP, Technical Director — Date

Introduction

The unrestricted uranium release limit (DCGLw) for total uranium in subsurface soils in the test pit area is calculated and outlined in this technical memo.

General Method for Calculating Release Limits

The software code RESRAD[1] was used to provide pathway modeling, incorporating guidance on parameter values contained in NRC Policy and Guidance Directive PG-8-08[2] and the "Method for Surveying and Averaging Concentrations of Thorium in Contaminated Subsurface Soil"[3]. Where specific guidance was not provided, and sufficient justification for appropriate alternate parameter values are presented and justified, conservative modeling parameters were selected such as the default values from RESRAD. The computer code DandD[4] is acknowledged as the default code for performing calculations to support release criteria for decommissioning activities by the USNRC. However, the DandD code lacks the ability to model complex soil columns for contaminant transport considerations, thus making the RESRAD code the preferred code for the Technical Center analysis.

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[1] Yu, C., A.J. Zielen, J.J. Cheng, Y.C. Yuan, L.G. Jones, D.J. LePoire, Y.Y. Wang, C.O. Loureiro, E. Gnanapragasam, E. Faillace, A. Wallo III, W.A. Williams, and H. Peterson, *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.61*, ANL/EAD/LD-2, Argonne National laboratory, Argonne, Illinois, 1993.

[2] USNRC. Scenarios for Assessing Potential Doses Associated with Residual Radioactivity. Policy and Guidance Directive PG-8-08.

[3] USNRC. 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". 1997.

[4] USNRC. DandD computer code to support license termination, version 1.0. Sandia National Laboratory.

The following bullets describe key parameters and criteria used for this modeling.

- **Subsurface modeling** – The depth criteria for subsurface soil access is usually limited to 3 meters as it is based upon the depth one would expect an individual to dig while building a house with a basement. This 3 meter depth for a basement is itself conservative as recent building code requirements for access and egress from a basement dictate that a seven-foot excavation (excluding footings) depth is reasonable for new construction homes. The residual contamination within the Technical Center Test Pit area is at least 12 feet below the ground surface. Therefore, the material should remain essentially in place at the present location. This reduces the potential for external exposure of individuals and limits the available material that could be inhaled or ingested to waterborne pathways.

- **Saturated hydraulic conductivity** –The bottom of the Test Pit lies within the Renfrow Series, which are naturally well drained with low permeability. These upper zone soils result in a water bearing zone that produces little water and movement. Beneath the Hennessey Group shales lies the Garber-Wellington aquifer. This layer is described as orange-brown to red-brown fine-grained sandstone, irregularly bedded with red-brown shale and some chert and mudstone conglomerate[5]. This highly compacted layer is characterized as a sandy clay with a hydraulic conductivity of less than 100 ft/year[6]. In this analysis, a conservative saturated hydraulic conductivity value of 70 m/y[7] is used to account for potentially greater velocities due to fractured flow.

- **Distribution coefficient (Kd)** – NUREG 5512 default Kd values are used, except for the lower unsaturated soil layer, where the recommended Kd value for clay from Sheppard and Thibault[8] is used.

  In order to aid in more accurately classifying the unsaturated soil layers, a grain size and hydrometer analysis was performed on an upper soil sample representing the top meter of soil and a lower soil sample above the saturated soil column. The results of this analysis are included as Attachment 1. Classifying the soils in a manner similar to Sheppard and Thibault, the upper soil is classified as a clay loam with similar sized fractions of sand, clay and silt. The lower soil of the unsaturated soil column is similarly classified as a silty clay with a silt sized fraction of 58% and a clay sized fraction of 40%. The limited permeability and significant fraction of silt and clay sized particles in the unsaturated soil column provide an indication of the conservative nature of the use of the default Kds for the upper soil column.

<u>Soil Release Limit for bottom of the Uranium Test Pit</u>

The test pit and associated test cylinder removal area encompass an area of 22.7 m x 2.2 m, or 50 m^2 at a depth below ground surface of approximately 3.66 m. Attachment 2 provides the output of the RESRAD run supporting the dose concentration guide level (DCGLw) for the modeling of the residual

[5] Decommissioning Plan for Kerr-McGee Technical Center, March 2001.
[6] Personal communication with Roy Widman and Jim Crawford, Kerr-McGee, 12/6/00.
[7] Table E.2, RESRAD manual.
[8] Sheppard, M.I. and Thibault, D.H. Default soil solid/liquid partition coefficients, Kds, for four major soil types: a compendium. Health Physics. Vol. 59 (4), pp. 471-482. 1990. This reference is predominately used as the reference for the Kd recommendations from RESRAD.

contamination at the bottom of the Test Pit area. The results predict a peak dose of 0.2225 mrem/y/pCi/g total uranium (in equilibrium), or an 110 pCi/g limit to meet a 25 mrem/y standard.

Conclusions/Recommendations

The results for the release limit (DCGLw) for the Test Pit bottom are summarized in Table 1.

Table 1

Subsurface Uranium Release Limits for KMTC Test Pit

Application	Dose Conversion Factor (mrem/y/pCi/g)	Concentration for a 25 mrem/y limit (pCi/g)
Uranium Test Pit	0.2225	110

The assumptions used in calculating the dose from a given concentration of uranium are intended to apply to the average member of a critical group (resident farmer). The groundwater pathway is the most significant exposure pathway for this case. Dose in this case is limited by the volume of material that is potentially contaminated at the bottom of the test pit area.

STANDARD TESTING AND ENGINEERING COMPANY

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CA77 Exp. 06/30/01

Area Offices

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5358 S. 125TH EAST AVE., STE B	TULSA, OK 74146	(918) 459-2700

Acct. No:	0220CIM11 File No: CIM11		
Report Date:	12/19/00	Date Sampled:	11/20/00
Project:	Client Information	Sampled By:	Mike G.
Location:	Tech Center 778.1-110.2	By Order Of:	Karen Morgan
Arch./Engr:		Order No:	
Client:	Cimarron Corp.	Quantity Represented:	Red Sandy Clayey Silt
REPORT:	GRAIN SIZE ANALYSIS OF SOILS	LAB NO:	E-2487
Specification:		Test Method:	ASTM D422

TEST RESULTS

SIEVE ANALYSIS	
SIEVE SIZE	PERCENT PASSING
No. 4	100.0
No. 10	100.0
No. 40	99.5
No. 200	97.9
HYDROMETER ANALYSIS	
SMALLER THAN	PERCENT
0.074 mm	97.4
0.005 mm	39.9
0.001 mm	21.9

Charge: Cimarron Corp. Attn: Karen Morgan
Orig. Same
1-cc Laboratory

Unit Rates for this Report		
Units	@	Amount
S506 @ 100.00		
S504 @ 45.00		

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5358 S. 125TH EAST AVE., STE B — TULSA, OK 74146 — (918) 459-2700

Acct. No: 0220CIM11 File No: CIM11
Report Date: 12/19/00
Project: Client Information
Location: Tech Center 777-112.5
Arch./Engr:
Client: Cimarron Corp.

Date Sampled: 11/20/00
Sampled By: Mike G.
By Order Of: Karen Morgan
Order No:
Quantity Represented: Red Clayey Sandy Silt

REPORT: GRAIN SIZE ANALYSIS OF SOILS
Specification:

LAB NO: E-2488
Test Method: ASTM D422

TEST RESULTS

SIEVE ANALYSIS	
SIEVE SIZE	PERCENT PASSING
No. 4	100.0
No. 10	100.0
No. 40	97.7
No. 200	63.9
HYDROMETER ANALYSIS	
SMALLER THAN	PERCENT
0.074 mm	63.3
0.005 mm	21.2
0.001 mm	15.4

Charge: Cimarron Corp. Attn: Karen Morgan
Orig. Same
1-cc Laboratory

Unit Rates for this Report		
Units	@	Amount
S506	@	100.00
S504	@	45.00

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: Default.LIB

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pb-210+D	1.380E-02	1.380E-02	DCF2(3)
B-1	Po-210	9.400E-03	9.400E-03	DCF2(4)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(5)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(6)
B-1	U-234	1.320E-01	1.320E-01	DCF2(7)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(8)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(9)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pb-210+D	5.370E-03	5.370E-03	DCF3(3)
D-1	Po-210	1.900E-03	1.900E-03	DCF3(4)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(5)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(6)
D-1	U-234	2.830E-04	2.830E-04	DCF3(7)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(8)
D-1	U-238+D	2.690E-04	2.690E-04	DCF3(9)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)
D-34				
D-34	Po-210 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(4,1)
D-34	Po-210 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(4,2)
D-34	Po-210 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.400E-04	3.400E-04	RTF(4,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(7,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(7,3)

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: Default.LIB

Menu	Parameter	Current Value	Default	Parameter Name
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(8,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(8,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(9,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(9,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Po-210 , fish	1.000E+02	1.000E+02	BIOFAC(4,1)
D-5	Po-210 , crustacea and mollusks	2.000E+04	2.000E+04	BIOFAC(4,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(5,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(6,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(6,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(7,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(7,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(8,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(8,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(9,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(9,2)

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+02	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.000E-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)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	2.000E+01	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)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/q): Ac-227	2.250E-02	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/q): Pa-231	2.250E-02	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/q): Pb-210	4.890E-01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/q): Po-210	4.890E-01	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/q): Ra-226	4.890E-01	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/q): Th-230	4.890E-01	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/q): U-234	4.890E-01	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/q): U-235	2.250E-02	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/q): U-238	4.890E-01	0.000E+00	---	S1(9)
R012	Concentration in groundwater (pCi/L): Ac-227	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Pa-231	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Pb-210	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Po-210	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Th-230	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(9)
R013	Cover depth (m)	3.660E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.630E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.000E-03	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-05	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
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	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**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

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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 field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	7.000E+01	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	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
R015	Number of unsaturated zone strata	0	1	---	NS
R016	Distribution coefficients for Ac-227				
R016	Contaminated zone (cm**3/g)	4.200E+02	2.000E+01	---	DCNUCC(1)
R016	Saturated zone (cm**3/g)	4.200E+02	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.278E-03	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Pa-231				
R016	Contaminated zone (cm**3/g)	5.100E+02	5.000E+01	---	DCNUCC(2)
R016	Saturated zone (cm**3/g)	5.100E+02	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.876E-03	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Pb-210				
R016	Contaminated zone (cm**3/g)	2.700E+02	1.000E+02	---	DCNUCC(3)
R016	Saturated zone (cm**3/g)	2.700E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.543E-03	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Po-210				
R016	Contaminated zone (cm**3/g)	1.500E+02	1.000E+01	---	DCNUCC(4)
R016	Saturated zone (cm**3/g)	1.500E+02	1.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.374E-03	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCC(5)
R016	Saturated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.914E-03	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Th-230				
R016	Contaminated zone (cm**3/q)	3.200E+03	6.000E+04	---	DCNUCC(6)
R016	Saturated zone (cm**3/q)	3.200E+03	6.000E+04	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.991E-04	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/q)	1.500E+01	5.000E+01	---	DCNUCC(7)
R016	Saturated zone (cm**3/q)	1.500E+01	5.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.316E-02	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/q)	1.500E+01	5.000E+01	---	DCNUCC(8)
R016	Saturated zone (cm**3/q)	1.500E+01	5.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.316E-02	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/q)	1.500E+01	5.000E+01	---	DCNUCC(9)
R016	Saturated zone (cm**3/q)	1.500E+01	5.000E+01	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.316E-02	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R017	Inhalation rate (m**3/yr)	1.051E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (q/m**3)	2.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	5.000E+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	>0 shows circular AREA.	FS
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

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.660E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.100E+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-01	FPLANT
R018	Contamination fraction of meat	-1	-1	0.500E-02	FMEAT
R018	Contamination fraction of milk	-1	-1	0.500E-02	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
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
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
C14	DCF correction factor for gaseous forms of C14	not used	1.234E+02	---	CO2F
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	---	FLOOR1
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 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)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	9	---	---	LYMAX
TITL	Maximum number of integration points for risk	1	---	---	KYMAX

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
Find peak pathway doses	active

Contaminated Zone Dimensions

Area:	100.00 square meters
Thickness:	0.50 meters
Cover Depth:	3.66 meters

Initial Soil Concentrations, pCi/q

Ac-227	2.250E-02
Pa-231	2.250E-02
Pb-210	4.890E-01
Po-210	4.890E-01
Ra-226	4.890E-01
Th-230	4.890E-01
U-234	4.890E-01
U-235	2.250E-02
U-238	4.890E-01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 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):	1.527E-01	1.552E-01	1.614E-01	1.788E-01	2.020E-01	2.158E-01	2.840E-02	4.786E-02
M(t):	6.107E-03	6.207E-03	6.458E-03	7.151E-03	8.080E-03	8.630E-03	1.136E-03	1.914E-03

Maximum TDOSE(t): 2.225E-01 mrem/yr at t = 190.5 ± 0.4 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 = 1.905E+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	f:
Ac-227	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
Pa-231	2.436E-31	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
Pb-210	1.001E-30	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
Po-210	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
Ra-226	5.259E-21	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
Th-230	5.320E-22	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
U-234	7.083E-26	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
U-235	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
U-238	6.453E-30	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
Total	5.791E-21	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

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.905E+02 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathw.	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	f:
Ac-227	2.219E-06	0.0000	2.662E-09	0.0000	0.000E+00	0.0000	4.363E-08	0.0000	9.927E-12	0.0000	1.638E-11	0.0000	2.265E-06	0
Pa-231	1.326E-03	0.0060	1.100E-06	0.0000	0.000E+00	0.0000	2.610E-05	0.0001	5.471E-07	0.0000	7.105E-09	0.0000	1.354E-03	0
Pb-210	7.289E-05	0.0003	7.186E-07	0.0000	0.000E+00	0.0000	1.423E-06	0.0000	3.479E-08	0.0000	8.268E-09	0.0000	7.508E-05	0
Po-210	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
Ra-226	1.841E-02	0.0827	1.676E-04	0.0008	0.000E+00	0.0000	3.596E-04	0.0016	8.371E-06	0.0000	2.409E-06	0.0000	1.894E-02	0
Th-230	9.954E-04	0.0045	8.848E-06	0.0000	0.000E+00	0.0000	1.945E-05	0.0001	4.428E-07	0.0000	1.291E-07	0.0000	1.024E-03	0
U-234	9.881E-02	0.4440	1.315E-05	0.0001	0.000E+00	0.0000	1.943E-03	0.0087	7.524E-06	0.0000	2.189E-05	0.0001	1.008E-01	0
U-235	4.343E-03	0.0195	6.076E-07	0.0000	0.000E+00	0.0000	8.543E-05	0.0004	3.512E-07	0.0000	9.510E-07	0.0000	4.431E-03	0
U-238	9.402E-02	0.4225	1.242E-05	0.0001	0.000E+00	0.0000	1.849E-03	0.0083	7.155E-06	0.0000	2.083E-05	0.0001	9.591E-02	0
Total	2.180E-01	0.9795	2.045E-04	0.0009	0.000E+00	0.0000	4.285E-03	0.0193	2.443E-05	0.0001	4.623E-05	0.0002	2.225E-01	1

*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 = 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	f:
Ac-227	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
Pa-231	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
Pb-210	2.399E-29	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
Po-210	2.052E-29	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
Ra-226	6.247E-22	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
Th-230	1.357E-25	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
U-234	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
U-235	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
U-238	3.401E-26	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
Total	6.249E-22	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

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 Pathw.	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	f:
Ac-227	1.142E-04	0.0007	1.369E-07	0.0000	0.000E+00	0.0000	2.243E-06	0.0000	5.079E-10	0.0000	8.403E-10	0.0000	1.166E-04	0
Pa-231	1.060E-04	0.0007	7.027E-08	0.0000	0.000E+00	0.0000	2.085E-06	0.0000	6.279E-08	0.0000	4.701E-10	0.0000	1.082E-04	0
Pb-210	3.659E-03	0.0240	3.677E-05	0.0002	0.000E+00	0.0000	7.144E-05	0.0005	1.806E-06	0.0000	4.160E-07	0.0000	3.770E-03	0
Po-210	1.203E-03	0.0079	2.727E-05	0.0002	0.000E+00	0.0000	2.363E-05	0.0002	1.340E-06	0.0000	1.506E-07	0.0000	1.255E-03	0
Ra-226	1.429E-03	0.0094	1.271E-05	0.0001	0.000E+00	0.0000	2.792E-05	0.0002	6.525E-07	0.0000	2.025E-07	0.0000	1.470E-03	0
Th-230	6.554E-06	0.0000	4.380E-08	0.0000	0.000E+00	0.0000	1.282E-07	0.0000	2.226E-09	0.0000	7.664E-10	0.0000	6.729E-06	0
U-234	7.175E-02	0.4700	9.475E-06	0.0001	0.000E+00	0.0000	1.410E-03	0.0092	5.444E-06	0.0000	1.587E-05	0.0001	7.319E-02	0
U-235	3.116E-03	0.0204	4.119E-07	0.0000	0.000E+00	0.0000	6.126E-05	0.0004	2.377E-07	0.0000	6.890E-07	0.0000	3.179E-03	0
U-238	6.821E-02	0.4467	9.007E-06	0.0001	0.000E+00	0.0000	1.341E-03	0.0088	5.175E-06	0.0000	1.509E-05	0.0001	6.958E-02	0
Total	1.496E-01	0.9798	9.590E-05	0.0006	0.000E+00	0.0000	2.940E-03	0.0193	1.472E-05	0.0001	3.242E-05	0.0002	1.527E-01	1

*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	f:
Ac-227	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
Pa-231	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
Pb-210	4.057E-29	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
Po-210	3.320E-30	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
Ra-226	6.317E-22	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
Th-230	4.114E-25	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
U-234	2.789E-30	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
U-235	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
U-238	3.241E-26	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
Total	6.322E-22	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

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 Pathw.	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	f:
Ac-227	1.159E-04	0.0007	1.389E-07	0.0000	0.000E+00	0.0000	2.276E-06	0.0000	5.147E-10	0.0000	8.521E-10	0.0000	1.183E-04	0
Pa-231	1.128E-04	0.0007	7.570E-08	0.0000	0.000E+00	0.0000	2.218E-06	0.0000	6.574E-08	0.0000	5.049E-10	0.0000	1.152E-04	0
Pb-210	3.711E-03	0.0239	3.705E-05	0.0002	0.000E+00	0.0000	7.231E-05	0.0005	1.774E-06	0.0000	4.192E-07	0.0000	3.823E-03	0
Po-210	2.019E-04	0.0013	4.577E-06	0.0000	0.000E+00	0.0000	3.965E-06	0.0000	2.243E-07	0.0000	2.525E-08	0.0000	2.107E-04	0
Ra-226	1.539E-03	0.0099	1.365E-05	0.0001	0.000E+00	0.0000	3.001E-05	0.0002	6.829E-07	0.0000	2.158E-07	0.0000	1.583E-03	0
Th-230	7.290E-06	0.0000	4.940E-08	0.0000	0.000E+00	0.0000	1.424E-07	0.0000	2.450E-09	0.0000	8.565E-10	0.0000	7.485E-06	0
U-234	7.341E-02	0.4731	9.693E-06	0.0001	0.000E+00	0.0000	1.443E-03	0.0093	5.566E-06	0.0000	1.623E-05	0.0001	7.488E-02	0
U-235	3.188E-03	0.0205	4.215E-07	0.0000	0.000E+00	0.0000	6.267E-05	0.0004	2.432E-07	0.0000	7.047E-07	0.0000	3.252E-03	0
U-238	6.978E-02	0.4497	9.214E-06	0.0001	0.000E+00	0.0000	1.372E-03	0.0088	5.291E-06	0.0000	1.543E-05	0.0001	7.118E-02	0
Total	1.521E-01	0.9800	7.487E-05	0.0005	0.000E+00	0.0000	2.988E-03	0.0193	1.385E-05	0.0001	3.303E-05	0.0002	1.552E-01	1

*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 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	f:
Ac-227	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
Pa-231	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
Pb-210	4.213E-29	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
Po-210	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
Ra-226	6.460E-22	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
Th-230	9.833E-25	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
U-234	1.452E-29	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
U-235	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
U-238	2.943E-26	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
Total	6.470E-22	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

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 Pathw.	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	f:
Ac-227	1.186E-04	0.0007	1.422E-07	0.0000	0.000E+00	0.0000	2.329E-06	0.0000	5.271E-10	0.0000	8.723E-10	0.0000	1.210E-04	0
Pa-231	1.267E-04	0.0008	8.694E-08	0.0000	0.000E+00	0.0000	2.492E-06	0.0000	7.178E-08	0.0000	5.777E-10	0.0000	1.294E-04	0
Pb-210	3.796E-03	0.0235	3.786E-05	0.0002	0.000E+00	0.0000	7.396E-05	0.0005	1.814E-06	0.0000	4.289E-07	0.0000	3.910E-03	0
Po-210	5.652E-06	0.0000	1.281E-07	0.0000	0.000E+00	0.0000	1.110E-07	0.0000	6.283E-09	0.0000	7.071E-10	0.0000	5.899E-06	0
Ra-226	1.766E-03	0.0109	1.574E-05	0.0001	0.000E+00	0.0000	3.445E-05	0.0002	7.868E-07	0.0000	2.453E-07	0.0000	1.817E-03	0
Th-230	8.913E-06	0.0001	6.249E-08	0.0000	0.000E+00	0.0000	1.740E-07	0.0000	3.102E-09	0.0000	1.065E-09	0.0000	9.153E-06	0
U-234	7.642E-02	0.4734	1.009E-05	0.0001	0.000E+00	0.0000	1.502E-03	0.0093	5.798E-06	0.0000	1.690E-05	0.0001	7.796E-02	0
U-235	3.319E-03	0.0206	4.389E-07	0.0000	0.000E+00	0.0000	6.525E-05	0.0004	2.535E-07	0.0000	7.338E-07	0.0000	3.386E-03	0
U-238	7.265E-02	0.4500	9.593E-06	0.0001	0.000E+00	0.0000	1.428E-03	0.0088	5.512E-06	0.0000	1.607E-05	0.0001	7.411E-02	0
Total	1.582E-01	0.9800	7.415E-05	0.0005	0.000E+00	0.0000	3.109E-03	0.0193	1.425E-05	0.0001	3.438E-05	0.0002	1.614E-01	1

*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	f:
Ac-227	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
Pa-231	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
Pb-210	3.672E-29	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
Po-210	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
Ra-226	6.986E-22	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
Th-230	3.212E-24	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
U-234	1.237E-28	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
U-235	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
U-238	2.101E-26	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
Total	7.019E-22	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

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 Pathw.	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	f:
Ac-227	1.222E-04	0.0007	1.465E-07	0.0000	0.000E+00	0.0000	2.401E-06	0.0000	5.441E-10	0.0000	8.997E-10	0.0000	1.247E-04	0
Pa-231	1.775E-04	0.0010	1.290E-07	0.0000	0.000E+00	0.0000	3.490E-06	0.0000	9.276E-08	0.0000	8.494E-10	0.0000	1.812E-04	0
Pb-210	3.907E-03	0.0219	3.887E-05	0.0002	0.000E+00	0.0000	7.615E-05	0.0004	1.867E-06	0.0000	4.418E-07	0.0000	4.024E-03	0
Po-210	1.962E-11	0.0000	4.449E-13	0.0000	0.000E+00	0.0000	3.856E-13	0.0000	2.189E-14	0.0000	2.459E-15	0.0000	2.047E-11	0
Ra-226	2.609E-03	0.0146	2.355E-05	0.0001	0.000E+00	0.0000	5.089E-05	0.0003	1.173E-06	0.0000	3.540E-07	0.0000	2.684E-03	0
Th-230	1.624E-05	0.0001	1.234E-07	0.0000	0.000E+00	0.0000	3.172E-07	0.0000	6.138E-09	0.0000	2.011E-09	0.0000	1.669E-05	0
U-234	8.443E-02	0.4723	1.115E-05	0.0001	0.000E+00	0.0000	1.660E-03	0.0093	6.414E-06	0.0000	1.869E-05	0.0001	8.612E-02	0
U-235	3.668E-03	0.0205	4.856E-07	0.0000	0.000E+00	0.0000	7.212E-05	0.0004	2.809E-07	0.0000	8.113E-07	0.0000	3.742E-03	0
U-238	8.026E-02	0.4490	1.060E-05	0.0001	0.000E+00	0.0000	1.578E-03	0.0088	6.097E-06	0.0000	1.777E-05	0.0001	8.187E-02	0
Total	1.752E-01	0.9800	8.505E-05	0.0005	0.000E+00	0.0000	3.444E-03	0.0193	1.593E-05	0.0001	3.806E-05	0.0002	1.788E-01	1

*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	f
Ac-227	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
Pa-231	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
Pb-210	2.463E-29	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
Po-210	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
Ra-226	8.737E-22	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
Th-230	1.191E-23	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
U-234	9.540E-28	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
U-235	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
U-238	8.014E-27	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
Total	8.856E-22	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

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 Pathw	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	f
Ac-227	1.046E-04	0.0005	1.255E-07	0.0000	0.000E+00	0.0000	2.057E-06	0.0000	4.670E-10	0.0000	7.716E-10	0.0000	1.068E-04	0
Pa-231	3.304E-04	0.0016	2.601E-07	0.0000	0.000E+00	0.0000	6.500E-06	0.0000	1.512E-07	0.0000	1.692E-09	0.0000	3.374E-04	0
Pb-210	3.343E-03	0.0166	3.311E-05	0.0002	0.000E+00	0.0000	6.520E-05	0.0003	1.597E-06	0.0000	3.786E-07	0.0000	3.443E-03	0
Po-210	2.218E-27	0.0000	5.038E-29	0.0000	0.000E+00	0.0000	4.371E-29	0.0000	2.490E-30	0.0000	0.000E+00	0.0000	2.314E-27	0
Ra-226	5.146E-03	0.0255	4.705E-05	0.0002	0.000E+00	0.0000	1.004E-04	0.0005	2.338E-06	0.0000	6.779E-07	0.0000	5.296E-03	0
Th-230	5.229E-05	0.0003	4.355E-07	0.0000	0.000E+00	0.0000	1.021E-06	0.0000	2.169E-08	0.0000	6.667E-09	0.0000	5.378E-05	0
U-234	9.475E-02	0.4691	1.252E-05	0.0001	0.000E+00	0.0000	1.863E-03	0.0092	7.208E-06	0.0000	2.099E-05	0.0001	9.666E-02	0
U-235	4.120E-03	0.0204	5.476E-07	0.0000	0.000E+00	0.0000	8.104E-05	0.0004	3.177E-07	0.0000	9.112E-07	0.0000	4.203E-03	0
U-238	9.008E-02	0.4460	1.190E-05	0.0001	0.000E+00	0.0000	1.772E-03	0.0088	6.853E-06	0.0000	1.995E-05	0.0001	9.189E-02	0
Total	1.979E-01	0.9799	1.059E-04	0.0005	0.000E+00	0.0000	3.891E-03	0.0193	1.849E-05	0.0001	4.292E-05	0.0002	2.020E-01	1

*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	f:
Ac-227	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
Pa-231	4.233E-32	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
Pb-210	6.094E-30	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
Po-210	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
Ra-226	1.911E-21	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
Th-230	9.235E-23	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
U-234	1.128E-26	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
U-235	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
U-238	2.748E-28	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
Total	2.004E-21	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

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 Pathw.	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	f:
Ac-227	2.490E-05	0.0001	2.987E-08	0.0000	0.000E+00	0.0000	4.896E-07	0.0000	1.113E-10	0.0000	1.838E-10	0.0000	2.542E-05	0
Pa-231	8.215E-04	0.0038	6.811E-07	0.0000	0.000E+00	0.0000	1.617E-05	0.0001	3.390E-07	0.0000	4.398E-09	0.0000	8.387E-04	0
Pb-210	8.021E-04	0.0037	7.910E-06	0.0000	0.000E+00	0.0000	1.565E-05	0.0001	3.828E-07	0.0000	9.094E-08	0.0000	8.261E-04	0
Po-210	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
Ra-226	1.239E-02	0.0574	1.134E-04	0.0005	0.000E+00	0.0000	2.420E-04	0.0011	5.648E-06	0.0000	1.612E-06	0.0000	1.275E-02	0
Th-230	3.424E-04	0.0016	3.018E-06	0.0000	0.000E+00	0.0000	6.690E-06	0.0000	1.507E-07	0.0000	4.413E-08	0.0000	3.523E-04	0
U-234	9.876E-02	0.4577	1.307E-05	0.0001	0.000E+00	0.0000	1.942E-03	0.0090	7.517E-06	0.0000	2.188E-05	0.0001	1.007E-01	0
U-235	4.314E-03	0.0200	5.855E-07	0.0000	0.000E+00	0.0000	8.485E-05	0.0004	3.398E-07	0.0000	9.502E-07	0.0000	4.401E-03	0
U-238	9.393E-02	0.4354	1.241E-05	0.0001	0.000E+00	0.0000	1.847E-03	0.0086	7.148E-06	0.0000	2.081E-05	0.0001	9.582E-02	0
Total	2.114E-01	0.9797	1.511E-04	0.0007	0.000E+00	0.0000	4.156E-03	0.0193	2.153E-05	0.0001	4.539E-05	0.0002	2.158E-01	1

*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	f:
Ac-227	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
Pa-231	1.596E-30	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
Pb-210	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
Po-210	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
Ra-226	1.789E-20	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
Th-230	3.213E-21	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
U-234	4.419E-25	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
U-235	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
U-238	1.908E-29	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
Total	2.110E-20	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

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 Pathw.	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	f:
Ac-227	9.229E-08	0.0000	1.107E-10	0.0000	0.000E+00	0.0000	1.815E-09	0.0000	4.130E-13	0.0000	6.814E-13	0.0000	9.421E-08	0
Pa-231	1.819E-03	0.0641	1.505E-06	0.0001	0.000E+00	0.0000	3.579E-05	0.0013	7.546E-07	0.0000	9.724E-09	0.0000	1.857E-03	0
Pb-210	3.128E-06	0.0001	3.085E-08	0.0000	0.000E+00	0.0000	6.104E-08	0.0000	1.494E-09	0.0000	3.548E-10	0.0000	3.221E-06	0
Po-210	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
Ra-226	2.341E-02	0.8243	2.126E-04	0.0075	0.000E+00	0.0000	4.573E-04	0.0161	1.063E-05	0.0004	3.079E-06	0.0001	2.409E-02	0
Th-230	2.087E-03	0.0735	1.879E-05	0.0007	0.000E+00	0.0000	4.077E-05	0.0014	9.378E-07	0.0000	2.718E-07	0.0000	2.148E-03	0
U-234	1.290E-04	0.0045	2.480E-07	0.0000	0.000E+00	0.0000	2.537E-06	0.0001	1.951E-08	0.0000	2.610E-08	0.0000	1.318E-04	0
U-235	6.631E-05	0.0023	5.146E-08	0.0000	0.000E+00	0.0000	1.305E-06	0.0000	2.641E-08	0.0000	1.310E-09	0.0000	6.769E-05	0
U-238	9.653E-05	0.0034	1.281E-08	0.0000	0.000E+00	0.0000	1.902E-06	0.0001	7.426E-09	0.0000	2.151E-08	0.0000	9.848E-05	0
Total	2.761E-02	0.9722	2.332E-04	0.0082	0.000E+00	0.0000	5.397E-04	0.0190	1.238E-05	0.0004	3.410E-06	0.0001	2.840E-02	1

*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	f:
Ac-227	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
Pa-231	2.613E-25	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
Pb-210	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
Po-210	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
Ra-226	4.488E-17	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
Th-230	6.379E-17	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
U-234	9.090E-21	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
U-235	9.025E-29	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
U-238	4.079E-25	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
Total	1.087E-16	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

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 Pathw.	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	f:
Ac-227	3.372E-17	0.0000	4.046E-20	0.0000	0.000E+00	0.0000	6.633E-19	0.0000	1.510E-22	0.0000	2.491E-22	0.0000	3.443E-17	0
Pa-231	3.353E-03	0.0701	2.764E-06	0.0001	0.000E+00	0.0000	6.600E-05	0.0014	1.403E-06	0.0000	1.788E-08	0.0000	3.424E-03	0
Pb-210	1.597E-15	0.0000	1.580E-17	0.0000	0.000E+00	0.0000	3.117E-17	0.0000	7.645E-19	0.0000	1.812E-19	0.0000	1.645E-15	0
Po-210	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
Ra-226	3.108E-02	0.6495	2.837E-04	0.0059	0.000E+00	0.0000	6.072E-04	0.0127	1.416E-05	0.0003	4.112E-06	0.0001	3.199E-02	0
Th-230	1.192E-02	0.2491	1.080E-04	0.0023	0.000E+00	0.0000	2.329E-04	0.0049	5.395E-06	0.0001	1.569E-06	0.0000	1.227E-02	0
U-234	1.113E-04	0.0023	9.991E-07	0.0000	0.000E+00	0.0000	2.175E-06	0.0000	4.989E-08	0.0000	1.461E-08	0.0000	1.146E-04	0
U-235	5.687E-05	0.0012	4.684E-08	0.0000	0.000E+00	0.0000	1.119E-06	0.0000	2.384E-08	0.0000	3.030E-10	0.0000	5.806E-05	0
U-238	3.051E-08	0.0000	2.731E-10	0.0000	0.000E+00	0.0000	5.980E-10	0.0000	1.416E-11	0.0000	4.115E-12	0.0000	3.140E-08	0
Total	4.653E-02	0.9722	3.955E-04	0.0083	0.000E+00	0.0000	9.095E-04	0.0190	2.104E-05	0.0004	5.713E-06	0.0001	4.786E-02	1

*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/q) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ac-227	Ac-227	1.000E+00		5.180E-03	5.256E-03	5.379E-03	5.543E-03	4.748E-03	1.130E-03	4.187E-06	1.530E-15
Pa-231	Pa-231	1.000E+00		2.547E-03	2.669E-03	2.912E-03	3.754E-03	6.099E-03	1.363E-02	3.032E-02	5.637E-02
Pa-231	Ac-227	1.000E+00		2.264E-03	2.451E-03	2.838E-03	4.299E-03	8.894E-03	2.364E-02	5.220E-02	9.579E-02
Pa-231	∑DSR(j)			4.811E-03	5.120E-03	5.750E-03	8.053E-03	1.499E-02	3.728E-02	8.253E-02	1.522E-01
Pb-210	Pb-210	1.000E+00		4.610E-03	4.679E-03	4.789E-03	4.940E-03	4.244E-03	1.022E-03	3.985E-06	2.030E-15
Pb-210	Po-210	1.000E+00		3.099E-03	3.139E-03	3.207E-03	3.289E-03	2.798E-03	6.675E-04	2.603E-06	1.335E-15
Pb-210	∑DSR(j)			7.709E-03	7.818E-03	7.996E-03	8.229E-03	7.041E-03	1.689E-03	6.587E-06	3.365E-15
Po-210	Po-210	1.000E+00		2.567E-03	4.309E-04	1.206E-05	4.186E-11	4.734E-27	0.000E+00	0.000E+00	0.000E+00
Ra-226	Ra-226	1.000E+00		3.326E-04	3.483E-04	3.797E-04	4.881E-04	7.862E-04	1.705E-03	3.481E-03	4.812E-03
Ra-226	Pb-210	1.000E+00		1.613E-03	1.744E-03	2.015E-03	3.024E-03	6.094E-03	1.486E-02	2.798E-02	3.682E-02
Ra-226	Po-210	1.000E+00		1.061E-03	1.146E-03	1.322E-03	1.978E-03	3.950E-03	9.511E-03	1.780E-02	2.380E-02
Ra-226	∑DSR(j)			3.006E-03	3.238E-03	3.716E-03	5.490E-03	1.083E-02	2.608E-02	4.926E-02	6.543E-02
Th-230	Th-230	1.000E+00		3.295E-06	3.455E-06	3.776E-06	4.895E-06	8.080E-06	1.907E-05	4.915E-05	1.406E-04
Th-230	Ra-226	1.000E+00		1.655E-06	1.819E-06	2.169E-06	3.630E-06	9.773E-06	5.224E-05	3.107E-04	1.841E-03
Th-230	Pb-210	1.000E+00		5.326E-06	6.067E-06	7.728E-06	1.551E-05	5.604E-05	3.976E-04	2.460E-03	1.407E-02
Th-230	Po-210	1.000E+00		3.484E-06	3.965E-06	5.046E-06	1.010E-05	3.609E-05	2.516E-04	1.572E-03	9.048E-03
Th-230	∑DSR(j)			1.376E-05	1.531E-05	1.872E-05	3.414E-05	1.100E-04	7.205E-04	4.392E-03	2.510E-02
U-234	U-234	1.000E+00		1.497E-01	1.531E-01	1.594E-01	1.761E-01	1.977E-01	2.060E-01	2.115E-04	1.327E-23
U-234	Th-230	1.000E+00		1.612E-07	1.758E-07	2.022E-07	3.011E-07	6.168E-07	1.805E-06	3.628E-06	3.587E-06
U-234	Ra-226	1.000E+00		8.057E-09	9.073E-09	1.160E-08	2.318E-08	8.445E-08	6.535E-07	4.747E-06	1.785E-05
U-234	Pb-210	1.000E+00		9.940E-09	1.111E-08	1.576E-08	3.831E-08	2.126E-07	2.883E-06	3.019E-05	1.293E-04
U-234	Po-210	1.000E+00		6.014E-09	6.658E-09	9.504E-09	2.343E-08	1.332E-07	1.843E-06	1.948E-05	8.363E-05
U-234	∑DSR(j)			1.497E-01	1.531E-01	1.594E-01	1.761E-01	1.977E-01	2.060E-01	2.695E-04	2.343E-04
U-235	U-235	1.000E+00		1.412E-01	1.445E-01	1.504E-01	1.662E-01	1.865E-01	1.944E-01	1.997E-04	1.256E-23
U-235	Pa-231	1.000E+00		4.542E-05	4.919E-05	5.680E-05	8.546E-05	1.773E-04	5.231E-04	1.047E-03	9.576E-04
U-235	Ac-227	1.000E+00		1.595E-05	1.801E-05	2.254E-05	4.267E-05	1.324E-04	6.384E-04	1.761E-03	1.623E-03
U-235	∑DSR(j)			1.413E-01	1.445E-01	1.505E-01	1.663E-01	1.868E-01	1.956E-01	3.009E-03	2.581E-03
U-238	U-238	1.000E+00		1.423E-01	1.456E-01	1.515E-01	1.674E-01	1.879E-01	1.959E-01	2.012E-04	1.265E-23
U-238	U-234	1.000E+00		8.699E-06	9.333E-06	1.062E-05	1.523E-05	2.830E-05	7.039E-05	1.922E-07	3.845E-26
U-238	Th-230	1.000E+00		1.901E-11	2.545E-11	2.438E-11	3.030E-11	7.005E-11	3.454E-10	1.219E-09	1.171E-09
U-238	Ra-226	1.000E+00		2.335E-10	3.205E-10	2.796E-10	2.735E-10	4.215E-10	4.004E-10	1.176E-09	4.938E-09
U-238	Pb-210	1.000E+00		1.746E-09	2.397E-09	2.091E-09	2.044E-09	3.134E-09	2.796E-09	7.129E-09	3.528E-08
U-238	Po-210	1.000E+00		1.130E-09	1.549E-09	1.353E-09	1.328E-09	2.028E-09	1.809E-09	4.599E-09	2.283E-08
U-238	∑DSR(j)			1.423E-01	1.456E-01	1.515E-01	1.674E-01	1.879E-01	1.959E-01	2.014E-04	6.422E-08

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 30 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/q
Basic Radiation Dose Limit = 25 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
Ac-227	4.826E+03	4.756E+03	4.648E+03	4.510E+03	5.265E+03	2.213E+04	5.970E+06	*7.230E+13
Pa-231	5.196E+03	4.883E+03	4.348E+03	3.104E+03	1.667E+03	6.707E+02	3.029E+02	1.643E+02
Pb-210	3.243E+03	3.198E+03	3.127E+03	3.038E+03	3.550E+03	1.480E+04	3.795E+06	*7.631E+13
Po-210	9.738E+03	5.802E+04	2.073E+06	5.972E+11	*4.492E+15	*4.492E+15	*4.492E+15	*4.492E+15
Ra-226	8.316E+03	7.720E+03	6.727E+03	4.554E+03	2.308E+03	9.587E+02	5.075E+02	3.821E+02
Th-230	1.817E+06	1.633E+06	1.336E+06	7.323E+05	2.273E+05	3.470E+04	5.692E+03	9.962E+02
U-234	1.670E+02	1.633E+02	1.568E+02	1.419E+02	1.265E+02	1.213E+02	9.276E+04	1.067E+05
U-235	1.770E+02	1.730E+02	1.661E+02	1.503E+02	1.338E+02	1.278E+02	8.310E+03	9.688E+03
U-238	1.757E+02	1.717E+02	1.650E+02	1.493E+02	1.330E+02	1.276E+02	1.241E+05	*3.360E+05

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/q)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/q
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 190.5 ± 0.4 years

Nuclide (i)	Initial pCi/q	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/q)	DSR(i,tmax)	G(i,tmax) (pCi/q)
Ac-227	2.250E-02	9.83 ± 0.02	5.543E-03	4.510E+03	1.007E-04	2.483E+05
Pa-231	2.250E-02	1.000E+03	1.522E-01	1.643E+02	6.018E-02	4.154E+02
Pb-210	4.890E-01	9.71 ± 0.02	8.229E-03	3.038E+03	1.535E-04	1.628E+05
Po-210	4.890E-01	0.000E+00	2.567E-03	9.738E+03	0.000E+00	*4.492E+15
Ra-226	4.890E-01	838 ± 2	6.619E-02	3.777E+02	3.874E-02	6.453E+02
Th-230	4.890E-01	1.000E+03	2.510E-02	9.962E+02	2.095E-03	1.194E+04
U-234	4.890E-01	190.5 ± 0.4	2.061E-01	1.213E+02	2.061E-01	1.213E+02
U-235	2.250E-02	190.5 ± 0.4	1.969E-01	1.270E+02	1.969E-01	1.270E+02
U-238	4.890E-01	190.5 ± 0.4	1.961E-01	1.275E+02	1.961E-01	1.275E+02

*At specific activity limit

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TECHNICAL MEMORANDUM

April 3, 2001

Originator: A.H. Thatcher, CHP, Senior HP Scientist

Subject: ***Derivation of Surface Soil DCGLs for KMTC***

Revision: 1

ENDORSEMENT: This document contains the results of research and technical analysis which have been reviewed and approved for publication by the Technical Director, NEXTEP Environmental, Inc.

H Newman 4/4/01

Harry J. Newman, CHP, Technical Director — Date

Introduction:

This document provides information regarding the modeling and parameters used in release limits for outdoor areas where the soil survey unit lies on the surface of the ground. As this modeling supports MARSSIM activities, the release limits will be referred to as Derived Concentration Guideline Levels (DCGL). The characterization data for the outdoor areas of the Technical Center indicates that elevated quantities of uranium and thorium contamination exist at several locations. The data also reveals that radium 226 may not be in equilibrium with uranium 238. DCGLs are therefore derived for:

- Thorium-232 and progeny
- The uranium series to uranium 234
- Ra-226 and progeny (includes dose contribution from Th-230)

The use of three DCGLs allows flexibility whereby higher or lower than expected concentrations of radium 226 (in comparison to uranium 238) can be accommodated.

The remaining section of this document provides the area factors for the three DCGLs.

General Method for Calculating DCGLs:

The software code RESRAD[1] was used to provide pathway modeling, incorporating guidance on parameter values contained in NRC Policy and Guidance Directive PG-8-08[2] and the "Method for Surveying and Averaging Concentrations of Thorium in Contaminated Subsurface Soil"[3]. Where specific guidance is not provided, and sufficient justification for appropriate alternate parameter values are presented and justified, conservative modeling parameters are selected such as the default values from RESRAD.

The computer code DandD[4] is acknowledged as the default code for performing calculations to support release criteria for decommissioning activities by the USNRC. However, the DandD code lacks the ability to model complex soil columns for contaminant transport considerations, thus making the RESRAD code the preferred code for the Technical Center analysis.

The following bullets describe key parameters and criteria used for this modeling.

- **ICRP 72[5] Ingestion Dose Coefficients[6]** – The ingestion dose conversion factors (DCFs) from ICRP 56+ documents are summarized in ICRP 72 and applied in this analysis. The ICRP72 DCFs were developed specifically for calculation of dose to members of the public. ICRP 72 retains the gastrointestinal tract model used in ICRP 30, but also utilizes the updated tissue weighting factors presented in ICRP 60, and revised biokinetic information to reflect increased knowledge in the uptake and retention of various elements in the body.
- **Surface modeling** – Uniform contamination is assumed to exist to a depth of 30 cm (1 foot) over an area of 10,000 m^2. A 10,000 m^2 area is used as this effectively represents an infinite slab for external exposures. The exposure characteristics for the modeling are for a residential scenario.
- **Saturated hydraulic conductivity** – The upper saturated soil column is located within the Garber-Wellington aquifer. This layer is described as orange-brown to red-brown fine-grained sandstone, irregularly bedded with red-brown shale and some chert and mudstone conglomerate[7]. This highly compacted layer is characterized as a sandy clay with a hydraulic conductivity of less than 100 ft/year[8]. In this analysis, a conservative saturated hydraulic conductivity value of 70 m/y[9] is used to account for potentially greater velocities due to fractured flow.

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[1] Yu, C., A.J. Zielen, J.J. Cheng, Y.C. Yuan, L.G. Jones, D.J. LePoire, Y.Y. Wang, C.O. Loureiro, E. Gnanapragasam, E. Faillace, A. Wallo III, W.A. Williams, and H. Peterson, *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.61*, ANL/EAD/LD-2, Argonne National laboratory, Argonne, Illinois, 1993.

[2] USNRC. Scenarios for Assessing Potential Doses Associated with Residual Radioactivity. Policy and Guidance Directive PG-8-08.

[3] USNRC. 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". 1997.

[4] USNRC. DandD computer code to support license termination, version 1.0. Sandia National Laboratory.

[5] ICRP, Age-Dependent Doses to Members of the Public From Intake of Radionuclides: Part 5 Compilation of Ingestion and Inhalation Dose Coefficients, ICRP Publication 72, Oxford, Pergamon Press, 1995.

[6] The ingestion pathway is of significant concern in the dose modeling, other pathways are much less significant.

[7] Decommissioning Plan for Kerr-McGee Technical Center, March 2001.

[8] Personal communication with Roy Widman and Jim Crawford, Kerr-McGee, 12/6/00.

[9] Table E.2, RESRAD manual.

- **Distribution coefficient (Kd)** – A total of four soil layers are included in the analysis. Those layers are the contaminated layer, the upper unsaturated soil layer, the lower unsaturated soil layer, and the saturated soil column. For all layers except the lower unsaturated soil layer, NUREG 5512 default Kd values are used. For the lower unsaturated soil layer, the recommended Kd value for clay from Sheppard and Thibault[10] is used.

  In order to more accurately classify the unsaturated soil layers, a grain size and hydrometer analysis was performed on an upper soil sample representing the top meter of soil and a lower soil sample above the saturated soil column. The results of this analysis are included as Attachment 1. Classifying the soils in a manner similar to Sheppard and Thibault, the upper soil is classified as a clay loam with similar sized fractions of sand, clay and silt. The lower soil of the unsaturated soil column is similarly classified as a silty clay with a silt sized fraction of 58% and a clay sized fraction of 40%. The limited permeability and significant fraction of silt and clay sized particles in the unsaturated soil column provide an indication of the conservative nature of the use of the default Kds for the upper soil column.

DCGLw for Thorium-232 and progeny

Attachment 2 provides the RESRAD output for the modeling results and the specific parameters used. Figure 1 displays the contribution to dose over time as well. The major pathways are external exposure and ingestion of plants. The analysis predicted a peak dose of 4.802 mrem/y/pCi/g, or a 5.2 pCi/g limit to meet a 25 mrem/y standard.

DCGLw for Total Uranium (to Uranium 234)

Attachment 3 provides the RESRAD output for the modeling results and the specific parameters used. The graph below displays the contribution to dose over time as well. Over 50% of the dose is initially delivered via plant ingestion. The analysis predicted a peak dose of 0.141 mrem/y/pCi/g, or a 170 pCi/g limit to meet a 25 mrem/y standard. The significantly lower contribution from the uranium series to uranium 234 (as compared to natural thorium) is due to the lack of any significant gamma sources for external exposure from these radionuclides.

DCGLw for Ra-226 and Progeny (including Th-230)

Attachment 4 provides the RESRAD output for the modeling results and the specific parameters used. The graph below displays the contribution to dose over time as well. The overwhelming contribution to dose is from radium 226 via external exposure and plant ingestion. Lead 210 is also predicted to contribute to exposure through the plant pathway. The analysis predicted a peak dose of 7.102 mrem/y/pCi/g, or an 3.5 pCi/g limit to meet a 25 mrem/y standard.

[10] Sheppard, M.I. and Thibault, D.H. Default soil solid/liquid partition coefficients, Kds, for four major soil types: a compendium. Health Physics. Vol. 59 (4), pp. 471-482. 1990. This reference is predominately used as the reference for the Kd recommendations from RESRAD.

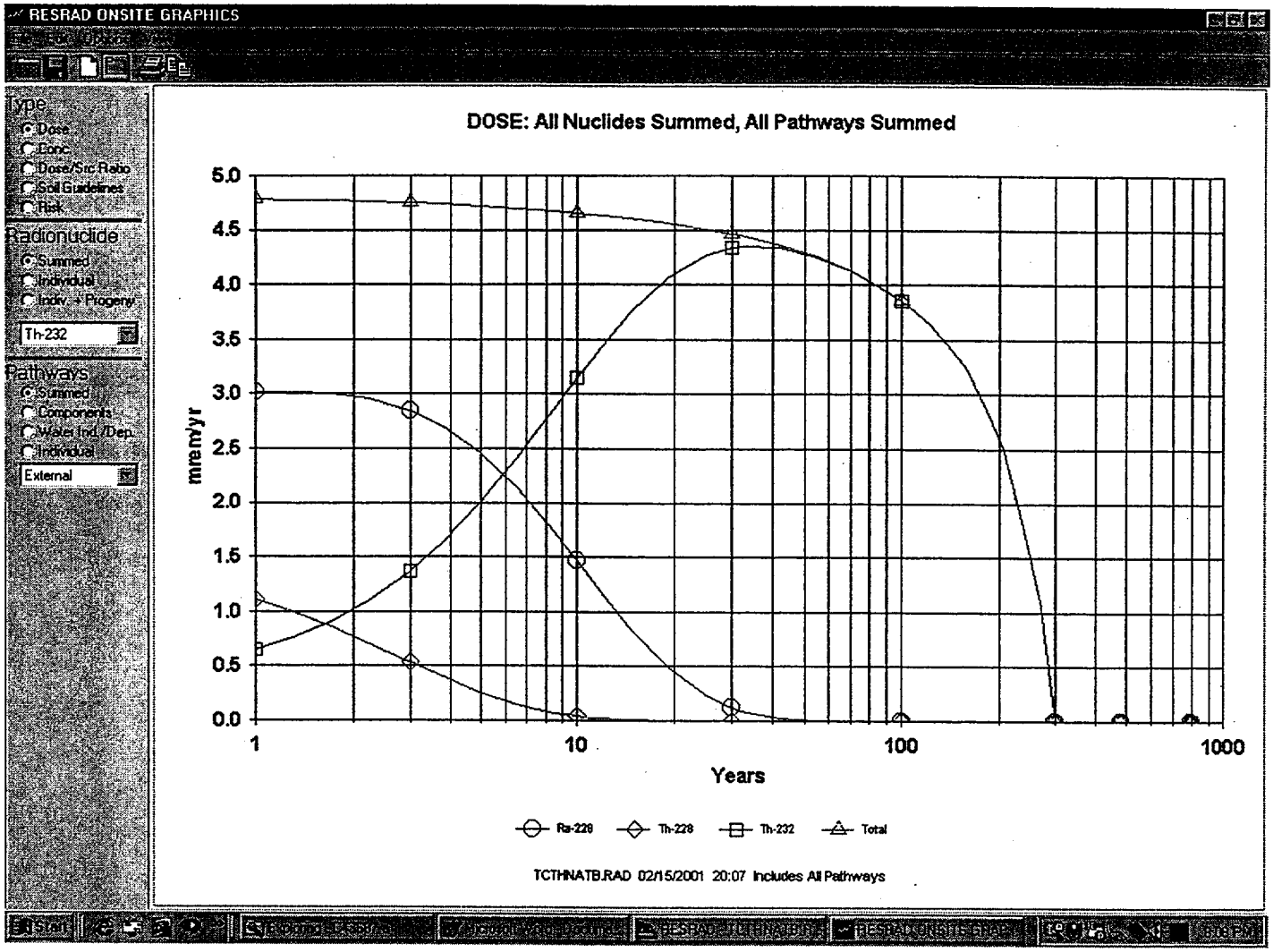

Figure 1
Dose Due to Thorium –232 and Progeny

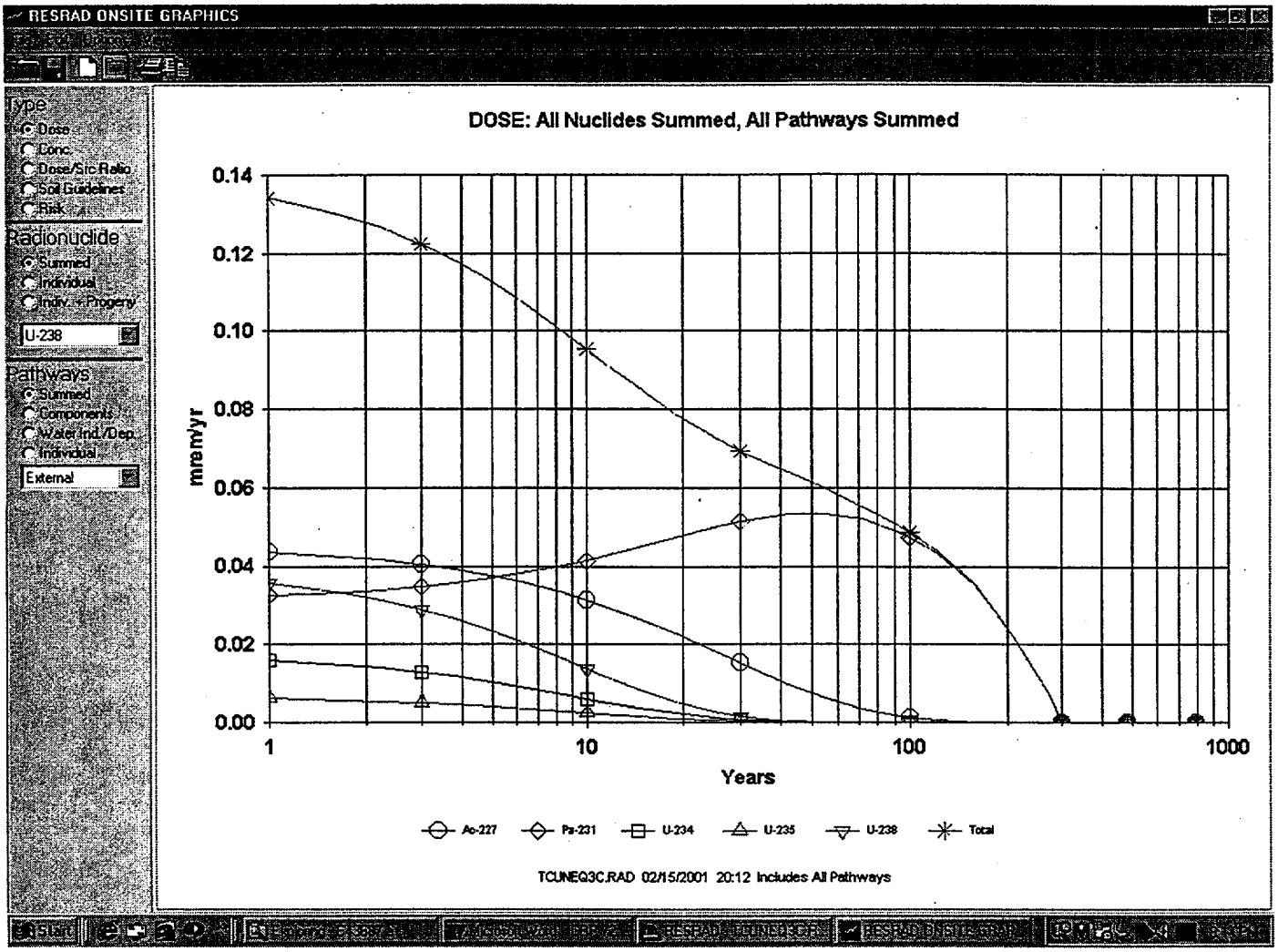

Figure 2
Dose Due to Total Uranium (to U-234)

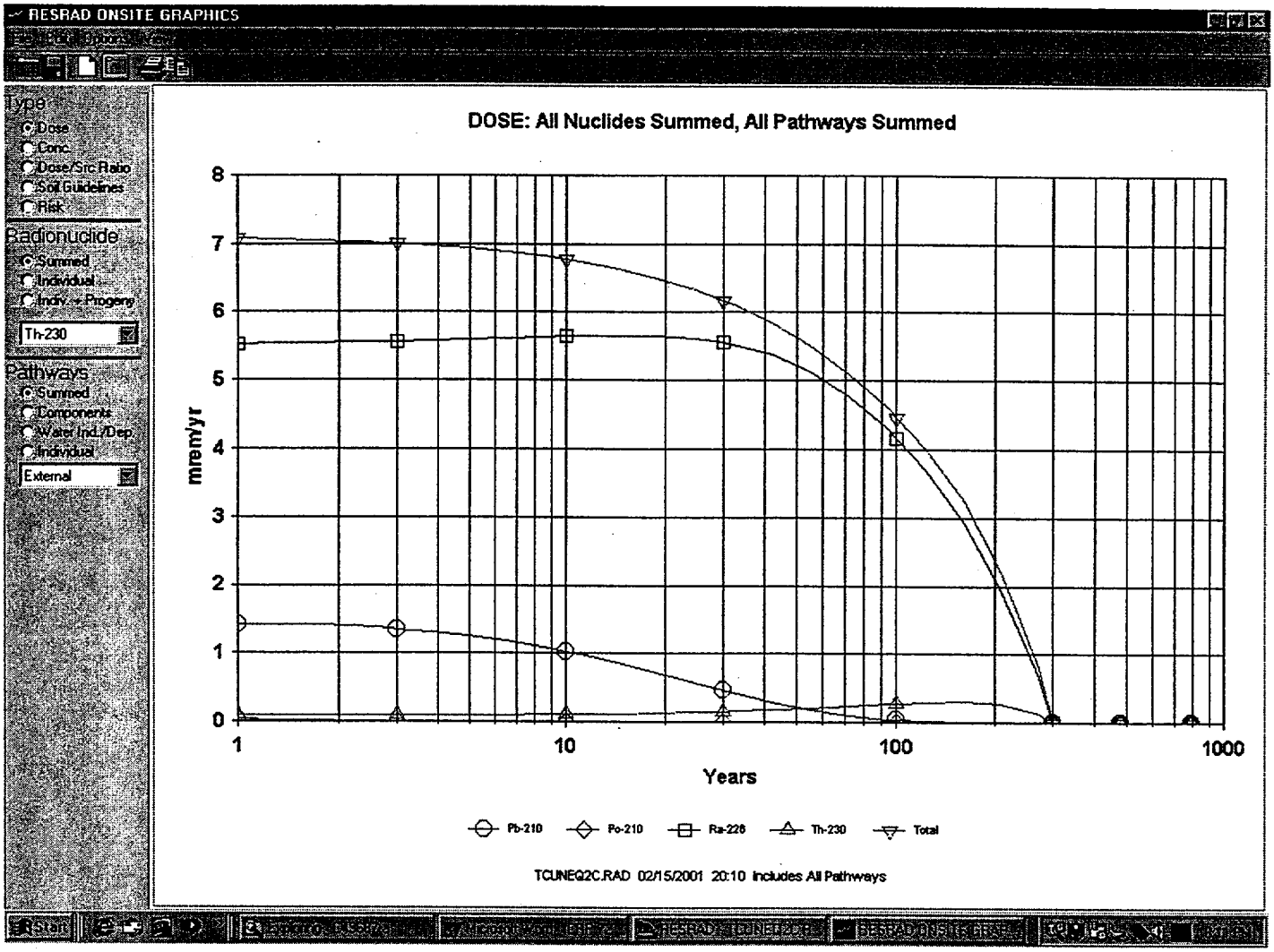

Figure 3
Dose Due to Ra-226 and Progeny

Area Factor Results

Successive RESRAD computations were run for each of the three nuclide series described above while varying the contaminated area from 10,000 m^2 down to 1 m^2 to determine the area factors for each nuclide. Figure 4 provides the individual curves for each of the DCGLs detailed in this document. These area factor curves will be used to evaluate elevated measurements significantly greater than the DCGL. In practice, the area factor for an individual release limit may be determined by interpolation from the graph, by developing an equation of the line for each area factor curve, or by performing actual RESRAD computations for the specific surface area.

The computed equations for the three curves in Figure 4 are as follows:

Natural Thorium Area Factor = $10.3*(\text{area of elevated activity})^{-0.3722}$

Uranium Series through U-234 Area Factor = $6.359*(\text{area of elevated activity})^{-0.255}$

Ra-226 and progeny Area Factor = $11.8*(\text{area of elevated activity})^{-0.387}$

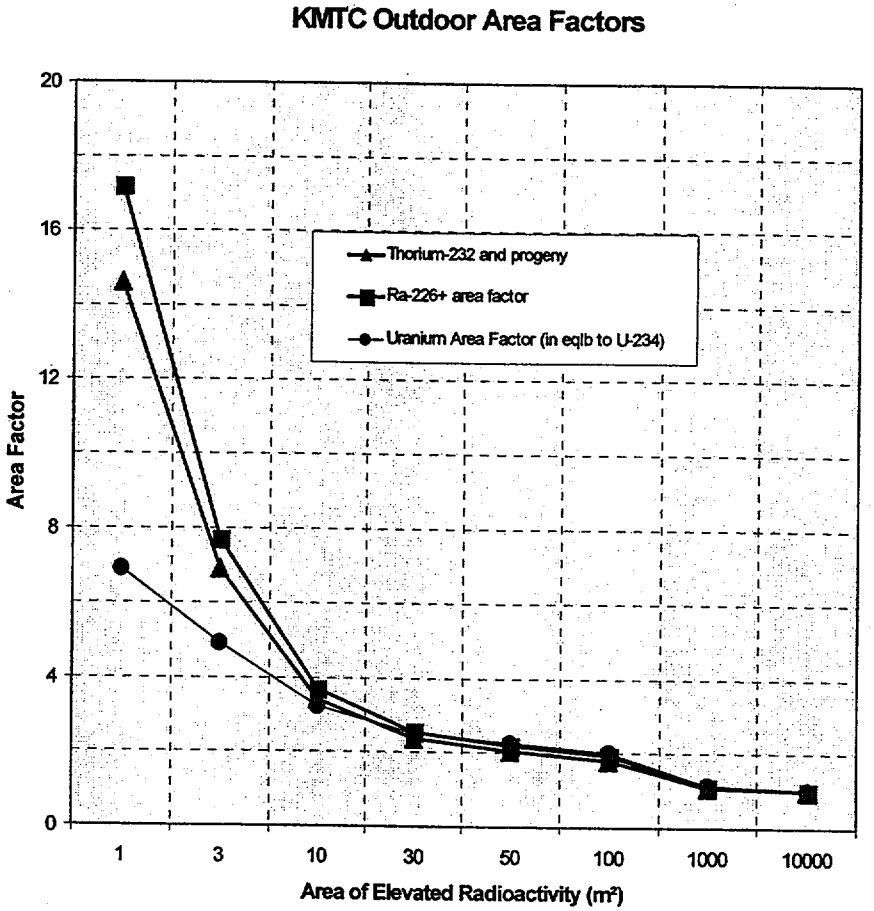

Figure 4
Area Factor Calculations

Conclusions/Recommendations

Guidance on application and use of the unity rule for three separate DCGLs is outlined in MARSSIM, appendix I.11. The individual surface DCGLs are summarized in Table 1.

Table 1
Calculated Surface Soil DCGLs for KMTC

Nuclide Series	Dose Conversion Factor (mrem/y/pCi/g)	DCGLw (pCi/g)
Thorium-232 and progeny	4.802	5.2
Total Uranium (to Uranium 234)	0.141	170
Ra-226 and progeny	7.102	3.5

The assumptions used in calculating the dose are intended to apply to the average member of a critical group or to the maximally exposed member of the general population. The primary pathway for exposure is generally the external pathway and to a lesser extent the ingestion of contaminated foodstuffs.

The use of area factors allows for the evaluation of higher than expected contaminant concentrations in areas significantly smaller than the modeled 10,000 m^2. In practice, the area factor for a specific area may be determined by interpolation from the graph, by using the given equations for the curves, or by performing RESRAD computations.

STANDARD TESTING AND ENGINEERING COMPANY

CORPORATE OFFICE and CENTRAL LABORATORY
3400 N. LINCOLN, OKLAHOMA CITY, OK 73105 (405) 528-0541
CA77 Exp. 06/30/01

Area Offices

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900 S.E. SECOND	LAWTON, OK 73501	(580) 353-0872
5358 S. 125TH EAST AVE., STE B	TULSA, OK 74146	(918) 459-2700

Acct. No:	0220CIM11 File No: CIM11		
Report Date:	12/19/00	Date Sampled:	11/20/00
Project:	Client Information	Sampled By:	Mike G.
Location:	Tech Center 778.1-110.2	By Order Of:	Karen Morgan
Arch./Engr:		Order No:	
Client:	Cimarron Corp.	Quantity Represented:	Red Sandy Clayey Silt
REPORT:	GRAIN SIZE ANALYSIS OF SOILS	LAB NO:	E-2487
Specification:		Test Method:	ASTM D422

TEST RESULTS

SIEVE ANALYSIS	
SIEVE SIZE	PERCENT PASSING
No. 4	100.0
No. 10	100.0
No. 40	99.5
No. 200	97.9
HYDROMETER ANALYSIS	
SMALLER THAN	PERCENT
0.074 mm	97.4
0.005 mm	39.9
0.001 mm	21.9

Charge: Cimarron Corp. Attn: Karen Morgan
Orig. Same
1-cc Laboratory

Unit Rates for this Report		
Units	@	Amount
S506 @ 100.00		
S504 @ 45.00		

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5358 S. 125TH EAST AVE., STE B	TULSA, OK 74146	(918) 459-2700

Acct. No:	0220CIM11 File No: CIM11		
Report Date:	12/19/00	Date Sampled:	11/20/00
Project:	Client Information	Sampled By:	Mike G.
Location:	Tech Center 777-112.5	By Order Of:	Karen Morgan
Arch./Engr:		Order No:	
Client:	Cimarron Corp.	Quantity Represented:	Red Clayey Sandy Silt
REPORT:	GRAIN SIZE ANALYSIS OF SOILS	LAB NO:	E-2488
Specification:		Test Method:	ASTM D422

TEST RESULTS

SIEVE ANALYSIS	
SIEVE SIZE	PERCENT PASSING
No. 4	100.0
No. 10	100.0
No. 40	97.7
No. 200	63.9
HYDROMETER ANALYSIS	
SMALLER THAN	PERCENT
0.074 mm	63.3
0.005 mm	21.2
0.001 mm	15.4

Charge: Cimarron Corp. Attn: Karen Morgan
Orig. Same
1-cc Laboratory

Unit Rates for this Report		
Units	@	Amount
S506 @ 100.00		
S504 @ 45.00		

```
1RESRAD, Version 6.0      T« Limit = 30 days          02/22/2001  14:41  Page   1
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 File    : 0219-T~3.RAD
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Part I: Mixture Sums and Single Radionuclide Guidelines

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Dose Conversion Factor (and Related) Parameter Summary
File: 07961672.LIB

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ra-228+D	5.080E-03	5.080E-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	2.560E-03	1.440E-03	DCF3(1)
D-1	Th-228+D	2.670E-04	8.080E-04	DCF3(2)
D-1	Th-232	8.520E-04	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)

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Summary : KMTC 1 pCi/g natural Th in eqlb, 5512 default Kd parameters, Kd for clay layer
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Site-Specific Parameter Summary

0 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)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	2.000E+01	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)	4.810E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	7.940E+02	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-228	5.000E-01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Th-228	5.000E-01	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Th-232	5.000E-01	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 field capacity	2.000E-01	2.000E-01	---	FCCZ
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	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**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 field capacity	2.000E-01	2.000E-01	---	FCSZ

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone hydraulic conductivity (m/yr)	7.000E+01	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	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
R015	Number of unsaturated zone strata	2	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, field capacity	2.000E-01	2.000E-01	---	FCUZ(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)
R015	Unsat. zone 2, thickness (m)	2.660E+00	0.000E+00	---	H(2)
R015	Unsat. zone 2, soil density (g/cm**3)	1.630E+00	1.500E+00	---	DENSUZ(2)
R015	Unsat. zone 2, total porosity	3.000E-01	4.000E-01	---	TPUZ(2)
R015	Unsat. zone 2, effective porosity	2.000E-01	2.000E-01	---	EPUZ(2)
R015	Unsat. zone 2, field capacity	2.000E-01	2.000E-01	---	FCUZ(2)
R015	Unsat. zone 2, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(2)
R015	Unsat. zone 2, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(2)
R016	Distribution coefficients for Ra-228				
R016	Contaminated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCU(1,1)
R016	Unsaturated zone 2 (cm**3/g)	9.100E+03	7.000E+01	---	DCNUCU(1,2)
R016	Saturated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.189E-03	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)	3.200E+03	6.000E+04	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(2,1)
R016	Unsaturated zone 2 (cm**3/g)	5.800E+03	6.000E+04	---	DCNUCU(2,2)
R016	Saturated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.984E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Th-232				

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0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Contaminated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(3,1)
R016	Unsaturated zone 2 (cm**3/g)	5.800E+03	6.000E+04	---	DCNUCU(3,2)
R016	Saturated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.984E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	5.000E+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	>0 shows circular AREA.	FS
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	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.660E+02	1.600E+02	---	DIET(1)

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Leafy vegetable consumption (kg/yr)	1.100E+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
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM

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Summary : KMTC 1 pCi/g natural Th in eqlb, 5512 default Kd parameters, Kd for clay layer
File : 0219-T~3.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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
C14	DCF correction factor for gaseous forms of C14	not used	1.234E+02	---	CO2F
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	---	FLOOR1
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 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)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	9	---	---	LYMAX
TITL	Maximum number of integration points for risk	1	---	---	KYMAX

Attachment 2
Natural Thorium

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
Find peak pathway doses	active

Attachment 2
Natural Thorium

Summary : KMTC 1 pCi/g natural Th in eqlb, 5512 default Kd parameters, Kd for clay layer
File : 0219-T~3.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	10000.00 square meters	Ra-228	5.000E-01
Thickness:	0.30 meters	Th-228	5.000E-01
Cover Depth:	0.00 meters	Th-232	5.000E-01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 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	4.810E+02	7.940E+02
TDOSE(t):	4.802E+00	4.785E+00	4.753E+00	4.655E+00	4.463E+00	3.859E+00	9.988E-06	0.000E+00	0.000E+00
M(t):	1.921E-01	1.914E-01	1.901E-01	1.862E-01	1.785E-01	1.544E-01	3.995E-07	0.000E+00	0.000E+00

Maximum TDOSE(t): 4.802E+00 mrem/yr at t = 0.000E+00 years

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Summary : KMTC 1 pCi/g natural Th in eqlb, 5512 default Kd parameters, Kd for clay layer
File : 0219-T~3.RAD

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	1.335E+00	0.2781	4.005E-03	0.0008	0.000E+00	0.0000	1.421E+00	0.2959	5.347E-02	0.0111	7.423E-02	0.0155	1.699E-02	0.0035
Th-228	1.573E+00	0.3276	1.996E-02	0.0042	0.000E+00	0.0000	3.309E-03	0.0007	1.844E-04	0.0000	1.452E-05	0.0000	1.553E-03	0.0003
Th-232	7.653E-02	0.0159	1.133E-01	0.0236	0.000E+00	0.0000	9.488E-02	0.0198	3.291E-03	0.0007	4.066E-03	0.0008	6.946E-03	0.0014
Total	2.985E+00	0.6216	1.372E-01	0.0286	0.000E+00	0.0000	1.519E+00	0.3163	5.694E-02	0.0119	7.831E-02	0.0163	2.548E-02	0.0053

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	2.905E+00	0.6049
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	1.598E+00	0.3328
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	2.990E-01	0.0623
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	4.802E+00	1.0000

*Sum of all water independent and dependent pathways.

Attachment 3
Total Uranium (to U-234)

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Summary : KMTC 1 pCi/g total U in eqlb to U-234, 5512 default Kd parameters, Kd for clay
File : 0219-T~1.RAD

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Summary : KMTC 1 pCi/g total U in eqlb to U-234, 5512 default Kd parameters, Kd for clay
File : 0219-T~1.RAD

Dose Conversion Factor (and Related) Parameter Summary
File: 07961672.LIB

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pb-210+D	1.380E-02	1.380E-02	DCF2(3)
B-1	Po-210	9.400E-03	9.400E-03	DCF2(4)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(5)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(6)
B-1	U-234	1.320E-01	1.320E-01	DCF2(7)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(8)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(9)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	4.070E-03	1.480E-02	DCF3(1)
D-1	Pa-231	2.630E-03	1.060E-02	DCF3(2)
D-1	Pb-210+D	2.560E-03	5.370E-03	DCF3(3)
D-1	Po-210	4.440E-03	1.900E-03	DCF3(4)
D-1	Ra-226+D	1.040E-03	1.330E-03	DCF3(5)
D-1	Th-230	7.780E-04	5.480E-04	DCF3(6)
D-1	U-234	1.810E-04	2.830E-04	DCF3(7)
D-1	U-235+D	1.740E-04	2.670E-04	DCF3(8)
D-1	U-238+D	1.670E-04	2.690E-04	DCF3(9)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)
D-34				
D-34	Po-210 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(4,1)
D-34	Po-210 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(4,2)
D-34	Po-210 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.400E-04	3.400E-04	RTF(4,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)

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Summary : KMTC 1 pCi/g total U in eqlb to U-234, 5512 default Kd parameters, Kd for clay
File : 0219-T~1.RAD

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: 07961672.LIB

Menu	Parameter	Current Value	Default	Parameter Name
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(7,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(7,3)
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(8,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(8,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(9,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(9,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Po-210 , fish	1.000E+02	1.000E+02	BIOFAC(4,1)
D-5	Po-210 , crustacea and mollusks	2.000E+04	2.000E+04	BIOFAC(4,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(5,2)
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(6,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(6,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(7,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(7,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(8,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(8,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(9,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(9,2)

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Summary : KMTC 1 pCi/g total U in eqlb to U-234, 5512 default Kd parameters, Kd for clay
File : 0219-T~1.RAD

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)		2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)		2.000E+01	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)		4.810E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)		7.940E+02	0.000E+00	---	T(9)
R011	Times for calculations (yr)		not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g):	Ac-227	2.250E-02	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g):	Pa-231	2.250E-02	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g):	U-234	4.890E-01	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g):	U-235	2.250E-02	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g):	U-238	4.890E-01	0.000E+00	---	S1(9)
R012	Concentration in groundwater (pCi/L):	Ac-227	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L):	Pa-231	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L):	U-234	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L):	U-235	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L):	U-238	not used	0.000E+00	---	W1(9)
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 field capacity		2.000E-01	2.000E-01	---	FCCZ
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	Average annual wind speed (m/sec)		2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**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

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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 field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	7.000E+01	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	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
R015	Number of unsaturated zone strata	2	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, field capacity	2.000E-01	2.000E-01	---	FCUZ(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)
R015	Unsat. zone 2, thickness (m)	2.660E+00	0.000E+00	---	H(2)
R015	Unsat. zone 2, soil density (g/cm**3)	1.630E+00	1.500E+00	---	DENSUZ(2)
R015	Unsat. zone 2, total porosity	3.000E-01	4.000E-01	---	TPUZ(2)
R015	Unsat. zone 2, effective porosity	2.000E-01	2.000E-01	---	EPUZ(2)
R015	Unsat. zone 2, field capacity	2.000E-01	2.000E-01	---	FCUZ(2)
R015	Unsat. zone 2, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(2)
R015	Unsat. zone 2, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(2)
R016	Distribution coefficients for Ac-227				
R016	Contaminated zone (cm**3/g)	4.200E+02	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	4.200E+02	2.000E+01	---	DCNUCU(1,1)
R016	Unsaturated zone 2 (cm**3/g)	2.400E+03	2.000E+01	---	DCNUCU(1,2)
R016	Saturated zone (cm**3/g)	4.200E+02	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.796E-03	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Pa-231				
R016	Contaminated zone (cm**3/g)	5.100E+02	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.100E+02	5.000E+01	---	DCNUCU(2,1)
R016	Unsaturated zone 2 (cm**3/g)	2.700E+03	5.000E+01	---	DCNUCU(2,2)
R016	Saturated zone (cm**3/g)	5.100E+02	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.127E-03	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCU(7,1)
R016	Unsaturated zone 2 (cm**3/g)	1.600E+03	5.000E+01	---	DCNUCU(7,2)
R016	Saturated zone (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.053E-01	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCU(8,1)
R016	Unsaturated zone 2 (cm**3/g)	1.600E+03	5.000E+01	---	DCNUCU(8,2)
R016	Saturated zone (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.053E-01	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCU(9,1)
R016	Unsaturated zone 2 (cm**3/g)	1.600E+03	5.000E+01	---	DCNUCU(9,2)
R016	Saturated zone (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.053E-01	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	2.700E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	2.700E+02	1.000E+02	---	DCNUCU(3,1)
R016	Unsaturated zone 2 (cm**3/g)	5.500E+02	1.000E+02	---	DCNUCU(3,2)
R016	Saturated zone (cm**3/g)	2.700E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.904E-03	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Po-210				
R016	Contaminated zone (cm**3/g)	1.500E+02	1.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	1.500E+02	1.000E+01	---	DCNUCU(4,1)
R016	Unsaturated zone 2 (cm**3/g)	3.000E+03	1.000E+01	---	DCNUCU(4,2)
R016	Saturated zone (cm**3/g)	1.500E+02	1.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.062E-02	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCU(5,1)
R016	Unsaturated zone 2 (cm**3/g)	9.100E+03	7.000E+01	---	DCNUCU(5,2)
R016	Saturated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCS(5)

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.189E-03	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(6,1)
R016	Unsaturated zone 2 (cm**3/g)	5.800E+03	6.000E+04	---	DCNUCU(6,2)
R016	Saturated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.984E-04	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	5.000E+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	>0 shows circular AREA.	FS
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	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.660E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.100E+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
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
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
C14	DCF correction factor for gaseous forms of C14	not used	1.234E+02	---	CO2F
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	---	FLOOR1
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 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

Attachment 3
Total Uranium (to U-234)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	9	---	---	LYMAX
TITL	Maximum number of integration points for risk	1	---	---	KYMAX

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
Find peak pathway doses	active

Attachment 3
Total Uranium (to U-234)

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Contaminated Zone Dimensions

Area:	10000.00 square meters
Thickness:	0.30 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g

Ac-227	2.250E-02
Pa-231	2.250E-02
U-234	4.890E-01
U-235	2.250E-02
U-238	4.890E-01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 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	4.810E+02	7.940E+02
TDOSE(t):	1.410E-01	1.342E-01	1.224E-01	9.542E-02	6.943E-02	4.875E-02	1.270E-07	0.000E+00	0.000E+00
M(t):	5.639E-03	5.367E-03	4.895E-03	3.817E-03	2.777E-03	1.950E-03	5.079E-09	0.000E+00	0.000E+00

Maximum TDOSE(t): 1.410E-01 mrem/yr at t = 0.000E+00 years

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Summary : KMTC 1 pCi/g total U in eqlb to U-234, 5512 default Kd parameters, Kd for clay
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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 mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Ac-227	1.671E-02	0.1186	2.049E-02	0.1453	0.000E+00	0.0000	6.634E-03	0.0471	3.157E-05	0.0002	4.913E-05	0.0003	1.248E-03	0.0089
Pa-231	1.883E-03	0.0134	4.294E-03	0.0305	0.000E+00	0.0000	1.753E-02	0.1244	6.779E-03	0.0481	1.092E-05	0.0001	8.394E-04	0.0060
U-234	7.084E-05	0.0005	8.452E-03	0.0599	0.000E+00	0.0000	6.213E-03	0.0441	5.039E-04	0.0036	1.378E-03	0.0098	1.165E-03	0.0083
U-235	6.102E-03	0.0433	3.624E-04	0.0026	0.000E+00	0.0000	2.750E-04	0.0020	2.235E-05	0.0002	6.094E-05	0.0004	5.155E-05	0.0004
U-238	2.372E-02	0.1682	7.555E-03	0.0536	0.000E+00	0.0000	5.733E-03	0.0407	4.649E-04	0.0033	1.271E-03	0.0090	1.075E-03	0.0076
Total	4.849E-02	0.3439	4.115E-02	0.2919	0.000E+00	0.0000	3.639E-02	0.2581	7.802E-03	0.0553	2.770E-03	0.0196	4.379E-03	0.0311

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 mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Ac-227	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	4.517E-02	0.3204
Pa-231	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	3.134E-02	0.2223
U-234	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	1.778E-02	0.1261
U-235	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	6.875E-03	0.0488
U-238	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	3.982E-02	0.2824
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	1.410E-01	1.0000

*Sum of all water independent and dependent pathways.

Attachment 4
Th-230 and Progeny

Summary : Tc 1 pCi/g Th-230 and progeny, 5512 default Kd parameters, Kd for clay layer
File : 0219-T~2.RAD

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Summary : Tc 1 pCi/g Th-230 and progeny, 5512 default Kd parameters, Kd for clay layer
File : 0219-T~2.RAD

Dose Conversion Factor (and Related) Parameter Summary
File: 07961672.LIB

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pb-210+D	1.380E-02	1.380E-02	DCF2(3)
B-1	Po-210	9.400E-03	9.400E-03	DCF2(4)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(5)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(6)
B-1	U-234	1.320E-01	1.320E-01	DCF2(7)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(8)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(9)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	4.070E-03	1.480E-02	DCF3(1)
D-1	Pa-231	2.630E-03	1.060E-02	DCF3(2)
D-1	Pb-210+D	2.560E-03	5.370E-03	DCF3(3)
D-1	Po-210	4.440E-03	1.900E-03	DCF3(4)
D-1	Ra-226+D	1.040E-03	1.330E-03	DCF3(5)
D-1	Th-230	7.780E-04	5.480E-04	DCF3(6)
D-1	U-234	1.810E-04	2.830E-04	DCF3(7)
D-1	U-235+D	1.740E-04	2.670E-04	DCF3(8)
D-1	U-238+D	1.670E-04	2.690E-04	DCF3(9)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)
D-34				

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Summary : Tc 1 pCi/g Th-230 and progeny, 5512 default Kd parameters, Kd for clay layer
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Dose Conversion Factor (and Related) Parameter Summary (continued)
File: 07961672.LIB

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	Po-210 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(4,1)
D-34	Po-210 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(4,2)
D-34	Po-210 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.400E-04	3.400E-04	RTF(4,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(6,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(7,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(7,3)
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(8,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(8,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(9,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(9,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(9,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Po-210 , fish	1.000E+02	1.000E+02	BIOFAC(4,1)
D-5	Po-210 , crustacea and mollusks	2.000E+04	2.000E+04	BIOFAC(4,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(5,2)

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Summary : Tc 1 pCi/g Th-230 and progeny, 5512 default Kd parameters, Kd for clay layer
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Dose Conversion Factor (and Related) Parameter Summary (continued)
File: 07961672.LIB

Menu	Parameter	Current Value	Default	Parameter Name
D-5				
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(6,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(6,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(7,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(7,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(8,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(8,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(9,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(9,2)

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Summary : Tc 1 pCi/g Th-230 and progeny, 5512 default Kd parameters, Kd for clay layer
File : 0219-T~2.RAD

Site-Specific Parameter Summary

0

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)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	2.000E+01	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)	4.810E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	7.940E+02	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Pb-210	1.000E+00	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Po-210	1.000E+00	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Ra-226	1.000E+00	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Th-230	1.000E+00	0.000E+00	---	S1(6)
R012	Concentration in groundwater (pCi/L): Pb-210	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Po-210	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Th-230	not used	0.000E+00	---	W1(6)
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 field capacity	2.000E-01	2.000E-01	---	FCCZ
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	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**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

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Summary : Tc 1 pCi/g Th-230 and progeny, 5512 default Kd parameters, Kd for clay layer
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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	7.000E+01	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	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
R015	Number of unsaturated zone strata	2	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, field capacity	2.000E-01	2.000E-01	---	FCUZ(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)
R015	Unsat. zone 2, thickness (m)	2.660E+00	0.000E+00	---	H(2)
R015	Unsat. zone 2, soil density (g/cm**3)	1.630E+00	1.500E+00	---	DENSUZ(2)
R015	Unsat. zone 2, total porosity	3.000E-01	4.000E-01	---	TPUZ(2)
R015	Unsat. zone 2, effective porosity	2.000E-01	2.000E-01	---	EPUZ(2)
R015	Unsat. zone 2, field capacity	2.000E-01	2.000E-01	---	FCUZ(2)
R015	Unsat. zone 2, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(2)
R015	Unsat. zone 2, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(2)
R016	Distribution coefficients for Pb-210				
R016	Contaminated zone (cm**3/g)	2.700E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	2.700E+02	1.000E+02	---	DCNUCU(3,1)
R016	Unsaturated zone 2 (cm**3/g)	5.500E+02	1.000E+02	---	DCNUCU(3,2)
R016	Saturated zone (cm**3/g)	2.700E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.904E-03	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Po-210				
R016	Contaminated zone (cm**3/g)	1.500E+02	1.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	1.500E+02	1.000E+01	---	DCNUCU(4,1)
R016	Unsaturated zone 2 (cm**3/g)	3.000E+03	1.000E+01	---	DCNUCU(4,2)
R016	Saturated zone (cm**3/g)	1.500E+02	1.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.062E-02	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCC(5)

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Unsaturated zone 1 (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCU(5,1)
R016	Unsaturated zone 2 (cm**3/g)	9.100E+03	7.000E+01	---	DCNUCU(5,2)
R016	Saturated zone (cm**3/g)	5.000E+02	7.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.189E-03	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Th-230				
R016	Contaminated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(6,1)
R016	Unsaturated zone 2 (cm**3/g)	5.800E+03	6.000E+04	---	DCNUCU(6,2)
R016	Saturated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.984E-04	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	4.200E+02	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	4.200E+02	2.000E+01	---	DCNUCU(1,1)
R016	Unsaturated zone 2 (cm**3/g)	2.400E+03	2.000E+01	---	DCNUCU(1,2)
R016	Saturated zone (cm**3/g)	4.200E+02	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.796E-03	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.100E+02	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.100E+02	5.000E+01	---	DCNUCU(2,1)
R016	Unsaturated zone 2 (cm**3/g)	2.700E+03	5.000E+01	---	DCNUCU(2,2)
R016	Saturated zone (cm**3/g)	5.100E+02	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.127E-03	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter U-234				
R016	Contaminated zone (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCU(7,1)
R016	Unsaturated zone 2 (cm**3/g)	1.600E+03	5.000E+01	---	DCNUCU(7,2)
R016	Saturated zone (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.053E-01	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCU(8,1)
R016	Unsaturated zone 2 (cm**3/g)	1.600E+03	5.000E+01	---	DCNUCU(8,2)
R016	Saturated zone (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.053E-01	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)

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Site-Specific Parameter Summary (continued)

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Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter U-238				
R016	Contaminated zone (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCU(9,1)
R016	Unsaturated zone 2 (cm**3/g)	1.600E+03	5.000E+01	---	DCNUCU(9,2)
R016	Saturated zone (cm**3/g)	1.500E+01	5.000E+01	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.053E-01	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	5.000E+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	>0 shows circular AREA.	FS
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	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)

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Summary : Tc 1 pCi/g Th-230 and progeny, 5512 default Kd parameters, Kd for clay layer
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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Fruits, vegetables and grain consumption (kg/yr)	1.660E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.100E+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
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)

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Summary : Tc 1 pCi/g Th-230 and progeny, 5512 default Kd parameters, Kd for clay layer
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Site-Specific Parameter Summary (continued)

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Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
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
C14	DCF correction factor for gaseous forms of C14	not used	1.234E+02	---	CO2F
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	---	FLOOR1
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 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)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	1	---	---	KYMAX

Attachment 4
Th-230 and Progeny

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Summary : Tc 1 pCi/g Th-230 and progeny, 5512 default Kd parameters, Kd for clay layer
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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
Find peak pathway doses	active

Contaminated Zone Dimensions

Area:	10000.00 square meters
Thickness:	0.30 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g

Pb-210	1.000E+00
Po-210	1.000E+00
Ra-226	1.000E+00
Th-230	1.000E+00

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 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	4.810E+02	7.940E+02
TDOSE(t):	7.102E+00	7.079E+00	7.010E+00	6.778E+00	6.175E+00	4.466E+00	4.536E-06	0.000E+00	0.000E+00
M(t):	2.841E-01	2.831E-01	2.804E-01	2.711E-01	2.470E-01	1.786E-01	1.814E-07	0.000E+00	0.000E+00

Attachment 4
Th-230 and Progeny

Summary : Tc 1 pCi/g Th-230 and progeny, 5512 default Kd parameters, Kd for clay layer
File : 0219-T~2.RAD

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.
Pb-210	2.292E-03	0.0003	2.559E-03	0.0004	0.000E+00	0.0000	8.733E-01	0.1230	2.400E-01	0.0338	4.872E-02	0.0069	6.764E-02	0.0095
Po-210	8.890E-06	0.0000	5.928E-04	0.0001	0.000E+00	0.0000	6.005E-02	0.0085	1.673E-01	0.0236	1.790E-02	0.0025	2.815E-02	0.0040
Ra-226	4.142E+00	0.5832	1.221E-03	0.0002	0.000E+00	0.0000	1.239E+00	0.1745	4.935E-02	0.0069	6.477E-02	0.0091	1.533E-02	0.0022
Th-230	1.356E-03	0.0002	4.496E-02	0.0063	0.000E+00	0.0000	2.324E-02	0.0033	1.290E-03	0.0002	1.131E-04	0.0000	1.079E-02	0.0015
Total	4.146E+00	0.5838	4.933E-02	0.0069	0.000E+00	0.0000	2.196E+00	0.3092	4.579E-01	0.0645	1.315E-01	0.0185	1.219E-01	0.0172

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.
Pb-210	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	1.235E+00	0.1738
Po-210	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	2.740E-01	0.0386
Ra-226	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	5.512E+00	0.7761
Th-230	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	8.175E-02	0.0115
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	7.102E+00	1.0000

*Sum of all water independent and dependent pathways.

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TECHNICAL MEMORANDUM

April 3, 2001

Originator: Harry J. Newman, CHP, Technical Director

Subject: ***Derivation of Indoor Surface DCGLs for KMTC***

Revision: 1

Endorsement: This document contains the results of research and technical analysis which have been reviewed and approved for publication by the Technical Director, NEXTEP Environmental, Inc.

H Newman 4/4/01

Harry J. Newman, CHP, Technical Director — Date

Introduction

This Technical Memo provides information regarding the modeling and parameters used in deriving a 25 mrem/y, industrial use, release limit for indoor surfaces and structures. As this modeling supports MARSSIM activities, the release limits will be referred to as Derived Concentration Guideline Levels (DCGL). The characterization data for the Kerr-McGee Technical Center (KMTC) indicates that elevated quantities of uranium and thorium contamination exist at several locations. The data also reveals that radium 226 may not be in equilibrium with uranium 238. DCGLs are therefore derived for:

- Thorium – 232 and progeny
- The uranium series through uranium 234
- Ra-226 and progeny (includes dose contribution from Th-230)

This approach allows flexibility whereby higher or lower than expected concentrations of radium 226 (in comparison to uranium 238) can be accommodated, and allows for comparison of measured values with the calculated DCGLs.

$DCGL_{EMC}$ calculations for these scenarios are shown to be impractical due to the high residual contamination levels that would be allowable. KMTC has chosen to utilize a more conservative ALARA based approach as described herein.

General Method for Calculating DCGLs

The software code RESRAD-BUILD[1] is used to provide pathway modeling and contains default values for model parameters. The following bullets describe key parameters and criteria that differ from the default parameters used in RESRAD-BUILD.

- **Building Air Exchange Rate** – An air turnover rate of 10 exchanges per hour is used. This turnover rate conservatively represents the increased ventilation commonly found in laboratories at KMTC.

- **Room Height** – The height of the false ceiling for most rooms at KMTC is 10.8 feet[3]. A ceiling height of 3 m, or 9.8 feet is conservatively applied in the modeling.

- **Removable Fraction** – Ten percent removable fraction is used. This value is conservative based on the age of the facility and length of time since any activities were performed involving significant quantities of radioactive materials.

Derived DCGLs

The RESRAD-BUILD default room area of 6m x 6m was used, with a height of 3m. The individual is assumed to be located in the center of the room for the exposure duration with exposure from all 6 surfaces of the room. The input concentration for the RESRAD-BUILD code is in pCi/m^2 while the output is provided in mrem/y. The input values represent a contamination level of 1dpm/100cm^2 for the initial parent nuclide, with appropriate entries for daughter products. In order to convert the results from RESRAD-BUILD to the DCGLw, the following step is necessary.

$$DCGL_w = \frac{25 mrem\,\text{limit}}{RESRADoutput\{mrem/y(dpm/100cm^2)\}} * (beta + ice)/dpm$$

Where the betas plus internal conversion electron (i.c.e.) per /dpm is radionuclide series specific[4]. The individual DCGLs are provided in table 1. The units for the calculated DCGLw are Beta + i.c.e./100cm^2. Attachments 1-3 provide the results of the RESRAD-BUILD computer calculations for each radionuclide series.

[1] RESRAD-BUILD for Windows, Version 3.0. Argonne National Laboratory for USNRC and USDOE, August 25, 2000.

[2] ICRP. Human Respiratory Tract Model for Radiological Protection, ICRP 66, Oxford, Pergamon Press, 1993.

[3] In other locations such as the Pilot Plant, storage building, and TSSL building, the ceiling height is in excess of 14 feet.

[4] For the natural thorium series 3.61 betas + ice/dpm, for uranium 238 to uranium 234, 2.03 betas + ice/dpm, and 3.31 betas + ice/dpm is used for Ra-226 and progeny (including Th-230).

Table 1

Derived DCGLs

Radionuclide	mrem/y per dpm/100cm^2	DCGLw (dpm/100 cm^2)*
Thorium 232 and progeny	4.15E-02	2,150
Uranium Series through U-234	4.95E-03	10,250
Ra-226 and progeny	8.19E-03	10,100

**The release limit in dpm/100 cm² is based upon the total beta (plus i.c.e.) emissions.*

$DCGL_{EMC}$ and ALARA Considerations

The $DCGL_w$ for the 3 contaminant types is presented in table 1. The $DCGL_w$ is the residual concentration level at which a dose of 25 mrem/y will be received under the modeled scenario. Higher levels of residual contamination are allowable when the area of the contamination is less than 144m^2. For example, if only the floor area of 36m^2 was contaminated at the $DCGL_w$, the dose to the hypothetical modeled individual would be reduced by the contributions from the walls and ceiling. The following table presents the dose associated with this scenario for the three contaminant types at KMTC.

Table 2

Dose to Individual for Two Scenarios

	Entire Room Contaminated at $DCGL_w$	Floor only Contaminated at $DCGL_w$
Thorium 232 and progeny	25 mrem/y	6.4 mrem/y
Uranium Series through U-234	25 mrem/y	6.3 mrem/y
Ra-226 and progeny	25 mrem/y	6.8 mrem/y

The table shows that if the floor only was contaminated at a level between 3.6 and 4 times the DCGLw, the dose to the modeled individual would still be less than 25 mrem/y. Smaller areas of residual contamination would allow even higher levels to remain. However, in consideration of ALARA principles, KMTC will ensure that all residual indoor contamination exceeding the DCGLw will be limited to a value which is less than or equal to 3 x DCGLw. Therefore, the $DCGL_{EMC}$ values to be used at KMTC are as follows:

- Thorium – 232 and progeny : 6,450 dpm/100cm^2
- U-238 through U-234: 30,700 dpm/100cm^2
- Ra-226 and progeny: 30,300 dpm/100cm^2

where the units represent total beta plus i.c.e emissions per 100cm^2

Conclusions/Recommendations

The individual surface DCGLs are provided in Table 1. It will be possible in numerous locations to perform final status surveys assuming the contaminant is natural thorium only and apply this DCGLw, which is lower than the DCGLw for the other two series. In instances where contamination greater than the natural thorium DCGLw is identified, it will be necessary to determine the relative contaminant contributions if the residual contamination will be left in place. Guidance on application and use of the unity rule for three separate DCGLs in this instance is outlined in MARSSIM, appendix I.11.

The use of area factors allows for the evaluation of higher than expected contaminant concentrations in areas significantly smaller than the modeled 6m x 6m x 3m area ($144m^2$). KMTC has established the $DCGL_{EMC}$ at an upper threshold of 3x DCGLw, in consideration of ALARA.

Title : KMTC natural Th Evaluation
Input File : C:\WINBLD\TC_THNAT.I

RESRAD-BUILD Table of Contents

Title : KMTC natural Th Evaluation
Input File : C:\WINBLD\TC_THNAT.I

RESRAD-BUILD Input Parameters

Number of Sources : 6
Number of Receptors: 1
Total Time : 3.650000E+02 days
Fraction Inside : 7.000000E-01

Receptor Information

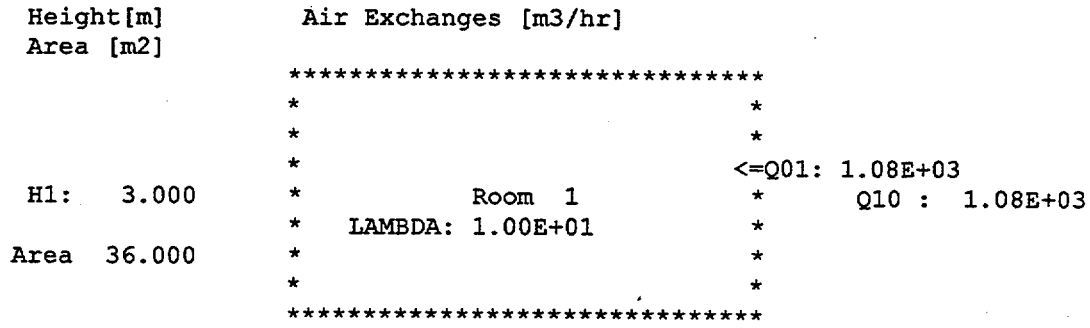
Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	3.000	3.000	1.000	0.330	3.36E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor	Source	Density [g/cm3]	Thickness [cm]	Material
1	1	2.40E+00	0.00E+00	Concrete
1	2	2.40E+00	0.00E+00	Concrete
1	3	2.40E+00	0.00E+00	Concrete
1	4	2.40E+00	0.00E+00	Concrete
1	5	2.40E+00	0.00E+00	Concrete
1	6	2.40E+00	0.00E+00	Concrete

íííííííí Building Information íííííííí

Building Air Exchange Rate: 1.00E+01 1/hr



Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s]

Title : KMTC natural Th Evaluation
Input File : C:\WINBLD\TC_THNAT.I

ÍÍÍÍÍÍÍÍ Source Information ÍÍÍÍÍÍÍÍ

Source: 1
Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00[m]
Geometry:: Type: Area Area:3.60E+01 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External Submersion (Volume)	
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
TH-232	4.550E+01	2.730E-03	1.640E+00	6.450E-08	3.260E-10	1.020E-06
TH-228	4.550E+01	8.080E-04	3.450E-01	1.650E-04	6.390E-06	9.410E-03
RA-228	4.550E+01	1.440E-03	5.080E-03	1.090E-04	3.740E-06	5.590E-03

Source: 2
Location:: Room : 1 x: 3.00 y: 3.00 z: 3.00[m]
Geometry:: Type: Area Area:3.60E+01 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External Submersion (Volume)	
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
TH-232	4.550E+01	2.730E-03	1.640E+00	6.450E-08	3.260E-10	1.020E-06
TH-228	4.550E+01	8.080E-04	3.450E-01	1.650E-04	6.390E-06	9.410E-03
RA-228	4.550E+01	1.440E-03	5.080E-03	1.090E-04	3.740E-06	5.590E-03

Source: 3
Location:: Room : 1 x: 0.00 y: 3.00 z: 1.50[m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External (Volume)	Submersion
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
TH-232	4.550E+01	2.730E-03	1.640E+00	6.450E-08	3.260E-10	1.020E-06
TH-228	4.550E+01	8.080E-04	3.450E-01	1.650E-04	6.390E-06	9.410E-03
RA-228	4.550E+01	1.440E-03	5.080E-03	1.090E-04	3.740E-06	5.590E-03

Source: 4
Location:: Room : 1 x: 3.00 y: 0.00 z: 1.50[m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: y
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External (Volume)	Submersion
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
TH-232	4.550E+01	2.730E-03	1.640E+00	6.450E-08	3.260E-10	1.020E-06
TH-228	4.550E+01	8.080E-04	3.450E-01	1.650E-04	6.390E-06	9.410E-03
RA-228	4.550E+01	1.440E-03	5.080E-03	1.090E-04	3.740E-06	5.590E-03

Title : KMTC natural Th Evaluation
Input File : C:\WINBLD\TC_THNAT.I

Source: 5
Location:: Room : 1 x: 6.00 y: 3.00 z: 1.50[m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External Submersion (Volume)	
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
TH-232	4.550E+01	2.730E-03	1.640E+00	6.450E-08	3.260E-10	1.020E-06
TH-228	4.550E+01	8.080E-04	3.450E-01	1.650E-04	6.390E-06	9.410E-03
RA-228	4.550E+01	1.440E-03	5.080E-03	1.090E-04	3.740E-06	5.590E-03

Source: 6
Location:: Room : 1 x: 3.00 y: 6.00 z: 1.50[m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: y
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External Submersion (Volume)	
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
TH-232	4.550E+01	2.730E-03	1.640E+00	6.450E-08	3.260E-10	1.020E-06
TH-228	4.550E+01	8.080E-04	3.450E-01	1.650E-04	6.390E-06	9.410E-03
RA-228	4.550E+01	1.440E-03	5.080E-03	1.090E-04	3.740E-06	5.590E-03

Title : KMTC natural Th Evaluation
Input File : C:\WINBLD\TC_THNAT.IEvaluation Time: 0.000000 years

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ÍÍÍ Assessment for Time: 1 ÍÍÍ
ÍÍÍ Time =0.00E+00 yr ÍÍÍ
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ÍÍÍÍÍÍÍÍ Source Information ÍÍÍÍÍÍÍÍ

Source: 1
Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m]
Geometry:: Type: Area Area:3.60E+01 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::	Nuclide	Concentration [pCi/m2]
	TH-232	4.550E+01
	TH-228	4.550E+01
	RA-228	4.550E+01

Source: 2
Location:: Room : 1 x: 3.00 y: 3.00 z: 3.00 [m]
Geometry:: Type: Area Area:3.60E+01 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::	Nuclide	Concentration [pCi/m2]
	TH-232	4.550E+01
	TH-228	4.550E+01
	RA-228	4.550E+01

Title : KMTC natural Th Evaluation
Input File : C:\WINBLD\TC_THNAT.IEvaluation Time: 0.000000 years

Source: 3
Location:: Room : 1 x: 0.00 y: 3.00 z: 1.50 [m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::	Nuclide	Concentration [pCi/m2]
	TH-232	4.550E+01
	TH-228	4.550E+01
	RA-228	4.550E+01

Source: 4
Location:: Room : 1 x: 3.00 y: 0.00 z: 1.50 [m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: y
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::	Nuclide	Concentration [pCi/m2]
	TH-232	4.550E+01
	TH-228	4.550E+01
	RA-228	4.550E+01

Title : KMTC natural Th Evaluation
Input File : C:\WINBLD\TC_THNAT.IEvaluation Time: 0.000000 years

Source: 5
Location:: Room : 1 x: 6.00 y: 3.00 z: 1.50 [m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration [pCi/m2]
TH-232 4.550E+01
TH-228 4.550E+01
RA-228 4.550E+01

Source: 6
Location:: Room : 1 x: 3.00 y: 6.00 z: 1.50 [m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: y
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration [pCi/m2]
TH-232 4.550E+01
TH-228 4.550E+01
RA-228 4.550E+01

Title : KMTC natural Th Evaluation
Input File : C:\WINBLD\TC_THNAT.IEvaluation Time: 0.000000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Source 4	Source 5	Source 6	Total
Receptor 1	1.1E-02	1.0E-02	5.1E-03	5.1E-03	5.1E-03	5.1E-03	4.2E-02
Total	1.1E-02	1.0E-02	5.1E-03	5.1E-03	5.1E-03	5.1E-03	4.2E-02

Title : KMTC natural Th Evaluation
Input File : C:\WINBLD\TC_THNAT.IEvaluation Time: 0.000000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	6.23E-04	4.58E-07	5.76E-09	9.51E-03	4.70E-04	3.37E-05
Total	6.23E-04	4.58E-07	5.76E-09	9.51E-03	4.70E-04	3.37E-05

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.34E-04	4.58E-07	5.76E-09	9.51E-03	4.70E-04	3.37E-05
Total	3.34E-04	4.58E-07	5.76E-09	9.51E-03	4.70E-04	3.37E-05

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.20E-04	2.29E-07	2.88E-09	4.76E-03	2.35E-04	1.69E-05
Total	1.20E-04	2.29E-07	2.88E-09	4.76E-03	2.35E-04	1.69E-05

Source: 4

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.20E-04	2.29E-07	2.88E-09	4.76E-03	2.35E-04	1.69E-05
Total	1.20E-04	2.29E-07	2.88E-09	4.76E-03	2.35E-04	1.69E-05

Source: 5

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.20E-04	2.29E-07	2.88E-09	4.76E-03	2.35E-04	1.69E-05
Total	1.20E-04	2.29E-07	2.88E-09	4.76E-03	2.35E-04	1.69E-05

Source: 6

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.20E-04	2.29E-07	2.88E-09	4.76E-03	2.35E-04	1.69E-05
Total	1.20E-04	2.29E-07	2.88E-09	4.76E-03	2.35E-04	1.69E-05

Nuclide Detail of Doses
[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-232		
TH-232	7.90E-03	7.90E-03
TH-228		
TH-228	2.46E-03	2.46E-03
RA-228		
RA-228	2.86E-04	2.86E-04

Source: 2

Nuclide	Receptor 1	Total
TH-232		
TH-232	7.90E-03	7.90E-03
TH-228		
TH-228	2.29E-03	2.29E-03
RA-228		
RA-228	1.69E-04	1.69E-04

Source: 3

Nuclide	Receptor 1	Total
TH-232		
TH-232	3.95E-03	3.95E-03
TH-228		
TH-228	1.12E-03	1.12E-03
RA-228		
RA-228	6.56E-05	6.56E-05

Source: 4

Nuclide	Receptor 1	Total
TH-232		
TH-232	3.95E-03	3.95E-03
TH-228		
TH-228	1.12E-03	1.12E-03
RA-228		
RA-228	6.56E-05	6.56E-05

Source: 5

Nuclide	Receptor 1	Total
TH-232		
TH-232	3.95E-03	3.95E-03
TH-228		
TH-228	1.12E-03	1.12E-03
RA-228		
RA-228	6.56E-05	6.56E-05

Source: 6

Nuclide	Receptor 1	Total
TH-232		
TH-232	3.95E-03	3.95E-03
TH-228		
TH-228	1.12E-03	1.12E-03
RA-228		
RA-228	6.56E-05	6.56E-05

RESRAD-BUILD Dose (Time) Tables

Receptor Doses Received for the Exposure Duration
(mrem)

	Evaluation Time [yr]
	0.00E+00
1	4.15E-02

Receptor Dose/Yr Averaged Over Exposure Duration
(mrem/yr)

	Evaluation Time [yr]
	0.00E+00
1	4.15E-02

Title : KMTC U-238 to U-234 Evaluation
Input File : C:\WINBLD\TC_238A.IN

RESRAD-BUILD Table of Contents

Title : KMTC U-238 to U-234 Evaluation
Input File : C:\WINBLD\TC_238A.IN

RESRAD-BUILD Input Parameters

Number of Sources : 6
Number of Receptors: 1
Total Time : 3.650000E+02 days
Fraction Inside : 7.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	3.000	3.000	1.000	0.330	3.36E+01	1.00E-04

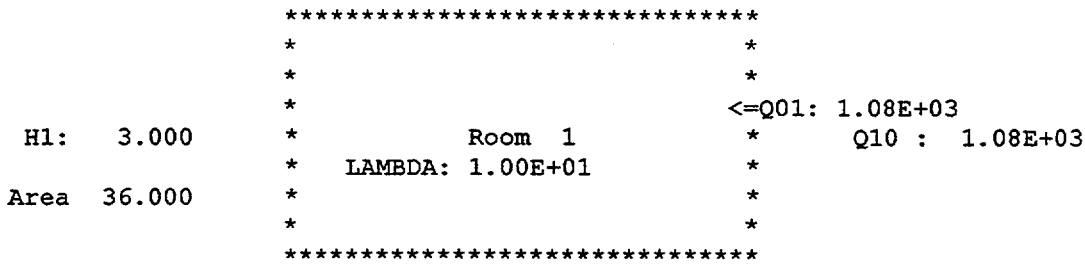
Receptor-Source Shielding Relationship

Receptor	Source	Density [g/cm3]	Thickness [cm]	Material
1	1	2.40E+00	0.00E+00	Concrete
1	2	2.40E+00	0.00E+00	Concrete
1	3	2.40E+00	0.00E+00	Concrete
1	4	2.40E+00	0.00E+00	Concrete
1	5	2.40E+00	0.00E+00	Concrete
1	6	2.40E+00	0.00E+00	Concrete

ÍÍÍÍÍÍÍÍ Building Information ÍÍÍÍÍÍÍÍ

Building Air Exchange Rate: 1.00E+01 1/hr

Height[m] Air Exchanges [m3/hr]
Area [m2]



Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s]

Title : KMTC U-238 to U-234 Evaluation
Input File : C:\WINBLD\TC_238A.IN

íííííííí Source Information íííííííí

Source: 1
Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00[m]
Geometry:: Type: Area Area:3.60E+01 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External (Volume)	Submersion
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
U-238	4.550E+01	2.690E-04	1.180E-01	3.530E-06	9.510E-08	1.600E-04
U-235	2.100E+00	2.670E-04	1.230E-01	1.950E-05	4.740E-07	9.030E-04
U-234	4.550E+01	2.830E-04	1.320E-01	8.750E-08	2.520E-10	8.930E-07
PA-231	0.000E+00	1.060E-02	1.280E+00	4.760E-06	1.190E-07	2.010E-04
TH-230	0.000E+00	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
AC-227	0.000E+00	1.480E-02	6.720E+00	4.530E-05	1.260E-06	2.160E-03
RA-226	0.000E+00	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	0.000E+00	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Source: 2
Location:: Room : 1 x: 3.00 y: 3.00 z: 3.00[m]
Geometry:: Type: Area Area:3.60E+01 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External (Volume)	Submersion
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
U-238	4.550E+01	2.690E-04	1.180E-01	3.530E-06	9.510E-08	1.600E-04
U-235	2.100E+00	2.670E-04	1.230E-01	1.950E-05	4.740E-07	9.030E-04
U-234	4.550E+01	2.830E-04	1.320E-01	8.750E-08	2.520E-10	8.930E-07
PA-231	0.000E+00	1.060E-02	1.280E+00	4.760E-06	1.190E-07	2.010E-04
TH-230	0.000E+00	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
AC-227	0.000E+00	1.480E-02	6.720E+00	4.530E-05	1.260E-06	2.160E-03
RA-226	0.000E+00	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	0.000E+00	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Title : KMTC U-238 to U-234 Evaluation
Input File : C:\WINBLD\TC_238A.IN

Source: 3
Location:: Room : 1 x: 0.00 y: 3.00 z: 1.50[m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External (Volume)	Submersion
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
U-238	4.550E+01	2.690E-04	1.180E-01	3.530E-06	9.510E-08	1.600E-04
U-235	2.100E+00	2.670E-04	1.230E-01	1.950E-05	4.740E-07	9.030E-04
U-234	4.550E+01	2.830E-04	1.320E-01	8.750E-08	2.520E-10	8.930E-07
PA-231	0.000E+00	1.060E-02	1.280E+00	4.760E-06	1.190E-07	2.010E-04
TH-230	0.000E+00	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
AC-227	0.000E+00	1.480E-02	6.720E+00	4.530E-05	1.260E-06	2.160E-03
RA-226	0.000E+00	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	0.000E+00	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Title : KMTC U-238 to U-234 Evaluation
Input File : C:\WINBLD\TC_238A.IN

Source: 4
Location:: Room : 1 x: 3.00 y: 0.00 z: 1.50[m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: y
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External (Volume)	Submersion
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
U-238	4.550E+01	2.690E-04	1.180E-01	3.530E-06	9.510E-08	1.600E-04
U-235	2.100E+00	2.670E-04	1.230E-01	1.950E-05	4.740E-07	9.030E-04
U-234	4.550E+01	2.830E-04	1.320E-01	8.750E-08	2.520E-10	8.930E-07
PA-231	0.000E+00	1.060E-02	1.280E+00	4.760E-06	1.190E-07	2.010E-04
TH-230	0.000E+00	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
AC-227	0.000E+00	1.480E-02	6.720E+00	4.530E-05	1.260E-06	2.160E-03
RA-226	0.000E+00	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	0.000E+00	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Title : KMTC U-238 to U-234 Evaluation
Input File : C:\WINBLD\TC_238A.IN

Source: 5
Location:: Room : 1 x: 6.00 y: 3.00 z: 1.50[m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External (Volume)	Submersion
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
U-238	4.550E+01	2.690E-04	1.180E-01	3.530E-06	9.510E-08	1.600E-04
U-235	2.100E+00	2.670E-04	1.230E-01	1.950E-05	4.740E-07	9.030E-04
U-234	4.550E+01	2.830E-04	1.320E-01	8.750E-08	2.520E-10	8.930E-07
PA-231	0.000E+00	1.060E-02	1.280E+00	4.760E-06	1.190E-07	2.010E-04
TH-230	0.000E+00	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
AC-227	0.000E+00	1.480E-02	6.720E+00	4.530E-05	1.260E-06	2.160E-03
RA-226	0.000E+00	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	0.000E+00	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Source: 6
Location:: Room : 1 x: 3.00 y: 6.00 z: 1.50[m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: y
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External (Volume)	Submersion
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
U-238	4.550E+01	2.690E-04	1.180E-01	3.530E-06	9.510E-08	1.600E-04
U-235	2.100E+00	2.670E-04	1.230E-01	1.950E-05	4.740E-07	9.030E-04
U-234	4.550E+01	2.830E-04	1.320E-01	8.750E-08	2.520E-10	8.930E-07
PA-231	0.000E+00	1.060E-02	1.280E+00	4.760E-06	1.190E-07	2.010E-04
TH-230	0.000E+00	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
AC-227	0.000E+00	1.480E-02	6.720E+00	4.530E-05	1.260E-06	2.160E-03
RA-226	0.000E+00	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	0.000E+00	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Title : KMTC U-238 to U-234 Evaluation
Input File : C:\WINBLD\TC_238A.INEvaluation Time: 0.000000 years

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ííí Assessment for Time: 1 ííí
ííí Time =0.00E+00 yr ííí
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íííííííí Source Information íííííííí

Source: 1
Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m]
Geometry:: Type: Area Area:3.60E+01 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [pCi/m2]
U-238	4.550E+01
U-235	2.100E+00
U-234	4.550E+01
PA-231	0.000E+00
TH-230	0.000E+00
AC-227	0.000E+00
RA-226	0.000E+00
PB-210	0.000E+00

Title : KMTC U-238 to U-234 Evaluation
Input File : C:\WINBLD\TC_238A.INEvaluation Time: 0.000000 years

Source: 2
Location:: Room : 1 x: 3.00 y: 3.00 z: 3.00 [m]
Geometry:: Type: Area Area:3.60E+01 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration [pCi/m2]

Nuclide	Concentration [pCi/m2]
U-238	4.550E+01
U-235	2.100E+00
U-234	4.550E+01
PA-231	0.000E+00
TH-230	0.000E+00
AC-227	0.000E+00
RA-226	0.000E+00
PB-210	0.000E+00

Source: 3
Location:: Room : 1 x: 0.00 y: 3.00 z: 1.50 [m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration [pCi/m2]

Nuclide	Concentration [pCi/m2]
U-238	4.550E+01
U-235	2.100E+00
U-234	4.550E+01
PA-231	0.000E+00
TH-230	0.000E+00
AC-227	0.000E+00
RA-226	0.000E+00
PB-210	0.000E+00

Title : KMTC U-238 to U-234 Evaluation
Input File : C:\WINBLD\TC_238A.INEvaluation Time: 0.000000 years

Source: 4
Location:: Room : 1 x: 3.00 y: 0.00 z: 1.50 [m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: y
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [pCi/m2]
U-238	4.550E+01
U-235	2.100E+00
U-234	4.550E+01
PA-231	0.000E+00
TH-230	0.000E+00
AC-227	0.000E+00
RA-226	0.000E+00
PB-210	0.000E+00

Source: 5
Location:: Room : 1 x: 6.00 y: 3.00 z: 1.50 [m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [pCi/m2]
U-238	4.550E+01
U-235	2.100E+00
U-234	4.550E+01
PA-231	0.000E+00
TH-230	0.000E+00
AC-227	0.000E+00
RA-226	0.000E+00
PB-210	0.000E+00

Title : KMTC U-238 to U-234 Evaluation
Input File : C:\WINBLD\TC_238A.INEvaluation Time: 0.000000 years

Source: 6
Location:: Room : 1 x: 3.00 y: 6.00 z: 1.50 [m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: y
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [pCi/m2]
U-238	4.550E+01
U-235	2.100E+00
U-234	4.550E+01
PA-231	0.000E+00
TH-230	0.000E+00
AC-227	0.000E+00
RA-226	0.000E+00
PB-210	0.000E+00

Title : KMTC U-238 to U-234 Evaluation
Input File : C:\WINBLD\TC_238A.INEvaluation Time: 0.000000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Source 4	Source 5	Source 6	Total
Receptor 1	1.2E-03	1.2E-03	6.2E-04	6.2E-04	6.2E-04	6.2E-04	5.0E-03
Total	1.2E-03	1.2E-03	6.2E-04	6.2E-04	6.2E-04	6.2E-04	5.0E-03

Pathway Detail of Doses
[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.04E-05	7.92E-09	7.94E-11	1.23E-03	1.92E-30	3.87E-06
Total	1.04E-05	7.92E-09	7.94E-11	1.23E-03	1.92E-30	3.87E-06

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	5.51E-06	7.92E-09	7.94E-11	1.23E-03	1.92E-30	3.87E-06
Total	5.51E-06	7.92E-09	7.94E-11	1.23E-03	1.92E-30	3.87E-06

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.97E-06	3.96E-09	3.97E-11	6.14E-04	9.59E-31	1.94E-06
Total	1.97E-06	3.96E-09	3.97E-11	6.14E-04	9.59E-31	1.94E-06

Source: 4

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.97E-06	3.96E-09	3.97E-11	6.14E-04	9.59E-31	1.94E-06
Total	1.97E-06	3.96E-09	3.97E-11	6.14E-04	9.59E-31	1.94E-06

Source: 5

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.97E-06	3.96E-09	3.97E-11	6.14E-04	9.59E-31	1.94E-06
Total	1.97E-06	3.96E-09	3.97E-11	6.14E-04	9.59E-31	1.94E-06

Source: 6

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.97E-06	3.96E-09	3.97E-11	6.14E-04	9.59E-31	1.94E-06
Total	1.97E-06	3.96E-09	3.97E-11	6.14E-04	9.59E-31	1.94E-06

Title : KMTC U-238 to U-234 Evaluation
Input File : C:\WINBLD\TC_238A.INEvaluation Time: 0.000000 years

Nuclide Detail of Doses
[mrem]

Source: 1

Nuclide	Receptor 1	Total
U-238		
U-238	5.77E-04	5.77E-04
U-235		
U-235	2.93E-05	2.93E-05
U-234		
U-234	6.36E-04	6.36E-04

Source: 2

Nuclide	Receptor 1	Total
U-238		
U-238	5.73E-04	5.73E-04
U-235		
U-235	2.84E-05	2.84E-05
U-234		
U-234	6.36E-04	6.36E-04

Source: 3

Nuclide	Receptor 1	Total
U-238		
U-238	2.86E-04	2.86E-04
U-235		
U-235	1.40E-05	1.40E-05
U-234		
U-234	3.18E-04	3.18E-04

Source: 4

Nuclide	Receptor 1	Total
U-238		
U-238	2.86E-04	2.86E-04
U-235		
U-235	1.40E-05	1.40E-05
U-234		
U-234	3.18E-04	3.18E-04

Source: 5

Nuclide	Receptor 1	Total
U-238		
U-238	2.86E-04	2.86E-04
U-235		
U-235	1.40E-05	1.40E-05
U-234		
U-234	3.18E-04	3.18E-04

Source: 6

Nuclide	Receptor 1	Total
U-238		
U-238	2.86E-04	2.86E-04
U-235		
U-235	1.40E-05	1.40E-05
U-234		
U-234	3.18E-04	3.18E-04

RESRAD-BUILD Dose (Time) Tables

Receptor Doses Received for the Exposure Duration
(mrem)

	Evaluation Time [yr]
	0.00E+00
1	4.95E-03

Receptor Dose/Yr Averaged Over Exposure Duration
(mrem/yr)

	Evaluation Time [yr]
	0.00E+00
1	4.95E-03

Title : KMTC Th-230 to end of chain Evaluation
Input File : C:\WINBLD\TC_230A.IN

RESRAD-BUILD Table of Contents

Title : KMTC Th-230 to end of chain Evaluation
Input File : C:\WINBLD\TC_230A.IN

RESRAD-BUILD Input Parameters

Number of Sources : 6
Number of Receptors: 1
Total Time : 3.650000E+02 days
Fraction Inside : 7.000000E-01

Receptor Information

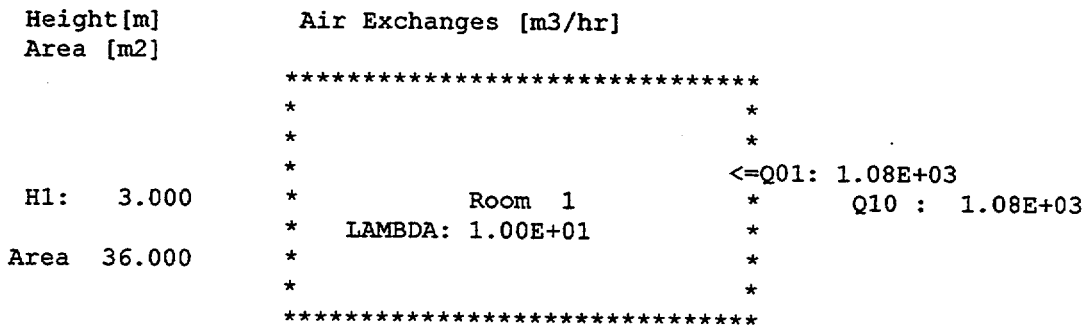
Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	3.000	3.000	1.000	0.330	3.36E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor	Source	Density [g/cm3]	Thickness [cm]	Material
1	1	2.40E+00	0.00E+00	Concrete
1	2	2.40E+00	0.00E+00	Concrete
1	3	2.40E+00	0.00E+00	Concrete
1	4	2.40E+00	0.00E+00	Concrete
1	5	2.40E+00	0.00E+00	Concrete
1	6	2.40E+00	0.00E+00	Concrete

ÍÍÍÍÍÍÍÍ Building Information ÍÍÍÍÍÍÍÍ

Building Air Exchange Rate: 1.00E+01 1/hr



Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s]

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Source: 1
Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00[m]
Geometry:: Type: Area Area:3.60E+01 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External Submersion (Volume)	
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
TH-230	4.550E+01	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
RA-226	4.550E+01	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	4.550E+01	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Source: 2
Location:: Room : 1 x: 3.00 y: 3.00 z: 3.00[m]
Geometry:: Type: Area Area:3.60E+01 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External Submersion (Volume)	
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
TH-230	4.550E+01	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
RA-226	4.550E+01	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	4.550E+01	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Source: 3
Location:: Room : 1 x: 0.00 y: 3.00 z: 1.50[m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External Submersion (Volume)	
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
TH-230	4.550E+01	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
RA-226	4.550E+01	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	4.550E+01	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Source: 4
Location:: Room : 1 x: 3.00 y: 0.00 z: 1.50[m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: y
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External Submersion (Volume)	
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
TH-230	4.550E+01	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
RA-226	4.550E+01	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	4.550E+01	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Source: 5
Location:: Room : 1 x: 6.00 y: 3.00 z: 1.50[m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External (Volume)	Submersion
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
TH-230	4.550E+01	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
RA-226	4.550E+01	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	4.550E+01	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Source: 6
Location:: Room : 1 x: 3.00 y: 6.00 z: 1.50[m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: y
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 1.000E-01
Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factors				
		Ingestion	Inhalation	External (Surface)	External (Volume)	Submersion
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/ (pCi/m2)]	[mrem/yr/ (pCi/m3)]	[mrem/yr/ (pCi/m3)]
TH-230	4.550E+01	5.480E-04	3.260E-01	8.780E-08	7.570E-10	2.040E-06
RA-226	4.550E+01	1.330E-03	8.600E-03	1.940E-04	7.000E-06	1.040E-02
PB-210	4.550E+01	7.270E-03	2.320E-02	4.140E-07	3.820E-09	1.430E-05

Title : KMTC Th-230 to end of chain Evaluation
Input File : C:\WINBLD\TC_230A.INEvaluation Time: 0.000000 years

íí
íí
ííí Assessment for Time: 1 ííí
ííí Time =0.00E+00 yr ííí
íí
íí

íííííííí Source Information íííííííí

Source: 1
Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m]
Geometry:: Type: Area Area:3.60E+01 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration [pCi/m2]
TH-230 4.550E+01
RA-226 4.550E+01
PB-210 4.550E+01

Source: 2
Location:: Room : 1 x: 3.00 y: 3.00 z: 3.00 [m]
Geometry:: Type: Area Area:3.60E+01 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration [pCi/m2]
TH-230 4.550E+01
RA-226 4.550E+01
PB-210 4.550E+01

Title : KMTC Th-230 to end of chain Evaluation
Input File : C:\WINBLD\TC_230A.INEvaluation Time: 0.000000 years

Source: 3
Location:: Room : 1 x: 0.00 y: 3.00 z: 1.50 [m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::	Nuclide	Concentration [pCi/m2]
	TH-230	4.550E+01
	RA-226	4.550E+01
	PB-210	4.550E+01

Source: 4
Location:: Room : 1 x: 3.00 y: 0.00 z: 1.50 [m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: y
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::	Nuclide	Concentration [pCi/m2]
	TH-230	4.550E+01
	RA-226	4.550E+01
	PB-210	4.550E+01

Title : KMTC Th-230 to end of chain Evaluation
Input File : C:\WINBLD\TC_230A.INEvaluation Time: 0.000000 years

Source: 5
Location:: Room : 1 x: 6.00 y: 3.00 z: 1.50 [m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: x
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration [pCi/m2]
TH-230 4.550E+01
RA-226 4.550E+01
PB-210 4.550E+01

Source: 6
Location:: Room : 1 x: 3.00 y: 6.00 z: 1.50 [m]
Geometry:: Type: Area Area:1.80E+01 [m2] Direction: y
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration [pCi/m2]
TH-230 4.550E+01
RA-226 4.550E+01
PB-210 4.550E+01

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Source 2	Source 3	Source 4	Source 5	Source 6	Total
Receptor 1	2.2E-03	2.0E-03	9.8E-04	9.8E-04	9.8E-04	9.8E-04	8.2E-03
Total	2.2E-03	2.0E-03	9.8E-04	9.8E-04	9.8E-04	9.8E-04	8.2E-03

Title : KMTC Th-230 to end of chain Evaluation
Input File : C:\WINBLD\TC_230A.INEvaluation Time: 0.000000 years

Pathway Detail of Doses
[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	4.53E-04	3.45E-07	4.08E-09	1.72E-03	3.31E-06	6.25E-05
Total	4.53E-04	3.45E-07	4.08E-09	1.72E-03	3.31E-06	6.25E-05

Source: 2

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.42E-04	3.45E-07	4.08E-09	1.72E-03	3.31E-06	6.25E-05
Total	2.42E-04	3.45E-07	4.08E-09	1.72E-03	3.31E-06	6.25E-05

Source: 3

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.71E-05	1.72E-07	2.04E-09	8.59E-04	1.65E-06	3.13E-05
Total	8.71E-05	1.72E-07	2.04E-09	8.59E-04	1.65E-06	3.13E-05

Source: 4

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.71E-05	1.72E-07	2.04E-09	8.59E-04	1.65E-06	3.13E-05
Total	8.71E-05	1.72E-07	2.04E-09	8.59E-04	1.65E-06	3.13E-05

Source: 5

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.71E-05	1.72E-07	2.04E-09	8.59E-04	1.65E-06	3.13E-05
Total	8.71E-05	1.72E-07	2.04E-09	8.59E-04	1.65E-06	3.13E-05

Source: 6

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	8.71E-05	1.72E-07	2.04E-09	8.59E-04	1.65E-06	3.13E-05
Total	8.71E-05	1.72E-07	2.04E-09	8.59E-04	1.65E-06	3.13E-05

Nuclide Detail of Doses
[mrem]

Source: 1

Nuclide	Receptor 1	Total
TH-230		
TH-230	1.57E-03	1.57E-03
RA-226		
RA-226	5.05E-04	5.05E-04
PB-210		
PB-210	1.63E-04	1.63E-04

Source: 2

Nuclide	Receptor 1	Total
TH-230		
TH-230	1.57E-03	1.57E-03
RA-226		
RA-226	2.95E-04	2.95E-04
PB-210		
PB-210	1.62E-04	1.62E-04

Source: 3

Nuclide	Receptor 1	Total
TH-230		
TH-230	7.85E-04	7.85E-04
RA-226		
RA-226	1.14E-04	1.14E-04
PB-210		
PB-210	8.07E-05	8.07E-05

Title : KMTC Th-230 to end of chain Evaluation
Input File : C:\WINBLD\TC_230A.INEvaluation Time: 0.000000 years

Source: 4

Nuclide	Receptor 1	Total
TH-230		
TH-230	7.85E-04	7.85E-04
RA-226		
RA-226	1.14E-04	1.14E-04
PB-210		
PB-210	8.07E-05	8.07E-05

Source: 5

Nuclide	Receptor 1	Total
TH-230		
TH-230	7.85E-04	7.85E-04
RA-226		
RA-226	1.14E-04	1.14E-04
PB-210		
PB-210	8.07E-05	8.07E-05

Source: 6

Nuclide	Receptor 1	Total
TH-230		
TH-230	7.85E-04	7.85E-04
RA-226		
RA-226	1.14E-04	1.14E-04
PB-210		
PB-210	8.07E-05	8.07E-05

Title : KMTC Th-230 to end of chain Evaluation
Input File : C:\WINBLD\TC_230A.IN

RESRAD-BUILD Dose (Time) Tables

Receptor Doses Received for the Exposure Duration
(mrem)

	Evaluation Time [yr]
	0.00E+00
1	8.18E-03

Receptor Dose/Yr Averaged Over Exposure Duration
(mrem/yr)

	Evaluation Time [yr]
	0.00E+00
1	8.19E-03

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TECHNICAL MEMORANDUM

April 3, 2001

Originator: A.H. Thatcher, CHP, Senior HP Scientist

Subject: ***Derivation of Outdoor Scan Thresholds and MDCR for KMTC***

Revision: 1

ENDORSEMENT: This document contains the results of research and technical analysis which have been reviewed and approved for publication by the Technical Director, NEXTEP Environmental, Inc.

Harry J. Newman, CHP, Technical Director — Date 4/4/01

Introduction

Soil sample measurements taken during Final Status Survey (FSS) of outdoor areas at KMTC will be supplemented by scans to ensure that Elevated Measurements Criteria (EMC) are not exceeded in the area between the soil samples in the array. For a given value of DCGLw, the maximum concentration permissible in any given area (EMC) is determined by the area factor. To make sure that no unacceptable hot spots are left in the areas between the soil samples it will be necessary to ensure that the MDC associated with the detector used to scan the area is less than the corresponding EMC value.

This analysis derives a correlation between soil specific activity concentration and the count rate expected using a shielded 3"x0.5" NaI detector, calculates the Minimum Detectable Count Rate (MDCR) for the detector, and relates the sample grid spacing interval to the scan threshold required to detect the EMC concentration in the largest possible circular space that can be drawn between neighboring soil samples.

The initial assumptions for all calculations are as follows:

- A class 1 survey unit exists with an area of 2,000 m^2. Using a relative shift of 1, the required number of samples is estimated as 33. This gives a grid spacing on the order of 7.8 m and an estimated area of elevated activity (the circular area inside of 4 grid points) of 93 m^2. It is the 93 m^2 elevated area of contamination that the scan surveys must be able to sufficiently identify.

- The DCGLw release limits for the three series are as follows:

  1. Natural Thorium – 5.2 pCi/g above background
  2. Ra-226 and progeny – 3.5 pCi/g above background (includes Th-230)
  3. Uranium 238 to Uranium 234 – 170 pCi/g above background

- The related $DCGL_{EMC}$ value for each release limit based upon the nuclide specific area factor[1] for the 93 m^2 area and is:

  1. Natural Thorium – 9.4 pCi/g above background
  4. Ra-226 and progeny – 7 pCi/g above background (includes Th-230)
  2. Uranium 238 to Uranium 234 – 350 pCi/g above background

- The detector is assumed to be held a fixed measurement distance of 5 cm from the ground surface. Each series release limit is assumed to uniformly exist to a depth of 15 cm to a radius of 1 meter[2]. The soil used for analysis is a Federal Guidance Report[3] #12 nipe clay (without iron) at a density of 1.6 g/cm^3.

Methodology for Conversion from Contaminant Concentration to CPM

The calculation of converting a given contaminant to counts for the NaI detector involves a number of steps. Conceptually, the conversion is performed by determining the fluence at a point 5 cm above the ground, the attenuation at that point is then calculated for NaI whereby the result is converted for the actual area of the detector. The steps are:

1. Using the Microshield computer code, the fluence rate at a point 5 cm above the circle of elevated activity is calculated by taking into consideration the contribution from a series of concentric rings around the detector. The contribution is segregated into finite energy increments. Attachment 1 provides calculated photon fluence rate for 10 increments of increasing radius for the three release limits.

2. The mass attenuation coefficient for NaI is then determined for each energy increment.

3. Corrections are then made for the area of the detector and the path traveled through the detector based upon the angular distance from each ring. For example, the second ring calculated is an average distance of 10.3 cm from the center of the probe (See Attachment 2). The effective area of the probe is reduced from 45.6cm^2 by the factor of Cos 64° (0.44), and becomes approximately 20 cm^2. Correspondingly, the average path length through the detector is assumed to increase from 1.3cm (0.5 inch) to 2.9 cm [detector thickness/(Cos 64°)]. For other angles, the

[1] See A.H. Thatcher, Tech Memo: Derivation of Surface Soil DCGL's for KMTC, Rev. 1, April 3 , 2001.
[2] One meter in radius effectively approximates an infinite horizon for a probe 5 cm from the ground surface.
[3] Eckerman, K.F., and J.C. Ryman, *External Exposure to Radionuclides in Air, Water, and Soil*, Federal Guidance Report No. 12, U.S. EPA, Washington D.C., 1993.

effective probe area was modified based upon the geometry. The path length through the detector was changed as appropriate but was maximized at 4cm[4] for source to detector distances greater than 26cm.

4. The counts for energy increment per annulus are then calculated using the formula:

$$[(\Phi_{outerring} - \Phi_{innerring}) * Area_{probe} * Cos\theta] * [1 - e^{(-\mu*(x/\cos\theta))}] \quad \text{Equation 1}$$

Where:

Φ = Fluence rate at the detector (photons/cm²/s)[5]

μ = Energy specific mass attenuation coefficient (cm²/g)

x = detector thickness (g/cm²)

5. The results are then summed for each annulus energy increment. The results for each release limit are analyzed and summarized in Attachment 2.

Results of Conversion from Contaminant Concentration to CPM

Based upon the results in Attachment 2, the conversion from an estimated uniform ground contamination to counts observed on the detector is summarized in Table 1.

Table 1
Unit conversion for Uniform Radionuclide Concentration in Soil to CPM for the 3" x 0.5" NaI Detector

Radionuclide	Unit Conversion (cpm/pCi/g)
Th-232 and progeny	1140
Uranium Series through U-234	38
Ra-226 and progeny	840

Evaluation of Instrument's Ability to Measurement Elevated Counts

Characterization measurements taken at KMTC for which both NaI scan data and soil spectroscopy data were available were used in order to provide experimental confirmation of the conversion factors in Table 1. The Elevated Sample Data Summary[6] Report was used to provide

[4] The 4 cm is taken as the average path length traveled through the detector.
[5] The MICROSHIELD code calculates the fluence from a total area. An inner annulus is therefore subtracted in order to obtain the fluence from the desired concentric ring.
[6] Laboratory summary of data by W.A. Rogers, October 11, 2000.

the soil concentrations and the reported counts from the NaI detector. The conversion factors in Table 1 were applied to the soil concentrations and are compared graphically in Figure 1 to the reported scan counts in the same report. The correlation coefficient for the data set is 0.845. The scan conversion factors in table 1 correlate soil concentrations with NaI scan count rates with sufficient accuracy to detect elevated concentrations during final status surveys.

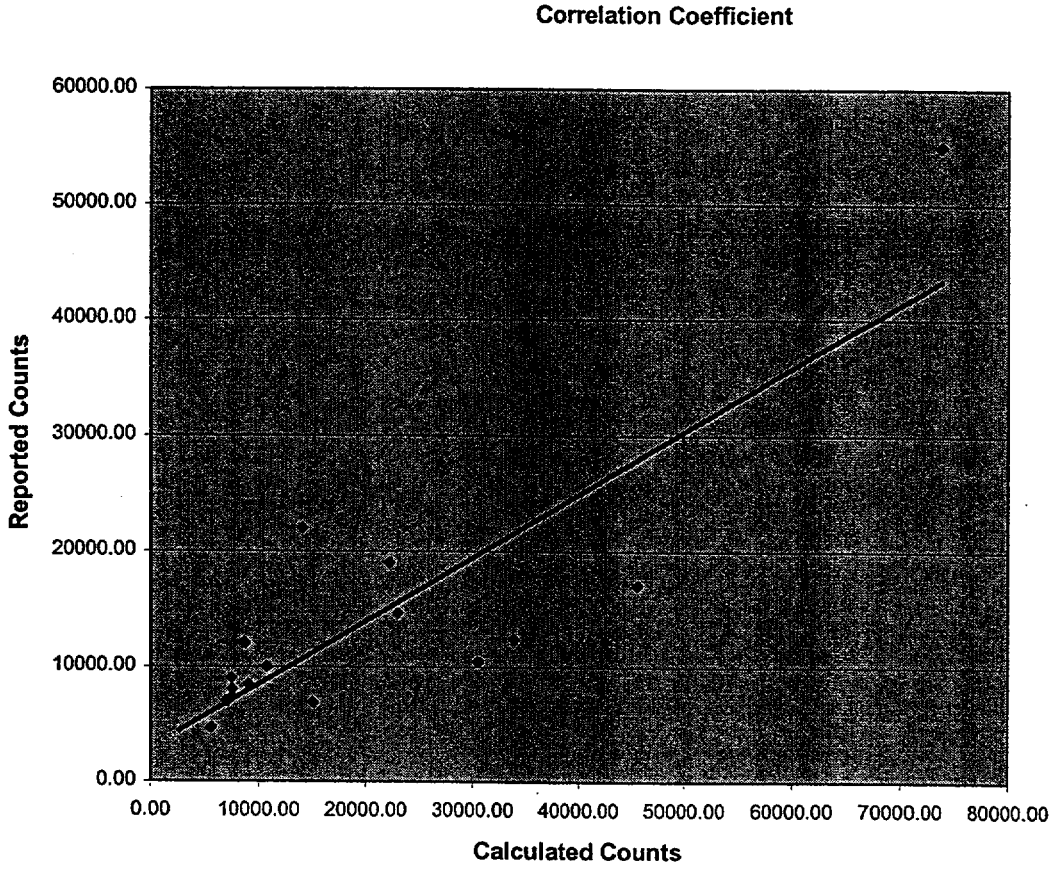

Figure 1
Correlation of NaI Scans With Measured Soil Concentrations

Calculation of Scan MDCR for 3"x0.5" NaI Detectors at KMTC

Scans will be utilized during Final Status Surveys in order to ensure that elevated areas of activity are not missed. The Scan MDCR is required to be less than the count rate corresponding to the EMC value to be detected. Using an average background count of 4,000cpm for the KMTC site, the Minimum Detectable Count Rate (MDCR) is determined using the method that follows:

Equation 2 is used to calculate the Scan MDCR (or MDCR of the surveyor)[7].

[7] Equation 6-10 of MARSSIM modified to report in terms of a count rate.

$$ScanMDCR = \frac{MDCR}{\sqrt{P} * \varepsilon_s}$$ Equation 2

Where

MDCR = minimum detectable count rate

ε_s = surface efficiency[8]
p = surveyor efficiency. Typical value of 0.5 will be used [9]

Equation 3 is needed to calculate the MDCR.

$$s_i = d' \sqrt{b_i}$$ Equation 3

Where:

s_i = minimum detectable number of net source counts in the assumed interval
d' = desired scanning performance[10].
b_i = number of background counts in the probe observation interval

Scan MDCR Calculations

The following calculations are based upon an assumed scan (probe) speed of 0.5 m/s.

b_i = 4,000 cpm * 1 sec * (1 min/60 sec) = 66.7 counts

$$MDCR = 1.38 * \sqrt{66.7} * (60/1) = 680 cpm$$

Where d' = 1.38 which corresponds to 95% correct detections and 60% false positives

$$ScanMDCR = \frac{680}{\sqrt{0.5} * 0.8} = 1200 cpm$$ net or **5200 cpm** gross

The MDCR for the 3"x0.5" NaI detector used to scan soil surfaces at KMTC is 5,200 cpm. This number will not change unless there is a change in the background count for the site.

Comparison of MDCR with EMC Thresholds Expected at KMTC

The initial assumptions listed at the beginning of this paper represent a typical survey unit at the KMTC site and the EMC threshold values calculated for the area between the grid data points are typical of what will be used for scans during a final status survey of the unit. These values are presented in table 2 and compared with the derived count rates using conversion factors from Table 1. The values in Table 2 do not include the background count rates for each nuclide which

[8] 80% is a reasonable value attributed to the attenuation of surface gamma photons for smooth soils.
[9] MARSSIM page 6-23
[10] For a first pass scan, one would generally accept a higher number of false positives in order to obtain a high rate of true positives. See Table 6.5 of MARSSIM.

could be added if desired. An adjustment for surveyor efficiency is also applied. In all three cases the EMC threshold count rates exceed the MDCR for the NaI detector to be used.

Table 2
Calculated Counts for Three $DCGL_{EMC}$ Concentrations

Radionuclide	Typical EMC Concentration Limit (pCi/g)	EMC Threshold * (cpm)
Thorium-232 and progeny	9.4	10,700
Uranium 238 to Uranium 234	350	14,100
Ra-226 and progeny	7	6,800

* Calculated EMC thresholds do not include average background, which may be added if necessary.

Conclusions/Recommendations

The Scan MDCR of 1200 net cpm above background (i.e., approximately 5200 cpm including background) is sufficiently low that the NaI detector can adequately identify locations that exceed the $DCGL_{EMC}$.

Determination of the actual scan threshold to be used in the field should take into consideration factors peculiar to the survey unit and the inaccuracies inherent in the methods described herein and should be published in each Final Status Survey Plan (FSSP).

Attachment 1
MicroShield Data Outputs

NEXTEP Environmental

Photon Fluence Rates for Ra-226 and progeny (including Th-230)

MicroShield v5.03 (5.03-00027)
Results With Buildup

FILE: C:\MS5\DATA\MI\TCTH230.MS5
Case Title: Th-230+ slab
This case was run on Wednesday, February 21, 2001 at 1:59:48 PM
Dose Point # 1 - (0200)cm

Group #	Energy (MeV)	Activity photons/sec	**Fluence Rate photons/cm²/sec**	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
Overall Summary					
1	0.015	4.62E+00	2.70E-07	4.05E-09	3.47E-10
2	0.02	2.66E+01	4.61E-06	9.21E-08	3.19E-09
3	0.03	1.26E+01	8.10E-06	2.43E-07	2.41E-09
4	0.04	2.90E+01	4.78E-05	1.91E-06	8.46E-09
5	0.05	1.19E+05	4.17E-01	2.09E-02	5.55E-05
6	0.06	1.02E+04	5.89E-02	3.53E-03	7.01E-06
7	0.08	6.36E+05	6.42E+00	5.13E-01	8.13E-04
8	0.1	5.79E+03	7.51E-02	7.51E-03	1.15E-05
9	0.15	3.13E+03	4.91E-02	7.36E-03	1.21E-05
10	0.2	2.96E+05	4.81E+00	9.63E-01	1.70E-03
11	0.3	5.70E+05	9.38E+00	2.81E+00	5.34E-03
12	0.4	1.05E+06	1.73E+01	6.93E+00	1.35E-02
13	0.5	4.88E+04	8.11E-01	4.06E-01	7.96E-04
14	0.6	1.32E+06	2.20E+01	1.32E+01	2.58E-02
15	0.8	2.59E+05	4.40E+00	3.52E+00	6.69E-03
16	1	8.55E+05	1.48E+01	1.48E+01	2.74E-02
17	1.5	5.20E+05	9.47E+00	1.42E+01	2.39E-02
18	2	7.30E+05	1.39E+01	2.78E+01	4.30E-02
TOTALS:		6.42E+06	1.04E+02	8.52E+01	1.49E-01
Group 1 of 10 0 - 5cm					
1	0.015	1.16E-02	1.04E-07	1.56E-09	1.34E-10
2	0.02	6.64E-02	1.41E-06	2.81E-08	9.73E-10
3	0.03	3.15E-02	2.28E-06	6.83E-08	6.77E-10
4	0.04	7.25E-02	1.19E-05	4.77E-07	2.11E-09
5	0.05	2.98E+02	8.98E-02	4.49E-03	1.20E-05
6	0.06	2.55E+01	1.09E-02	6.54E-04	1.30E-06
7	0.08	1.59E+03	9.42E-01	7.53E-02	1.19E-04
8	0.1	1.45E+01	9.54E-03	9.54E-04	1.46E-06
9	0.15	7.83E+00	5.30E-03	7.95E-04	1.31E-06
10	0.2	7.40E+02	4.88E-01	9.76E-02	1.72E-04
11	0.3	1.43E+03	8.97E-01	2.69E-01	5.11E-04

12	0.4	2.62E+03	1.60E+00	6.42E-01	1.25E-03
13	0.5	1.22E+02	7.35E-02	3.67E-02	7.21E-05
14	0.6	3.29E+03	1.96E+00	1.18E+00	2.29E-03
15	0.8	6.46E+02	3.80E-01	3.04E-01	5.79E-04
16	1	2.14E+03	1.25E+00	1.25E+00	2.31E-03
17	1.5	1.30E+03	7.62E-01	1.14E+00	1.92E-03
18	2	1.83E+03	1.08E+00	2.15E+00	3.33E-03
TOTALS:		1.60E+04	9.55E+00	7.16E+00	1.26E-02
Group 2 of 10 0 - 15.6cm					
1	0.015	1.12E-01	2.48E-07	3.72E-09	3.19E-10
2	0.02	6.43E-01	3.42E-06	6.83E-08	2.37E-09
3	0.03	3.05E-01	5.86E-06	1.76E-07	1.74E-09
4	0.04	7.02E-01	3.37E-05	1.35E-06	5.97E-09
5	0.05	2.89E+03	2.84E-01	1.42E-02	3.79E-05
6	0.06	2.47E+02	3.83E-02	2.30E-03	4.57E-06
7	0.08	1.54E+04	3.82E+00	3.06E-01	4.84E-04
8	0.1	1.40E+02	4.16E-02	4.16E-03	6.37E-06
9	0.15	7.58E+01	2.46E-02	3.69E-03	6.08E-06
10	0.2	7.16E+03	2.30E+00	4.60E-01	8.12E-04
11	0.3	1.38E+04	4.26E+00	1.28E+00	2.43E-03
12	0.4	2.54E+04	7.64E+00	3.06E+00	5.95E-03
13	0.5	1.18E+03	3.50E-01	1.75E-01	3.44E-04
14	0.6	3.18E+04	9.33E+00	5.60E+00	1.09E-02
15	0.8	6.25E+03	1.81E+00	1.45E+00	2.76E-03
16	1	2.07E+04	5.99E+00	5.99E+00	1.10E-02
17	1.5	1.26E+04	3.66E+00	5.49E+00	9.24E-03
18	2	1.77E+04	5.20E+00	1.04E+01	1.61E-02
TOTALS:		1.55E+05	4.48E+01	3.42E+01	6.01E-02
Group 3 of 10 0 - 26.1cm					
1	0.015	3.15E-01	2.86E-07	4.30E-09	3.68E-10
2	0.02	1.81E+00	4.01E-06	8.01E-08	2.78E-09
3	0.03	8.60E-01	6.92E-06	2.08E-07	2.06E-09
4	0.04	1.98E+00	4.06E-05	1.62E-06	7.17E-09
5	0.05	8.13E+03	3.49E-01	1.75E-02	4.65E-05
6	0.06	6.96E+02	4.84E-02	2.91E-03	5.77E-06
7	0.08	4.33E+04	5.11E+00	4.09E-01	6.47E-04
8	0.1	3.95E+02	5.80E-02	5.80E-03	8.88E-06
9	0.15	2.14E+02	3.60E-02	5.40E-03	8.90E-06
10	0.2	2.02E+04	3.43E+00	6.87E-01	1.21E-03
11	0.3	3.89E+04	6.47E+00	1.94E+00	3.68E-03
12	0.4	7.14E+04	1.17E+01	4.68E+00	9.11E-03
13	0.5	3.33E+03	5.38E-01	2.69E-01	5.28E-04

Attachment 1
MicroShield Data Outputs

14	0.6	8.97E+04	1.44E+01	8.64E+00	1.69E-02
15	0.8	1.76E+04	2.82E+00	2.25E+00	4.28E-03
16	1	5.83E+04	9.33E+00	9.33E+00	1.72E-02
17	1.5	3.54E+04	5.75E+00	8.63E+00	1.45E-02
18	2	4.98E+04	8.22E+00	1.64E+01	2.54E-02
TOTALS:		4.37E+05	6.83E+01	5.33E+01	9.35E-02
Group 4 of 10 0 - 36.7cm					
1	0.015	6.21E-01	2.97E-07	4.45E-09	3.82E-10
2	0.02	3.57E+00	4.27E-06	8.55E-08	2.96E-09
3	0.03	1.70E+00	7.37E-06	2.21E-07	2.19E-09
4	0.04	3.90E+00	4.36E-05	1.74E-06	7.70E-09
5	0.05	1.60E+04	3.77E-01	1.89E-02	5.02E-05
6	0.06	1.37E+03	5.28E-02	3.17E-03	6.29E-06
7	0.08	8.55E+04	5.66E+00	4.53E-01	7.17E-04
8	0.1	7.78E+02	6.53E-02	6.53E-03	9.99E-06
9	0.15	4.21E+02	4.16E-02	6.24E-03	1.03E-05
10	0.2	3.98E+04	4.02E+00	8.04E-01	1.42E-03
11	0.3	7.66E+04	7.68E+00	2.30E+00	4.37E-03
12	0.4	1.41E+05	1.40E+01	5.59E+00	1.09E-02
13	0.5	6.56E+03	6.48E-01	3.24E-01	6.36E-04
14	0.6	1.77E+05	1.74E+01	1.04E+01	2.04E-02
15	0.8	3.48E+04	3.42E+00	2.74E+00	5.21E-03
16	1	1.15E+05	1.14E+01	1.14E+01	2.10E-02
17	1.5	6.99E+04	7.09E+00	1.06E+01	1.79E-02
18	2	9.82E+04	1.02E+01	2.04E+01	3.15E-02
TOTALS:		8.63E+05	8.20E+01	6.51E+01	1.14E-01
Group 5 of 10 0 - 47.2cm					
1	0.015	1.03E+00	2.97E-07	4.45E-09	3.82E-10
2	0.02	5.92E+00	4.42E-06	8.84E-08	3.06E-09
3	0.03	2.81E+00	7.62E-06	2.29E-07	2.26E-09
4	0.04	6.47E+00	4.51E-05	1.80E-06	7.98E-09
5	0.05	2.66E+04	3.92E-01	1.96E-02	5.22E-05
6	0.06	2.28E+03	5.51E-02	3.31E-03	6.57E-06
7	0.08	1.42E+05	5.96E+00	4.77E-01	7.54E-04
8	0.1	1.29E+03	6.91E-02	6.91E-03	1.06E-05
9	0.15	6.98E+02	4.45E-02	6.68E-03	1.10E-05
10	0.2	6.60E+04	4.33E+00	8.66E-01	1.53E-03
11	0.3	1.27E+05	8.33E+00	2.50E+00	4.74E-03
12	0.4	2.34E+05	1.53E+01	6.10E+00	1.19E-02
13	0.5	1.09E+04	7.10E-01	3.55E-01	6.97E-04
14	0.6	2.94E+05	1.91E+01	1.15E+01	2.24E-02
15	0.8	5.76E+04	3.78E+00	3.03E+00	5.76E-03

16	1	1.91E+05	1.27E+01	1.27E+01	2.33E-02
17	1.5	1.16E+05	7.92E+00	1.19E+01	2.00E-02
18	2	1.63E+05	1.15E+01	2.29E+01	3.54E-02
TOTALS:		1.43E+06	9.01E+01	7.23E+01	1.27E-01
Group 6 of 10 0 - 57.8cm					
1	0.015	1.54E+00	2.89E-07	4.34E-09	3.72E-10
2	0.02	8.86E+00	4.50E-06	9.01E-08	3.12E-09
3	0.03	4.21E+00	7.78E-06	2.33E-07	2.31E-09
4	0.04	9.68E+00	4.60E-05	1.84E-06	8.14E-09
5	0.05	3.98E+04	4.01E-01	2.01E-02	5.35E-05
6	0.06	3.41E+03	5.65E-02	3.39E-03	6.73E-06
7	0.08	2.12E+05	6.13E+00	4.91E-01	7.77E-04
8	0.1	1.93E+03	7.14E-02	7.14E-03	1.09E-05
9	0.15	1.05E+03	4.62E-02	6.94E-03	1.14E-05
10	0.2	9.88E+04	4.51E+00	9.02E-01	1.59E-03
11	0.3	1.90E+05	8.73E+00	2.62E+00	4.97E-03
12	0.4	3.50E+05	1.61E+01	6.42E+00	1.25E-02
13	0.5	1.63E+04	7.49E-01	3.74E-01	7.35E-04
14	0.6	4.39E+05	2.02E+01	1.21E+01	2.37E-02
15	0.8	8.63E+04	4.02E+00	3.21E+00	6.11E-03
16	1	2.85E+05	1.35E+01	1.35E+01	2.49E-02
17	1.5	1.74E+05	8.51E+00	1.28E+01	2.15E-02
18	2	2.44E+05	1.24E+01	2.47E+01	3.82E-02
TOTALS:		2.14E+06	9.54E+01	7.72E+01	1.35E-01
Group 7 of 10 0 - 68.3cm					
1	0.015	2.16E+00	2.84E-07	4.26E-09	3.66E-10
2	0.02	1.24E+01	4.56E-06	9.12E-08	3.16E-09
3	0.03	5.89E+00	7.89E-06	2.37E-07	2.35E-09
4	0.04	1.35E+01	4.67E-05	1.87E-06	8.26E-09
5	0.05	5.57E+04	4.07E-01	2.04E-02	5.43E-05
6	0.06	4.77E+03	5.74E-02	3.44E-03	6.84E-06
7	0.08	2.97E+05	6.25E+00	5.00E-01	7.91E-04
8	0.1	2.70E+03	7.29E-02	7.29E-03	1.12E-05
9	0.15	1.46E+03	4.74E-02	7.11E-03	1.17E-05
10	0.2	1.38E+05	4.63E+00	9.26E-01	1.63E-03
11	0.3	2.66E+05	8.98E+00	2.70E+00	5.11E-03
12	0.4	4.89E+05	1.65E+01	6.62E+00	1.29E-02
13	0.5	2.28E+04	7.73E-01	3.87E-01	7.59E-04
14	0.6	6.15E+05	2.09E+01	1.26E+01	2.45E-02
15	0.8	1.21E+05	4.16E+00	3.33E+00	6.34E-03
16	1	3.99E+05	1.40E+01	1.40E+01	2.58E-02
17	1.5	2.43E+05	8.87E+00	1.33E+01	2.24E-02

18	2	3.41E+05	1.29E+01	2.59E+01	4.00E-02
TOTALS:		3.00E+06	9.87E+01	8.02E+01	1.40E-01
Group 8 of 10 0 - 78.9cm					
1	0.015	2.88E+00	2.80E-07	4.19E-09	3.60E-10
2	0.02	1.65E+01	4.59E-06	9.19E-08	3.18E-09
3	0.03	7.85E+00	7.97E-06	2.39E-07	2.37E-09
4	0.04	1.81E+01	4.72E-05	1.89E-06	8.34E-09
5	0.05	7.42E+04	4.12E-01	2.06E-02	5.48E-05
6	0.06	6.36E+03	5.80E-02	3.48E-03	6.91E-06
7	0.08	3.96E+05	6.32E+00	5.06E-01	8.00E-04
8	0.1	3.60E+03	7.39E-02	7.39E-03	1.13E-05
9	0.15	1.95E+03	4.82E-02	7.22E-03	1.19E-05
10	0.2	1.84E+05	4.71E+00	9.43E-01	1.66E-03
11	0.3	3.55E+05	9.16E+00	2.75E+00	5.21E-03
12	0.4	6.52E+05	1.69E+01	6.76E+00	1.32E-02
13	0.5	3.04E+04	7.90E-01	3.95E-01	7.75E-04
14	0.6	8.19E+05	2.14E+01	1.28E+01	2.51E-02
15	0.8	1.61E+05	4.27E+00	3.41E+00	6.49E-03
16	1	5.32E+05	1.44E+01	1.44E+01	2.65E-02
17	1.5	3.23E+05	9.13E+00	1.37E+01	2.30E-02
18	2	4.55E+05	1.33E+01	2.67E+01	4.12E-02
TOTALS:		3.99E+06	1.01E+02	8.24E+01	1.44E-01
Group 9 of 10 0 - 89.4cm					
1	0.015	3.70E+00	2.75E-07	4.12E-09	3.53E-10
2	0.02	2.12E+01	4.61E-06	9.22E-08	3.19E-09
3	0.03	1.01E+01	8.04E-06	2.41E-07	2.39E-09
4	0.04	2.32E+01	4.75E-05	1.90E-06	8.41E-09
5	0.05	9.54E+04	4.15E-01	2.07E-02	5.52E-05
6	0.06	8.17E+03	5.85E-02	3.51E-03	6.97E-06
7	0.08	5.09E+05	6.38E+00	5.10E-01	8.07E-04
8	0.1	4.63E+03	7.46E-02	7.46E-03	1.14E-05
9	0.15	2.51E+03	4.87E-02	7.31E-03	1.20E-05
10	0.2	2.37E+05	4.77E+00	9.55E-01	1.69E-03
11	0.3	4.56E+05	9.29E+00	2.79E+00	5.29E-03
12	0.4	8.38E+05	1.71E+01	6.86E+00	1.34E-02
13	0.5	3.91E+04	8.02E-01	4.01E-01	7.87E-04
14	0.6	1.05E+06	2.18E+01	1.31E+01	2.55E-02
15	0.8	2.07E+05	4.34E+00	3.47E+00	6.61E-03
16	1	6.84E+05	1.46E+01	1.46E+01	2.70E-02
17	1.5	4.16E+05	9.32E+00	1.40E+01	2.35E-02
18	2	5.84E+05	1.37E+01	2.73E+01	4.22E-02

Attachment 1
MicroShield Data Outputs

	TOTALS:	5.13E+06	1.03E+02	8.40E+01	1.47E-01
Group 10 of 10 100cm					
1	0.015	4.62E+00	2.70E-07	4.05E-09	3.47E-10
2	0.02	2.66E+01	4.61E-06	9.21E-08	3.19E-09
3	0.03	1.26E+01	8.10E-06	2.43E-07	2.41E-09
4	0.04	2.90E+01	4.78E-05	1.91E-06	8.46E-09
5	0.05	1.19E+05	4.17E-01	2.09E-02	5.55E-05
6	0.06	1.02E+04	5.89E-02	3.53E-03	7.01E-06
7	0.08	6.36E+05	6.42E+00	5.13E-01	8.13E-04
8	0.1	5.79E+03	7.51E-02	7.51E-03	1.15E-05
9	0.15	3.13E+03	4.91E-02	7.36E-03	1.21E-05
10	0.2	2.96E+05	4.81E+00	9.63E-01	1.70E-03
11	0.3	5.70E+05	9.38E+00	2.81E+00	5.34E-03
12	0.4	1.05E+06	1.73E+01	6.93E+00	1.35E-02
13	0.5	4.88E+04	8.11E-01	4.06E-01	7.96E-04
14	0.6	1.32E+06	2.20E+01	1.32E+01	2.58E-02
15	0.8	2.59E+05	4.40E+00	3.52E+00	6.69E-03
16	1	8.55E+05	1.48E+01	1.48E+01	2.74E-02
17	1.5	5.20E+05	9.47E+00	1.42E+01	2.39E-02
18	2	7.30E+05	1.39E+01	2.78E+01	4.30E-02
	TOTALS:	6.42E+06	1.04E+02	8.52E+01	1.49E-01

NEXTEP Environmental

Photon Fluence Rates for U-238 through U-234

MicroShield v5.03 (5.03-00027)
Results With Buildup
FILE: C:\MS5\DATA\MI\TCUU234.MS5
Case Title: uranium to U-234
This case was run on Wednesday, February 21,2001 at 1:53:49 PM
Dose Point # 1 - (0200)cm

Group #	Energy (MeV)	Activity photons/sec	**Fluence Rate photons/cm²/sec**	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
Overall Summary					
1	0.015	1.17E+02	6.83E-06	1.03E-07	8.79E-09
2	0.02	2.18E+02	3.78E-05	7.55E-07	2.62E-08
3	0.03	1.49E+04	9.58E-03	2.87E-04	2.85E-06
4	0.04	9.54E+01	1.57E-04	6.29E-06	2.78E-08
5	0.05	1.74E+03	6.07E-03	3.04E-04	8.09E-07
6	0.06	5.87E+04	3.38E-01	2.03E-02	4.03E-05
7	0.08	9.62E+03	9.71E-02	7.77E-03	1.23E-05
8	0.1	9.16E+04	1.19E+00	1.19E-01	1.82E-04
9	0.15	1.22E+04	1.92E-01	2.87E-02	4.73E-05
10	0.2	3.88E+04	6.32E-01	1.26E-01	2.23E-04
11	0.3	5.10E+03	8.39E-02	2.52E-02	4.77E-05
12	0.4	2.41E+02	3.99E-03	1.60E-03	3.11E-06
13	0.5	1.99E+02	3.30E-03	1.65E-03	3.24E-06
14	0.6	8.12E+02	1.36E-02	8.15E-03	1.59E-05
15	0.8	4.52E+03	7.70E-02	6.16E-02	1.17E-04
16	1	1.45E+04	2.51E-01	2.51E-01	4.63E-04
17	1.5	3.05E+02	5.56E-03	8.34E-03	1.40E-05
18	2	3.94E+01	7.48E-04	1.50E-03	2.31E-06
TOTALS:		2.54E+05	2.90E+00	6.62E-01	1.18E-03
Group 1 of 10 0 - 5cm					
1	0.015	2.93E-01	2.64E-06	3.96E-08	3.40E-09
2	0.02	5.44E-01	1.15E-05	2.30E-07	7.98E-09
3	0.03	3.73E+01	2.69E-03	8.07E-05	8.00E-07
4	0.04	2.38E-01	3.92E-05	1.57E-06	6.93E-09
5	0.05	4.34E+00	1.31E-03	6.54E-05	1.74E-07
6	0.06	1.47E+02	6.26E-02	3.76E-03	7.46E-06
7	0.08	2.41E+01	1.43E-02	1.14E-03	1.80E-06
8	0.1	2.29E+02	1.51E-01	1.51E-02	2.31E-05
9	0.15	3.05E+01	2.07E-02	3.10E-03	5.11E-06
10	0.2	9.71E+01	6.41E-02	1.28E-02	2.26E-05

11	0.3	1.27E+01	8.02E-03	2.41E-03	4.57E-06
12	0.4	6.04E-01	3.70E-04	1.48E-04	2.88E-07
13	0.5	4.97E-01	2.99E-04	1.50E-04	2.94E-07
14	0.6	2.03E+00	1.21E-03	7.25E-04	1.42E-06
15	0.8	1.13E+01	6.65E-03	5.32E-03	1.01E-05
16	1	3.62E+01	2.12E-02	2.12E-02	3.91E-05
17	1.5	7.63E-01	4.47E-04	6.71E-04	1.13E-06
18	2	9.84E-02	5.80E-05	1.16E-04	1.79E-07
TOTALS:		6.34E+02	3.55E-01	6.68E-02	1.18E-04
Group 2 of 10 0 - 15.6cm					
1	0.015	2.83E+00	6.28E-06	9.42E-08	8.08E-09
2	0.02	5.27E+00	2.80E-05	5.60E-07	1.94E-08
3	0.03	3.61E+02	6.92E-03	2.08E-04	2.06E-06
4	0.04	2.31E+00	1.11E-04	4.44E-06	1.96E-08
5	0.05	4.20E+01	4.14E-03	2.07E-04	5.52E-07
6	0.06	1.42E+03	2.20E-01	1.32E-02	2.63E-05
7	0.08	2.33E+02	5.78E-02	4.63E-03	7.32E-06
8	0.1	2.22E+03	6.58E-01	6.58E-02	1.01E-04
9	0.15	2.96E+02	9.60E-02	1.44E-02	2.37E-05
10	0.2	9.40E+02	3.02E-01	6.04E-02	1.07E-04
11	0.3	1.23E+02	3.81E-02	1.14E-02	2.17E-05
12	0.4	5.84E+00	1.76E-03	7.04E-04	1.37E-06
13	0.5	4.81E+00	1.43E-03	7.13E-04	1.40E-06
14	0.6	1.97E+01	5.76E-03	3.46E-03	6.75E-06
15	0.8	1.09E+02	3.17E-02	2.54E-02	4.83E-05
16	1	3.50E+02	1.01E-01	1.01E-01	1.87E-04
17	1.5	7.38E+00	2.15E-03	3.22E-03	5.42E-06
18	2	9.52E-01	2.80E-04	5.60E-04	8.66E-07
TOTALS:		6.14E+03	1.53E+00	3.06E-01	5.40E-04
Group 3 of 10 0 - 26.1cm					
1	0.015	7.98E+00	7.25E-06	1.09E-07	9.33E-09
2	0.02	1.48E+01	3.28E-05	6.57E-07	2.28E-08
3	0.03	1.02E+03	8.18E-03	2.45E-04	2.43E-06
4	0.04	6.50E+00	1.33E-04	5.34E-06	2.36E-08
5	0.05	1.18E+02	5.09E-03	2.54E-04	6.77E-07
6	0.06	4.00E+03	2.78E-01	1.67E-02	3.32E-05
7	0.08	6.56E+02	7.74E-02	6.19E-03	9.80E-06
8	0.1	6.24E+03	9.19E-01	9.19E-02	1.41E-04
9	0.15	8.33E+02	1.41E-01	2.11E-02	3.47E-05
10	0.2	2.65E+03	4.51E-01	9.01E-02	1.59E-04
11	0.3	3.48E+02	5.79E-02	1.74E-02	3.29E-05
12	0.4	1.65E+01	2.69E-03	1.08E-03	2.10E-06

13	0.5	1.36E+01	2.19E-03	1.10E-03	2.15E-06
14	0.6	5.54E+01	8.89E-03	5.33E-03	1.04E-05
15	0.8	3.08E+02	4.93E-02	3.94E-02	7.50E-05
16	1	9.86E+02	1.58E-01	1.58E-01	2.91E-04
17	1.5	2.08E+01	3.38E-03	5.06E-03	8.52E-06
18	2	2.68E+00	4.43E-04	8.85E-04	1.37E-06
TOTALS:		1.73E+04	2.16E+00	4.55E-01	8.04E-04

Group 4 of 10 0 - 36.7cm

1	0.015	1.57E+01	7.52E-06	1.13E-07	9.67E-09
2	0.02	2.93E+01	3.50E-05	7.01E-07	2.43E-08
3	0.03	2.00E+03	8.71E-03	2.61E-04	2.59E-06
4	0.04	1.28E+01	1.43E-04	5.73E-06	2.53E-08
5	0.05	2.34E+02	5.50E-03	2.75E-04	7.32E-07
6	0.06	7.89E+03	3.03E-01	1.82E-02	3.62E-05
7	0.08	1.29E+03	8.57E-02	6.85E-03	1.09E-05
8	0.1	1.23E+04	1.03E+00	1.03E-01	1.58E-04
9	0.15	1.64E+03	1.62E-01	2.44E-02	4.01E-05
10	0.2	5.22E+03	5.27E-01	1.06E-01	1.86E-04
11	0.3	6.85E+02	6.87E-02	2.06E-02	3.91E-05
12	0.4	3.25E+01	3.22E-03	1.29E-03	2.51E-06
13	0.5	2.67E+01	2.64E-03	1.32E-03	2.59E-06
14	0.6	1.09E+02	1.07E-02	6.44E-03	1.26E-05
15	0.8	6.08E+02	5.99E-02	4.79E-02	9.11E-05
16	1	1.94E+03	1.93E-01	1.93E-01	3.56E-04
17	1.5	4.10E+01	4.16E-03	6.24E-03	1.05E-05
18	2	5.29E+00	5.49E-04	1.10E-03	1.70E-06
TOTALS:		3.41E+04	2.47E+00	5.37E-01	9.51E-04

Group 5 of 10 0 - 47.2cm

1	0.015	2.61E+01	7.52E-06	1.13E-07	9.67E-09
2	0.02	4.86E+01	3.62E-05	7.25E-07	2.51E-08
3	0.03	3.32E+03	9.00E-03	2.70E-04	2.68E-06
4	0.04	2.13E+01	1.48E-04	5.93E-06	2.62E-08
5	0.05	3.87E+02	5.71E-03	2.86E-04	7.61E-07
6	0.06	1.31E+04	3.17E-01	1.90E-02	3.78E-05
7	0.08	2.15E+03	9.01E-02	7.21E-03	1.14E-05
8	0.1	2.04E+04	1.09E+00	1.09E-01	1.67E-04
9	0.15	2.72E+03	1.74E-01	2.60E-02	4.29E-05
10	0.2	8.66E+03	5.68E-01	1.14E-01	2.01E-04
11	0.3	1.14E+03	7.45E-02	2.24E-02	4.24E-05
12	0.4	5.38E+01	3.52E-03	1.41E-03	2.74E-06
13	0.5	4.43E+01	2.89E-03	1.44E-03	2.84E-06
14	0.6	1.81E+02	1.18E-02	7.08E-03	1.38E-05

15	0.8	1.01E+03	6.62E-02	5.29E-02	1.01E-04
16	1	3.22E+03	2.14E-01	2.14E-01	3.94E-04
17	1.5	6.80E+01	4.65E-03	6.97E-03	1.17E-05
18	2	8.78E+00	6.17E-04	1.23E-03	1.91E-06
TOTALS:		5.66E+04	2.64E+00	5.83E-01	1.03E-03
Group 6 of 10 0 - 57.8cm					
1	0.015	3.91E+01	7.33E-06	1.10E-07	9.43E-09
2	0.02	7.27E+01	3.69E-05	7.38E-07	2.56E-08
3	0.03	4.97E+03	9.19E-03	2.76E-04	2.73E-06
4	0.04	3.18E+01	1.51E-04	6.05E-06	2.68E-08
5	0.05	5.80E+02	5.85E-03	2.92E-04	7.79E-07
6	0.06	1.96E+04	3.25E-01	1.95E-02	3.87E-05
7	0.08	3.21E+03	9.28E-02	7.43E-03	1.18E-05
8	0.1	3.06E+04	1.13E+00	1.13E-01	1.73E-04
9	0.15	4.08E+03	1.80E-01	2.71E-02	4.45E-05
10	0.2	1.30E+04	5.92E-01	1.18E-01	2.09E-04
11	0.3	1.70E+03	7.81E-02	2.34E-02	4.44E-05
12	0.4	8.06E+01	3.70E-03	1.48E-03	2.88E-06
13	0.5	6.64E+01	3.05E-03	1.52E-03	2.99E-06
14	0.6	2.71E+02	1.25E-02	7.49E-03	1.46E-05
15	0.8	1.51E+03	7.03E-02	5.62E-02	1.07E-04
16	1	4.83E+03	2.28E-01	2.28E-01	4.21E-04
17	1.5	1.02E+02	4.99E-03	7.49E-03	1.26E-05
18	2	1.31E+01	6.66E-04	1.33E-03	2.06E-06
TOTALS:		8.47E+04	2.74E+00	6.13E-01	1.09E-03
Group 7 of 10 0 - 68.3cm					
1	0.015	5.46E+01	7.20E-06	1.08E-07	9.26E-09
2	0.02	1.02E+02	3.74E-05	7.47E-07	2.59E-08
3	0.03	6.96E+03	9.33E-03	2.80E-04	2.77E-06
4	0.04	4.45E+01	1.54E-04	6.14E-06	2.72E-08
5	0.05	8.11E+02	5.94E-03	2.97E-04	7.91E-07
6	0.06	2.74E+04	3.30E-01	1.98E-02	3.93E-05
7	0.08	4.49E+03	9.45E-02	7.56E-03	1.20E-05
8	0.1	4.28E+04	1.15E+00	1.15E-01	1.77E-04
9	0.15	5.70E+03	1.85E-01	2.77E-02	4.56E-05
10	0.2	1.81E+04	6.08E-01	1.22E-01	2.15E-04
11	0.3	2.38E+03	8.03E-02	2.41E-02	4.57E-05
12	0.4	1.13E+02	3.81E-03	1.53E-03	2.97E-06
13	0.5	9.28E+01	3.15E-03	1.57E-03	3.09E-06
14	0.6	3.79E+02	1.29E-02	7.75E-03	1.51E-05
15	0.8	2.11E+03	7.29E-02	5.83E-02	1.11E-04
16	1	6.75E+03	2.37E-01	2.37E-01	4.37E-04

17	1.5	1.42E+02	5.21E-03	7.81E-03	1.31E-05
18	2	1.84E+01	6.96E-04	1.39E-03	2.15E-06
TOTALS:		1.19E+05	2.80E+00	6.32E-01	1.12E-03
Group 8 of 10 0 - 78.9cm					
1	0.015	7.28E+01	7.08E-06	1.06E-07	9.11E-09
2	0.02	1.36E+02	3.77E-05	7.53E-07	2.61E-08
3	0.03	9.27E+03	9.42E-03	2.83E-04	2.80E-06
4	0.04	5.93E+01	1.55E-04	6.20E-06	2.74E-08
5	0.05	1.08E+03	6.00E-03	3.00E-04	7.99E-07
6	0.06	3.65E+04	3.33E-01	2.00E-02	3.97E-05
7	0.08	5.99E+03	9.57E-02	7.65E-03	1.21E-05
8	0.1	5.70E+04	1.17E+00	1.17E-01	1.79E-04
9	0.15	7.60E+03	1.88E-01	2.82E-02	4.64E-05
10	0.2	2.42E+04	6.19E-01	1.24E-01	2.18E-04
11	0.3	3.17E+03	8.19E-02	2.46E-02	4.66E-05
12	0.4	1.50E+02	3.89E-03	1.56E-03	3.03E-06
13	0.5	1.24E+02	3.22E-03	1.61E-03	3.16E-06
14	0.6	5.05E+02	1.32E-02	7.92E-03	1.55E-05
15	0.8	2.82E+03	7.47E-02	5.97E-02	1.14E-04
16	1	9.00E+03	2.43E-01	2.43E-01	4.48E-04
17	1.5	1.90E+02	5.36E-03	8.04E-03	1.35E-05
18	2	2.45E+01	7.18E-04	1.44E-03	2.22E-06
TOTALS:		1.58E+05	2.85E+00	6.45E-01	1.15E-03
Group 9 of 10 0 - 89.4cm					
1	0.015	9.36E+01	6.96E-06	1.04E-07	8.95E-09
2	0.02	1.74E+02	3.78E-05	7.56E-07	2.62E-08
3	0.03	1.19E+04	9.51E-03	2.85E-04	2.83E-06
4	0.04	7.63E+01	1.56E-04	6.25E-06	2.77E-08
5	0.05	1.39E+03	6.04E-03	3.02E-04	8.05E-07
6	0.06	4.70E+04	3.36E-01	2.02E-02	4.01E-05
7	0.08	7.70E+03	9.65E-02	7.72E-03	1.22E-05
8	0.1	7.33E+04	1.18E+00	1.18E-01	1.81E-04
9	0.15	9.77E+03	1.90E-01	2.85E-02	4.69E-05
10	0.2	3.11E+04	6.26E-01	1.25E-01	2.21E-04
11	0.3	4.08E+03	8.31E-02	2.49E-02	4.73E-05
12	0.4	1.93E+02	3.95E-03	1.58E-03	3.08E-06
13	0.5	1.59E+02	3.27E-03	1.63E-03	3.21E-06
14	0.6	6.50E+02	1.34E-02	8.05E-03	1.57E-05
15	0.8	3.62E+03	7.60E-02	6.08E-02	1.16E-04
16	1	1.16E+04	2.48E-01	2.48E-01	4.57E-04
17	1.5	2.44E+02	5.47E-03	8.21E-03	1.38E-05
18	2	3.15E+01	7.35E-04	1.47E-03	2.27E-06

Attachment 1
MicroShield Data Outputs

TOTALS:		2.03E+05	2.88E+00	6.55E-01	1.16E-03
Group 10 of 10 100cm					
1	0.015	1.17E+02	6.83E-06	1.03E-07	8.79E-09
2	0.02	2.18E+02	3.78E-05	7.55E-07	2.62E-08
3	0.03	1.49E+04	9.58E-03	2.87E-04	2.85E-06
4	0.04	9.54E+01	1.57E-04	6.29E-06	2.78E-08
5	0.05	1.74E+03	6.07E-03	3.04E-04	8.09E-07
6	0.06	5.87E+04	3.38E-01	2.03E-02	4.03E-05
7	0.08	9.62E+03	9.71E-02	7.77E-03	1.23E-05
8	0.1	9.16E+04	1.19E+00	1.19E-01	1.82E-04
9	0.15	1.22E+04	1.92E-01	2.87E-02	4.73E-05
10	0.2	3.88E+04	6.32E-01	1.26E-01	2.23E-04
11	0.3	5.10E+03	8.39E-02	2.52E-02	4.77E-05
12	0.4	2.41E+02	3.99E-03	1.60E-03	3.11E-06
13	0.5	1.99E+02	3.30E-03	1.65E-03	3.24E-06
14	0.6	8.12E+02	1.36E-02	8.15E-03	1.59E-05
15	0.8	4.52E+03	7.70E-02	6.16E-02	1.17E-04
16	1	1.45E+04	2.51E-01	2.51E-01	4.63E-04
17	1.5	3.05E+02	5.56E-03	8.34E-03	1.40E-05
18	2	3.94E+01	7.48E-04	1.50E-03	2.31E-06
TOTALS:		2.54E+05	2.90E+00	6.62E-01	1.18E-03

NEXTEP Environmental

Photon Fluence Rates for for Th-Nat
MicroShield v5.03 (5.03-00027)
Results With Buildup
FILE: C:\MS5\DATA\MI\TCNATTH.MS5
Case Title: Natural Thorium slab
This case was run on Wednesday, February 21, 2001 at 2:14:23 PM
Dose Point # 1 - (0200)cm

Group #	Energy (MeV)	Activity photons/sec	**Fluence Rate photons/cm²/sec**	Energy Fluence MeV/cm²/sec	Exposure Rate mR/hr
Overall Summary					
4	0.04	2.74E+04	4.51E-02	1.81E-03	7.99E-06
6	0.06	1.89E+04	1.09E-01	6.54E-03	1.30E-05
7	0.08	1.16E+06	1.17E+01	9.34E-01	1.48E-03
8	0.10	1.92E+05	2.50E+00	2.50E-01	3.82E-04
9	0.15	1.14E+05	1.79E+00	2.68E-01	4.42E-04
10	0.20	1.46E+06	2.37E+01	4.74E+00	8.36E-03
11	0.30	7.05E+05	1.16E+01	3.48E+00	6.61E-03
12	0.40	6.42E+04	1.06E+00	4.25E-01	8.27E-04
13	0.50	3.74E+05	6.21E+00	3.10E+00	6.09E-03
14	0.60	8.52E+05	1.43E+01	8.55E+00	1.67E-02
15	0.80	8.58E+05	1.46E+01	1.17E+01	2.22E-02
16	1.00	1.58E+06	2.75E+01	2.75E+01	5.06E-02
17	1.50	3.63E+05	6.61E+00	9.92E+00	1.67E-02
18	2.00	8.16E+03	1.55E-01	3.11E-01	4.80E-04
19	3.00	9.60E+05	1.93E+01	5.80E+01	7.87E-02
TOTALS:		8.73E+06	1.41E+02	1.29E+02	2.10E-01
Group 1 of 10 0 - 5cm					
4	0.04	6.84E+01	1.13E-02	4.50E-04	1.99E-06
6	0.06	4.73E+01	2.02E-02	1.21E-03	2.40E-06
7	0.08	2.89+03	1.71+00	1.37E-01	2.17E-04
8	0.1	4.81E+02	3.17E-01	3.17E-02	4.85E-05
9	0.15	2.85E+02	1.93E-01	2.90E-02	4.77E-05
10	0.2	3.64E+03	2.40E+00	4.80E-01	8.48E-04
11	0.3	1.76E+03	1.11E+00	3.33E-01	6.32E-04
12	0.4	1.61E+02	9.83E-02	3.93E-02	7.66E-05
13	0.5	9.34E+02	5.62E-01	2.81E-01	5.52E-04
14	0.6	2.13E+03	1.27E+00	7.60E-01	1.48E-03
15	0.8	2.14E+03	1.26E+00	1.01E+00	1.92E-03
16	1	3.95E+03	2.32E+00	2.32E+00	4.27E-03
17	1.5	9.07E+02	5.32E-01	7.98E-01	1.34E-03

18	2	2.04E+01	1.20E-02	2.41E-02	3.72E-05
19	3	2.40E+03	1.43E+00	4.28E+00	5.81E-03
TOTALS:		2.18E+04	1.32E+01	1.05E+01	1.73E-02
Group 2 of 10 0 - 15.6cm					
4	0.04	6.62E+02	3.18E-02	1.27E-03	5.63E-06
6	0.06	4.58E+02	7.10E-02	4.26E-03	8.46E-06
7	0.08	2.80E+04	6.95E+00	5.56E-01	8.80E-04
8	0.1	4.66E+03	1.38E+00	1.38E-01	2.12E-04
9	0.15	2.76E+03	8.96E-01	1.34E-01	2.21E-04
10	0.2	3.52E+04	1.13E+01	2.26E+00	4.00-03
11	0.3	1.71E+04	5.28E+00	1.58E+00	3.00E-03
12	0.4	1.55E+03	4.68E-01	1.87E-01	3.65E-04
13	0.5	9.04E+03	2.68E+00	1.34E+00	2.63E-03
14	0.6	2.06E+04	6.04E+00	3.63E+00	7.08E-03
15	0.8	2.08E+04	6.02E+00	4.82E+00	9.16E-03
16	1	3.82E+04	1.11E+01	1.11E+01	2.04E-02
17	1.5	8.78E+03	2.56E+00	3.83E+00	6.45E-03
18	2	1.98E+02	5.81E-02	1.16E-01	1.80E-04
19	3	2.32E+04	6.94E+00	2.08E+01	2.82E-02
TOTALS:		2.11E+05	6.18E+01	5.05E+01	8.28E-02
Group 3 of 10 0 - 26.1cm					
4	0.04	1.87E+03	3.83E-02	1.53E-03	6.77E-06
6	0.06	1.29E+03	8.97E-02	5.38E-03	1.07E-05
7	0.08	7.88E+04	9.30E+00	7.44E-01	1.18E-03
8	0.1	1.31E+04	1.93E+00	1.93E-01	2.95E-04
9	0.15	7.78E+03	1.31E+00	1.97E-01	3.24E-04
10	0.2	9.93E+04	1.69E+01	3.38E+00	5.96E-03
11	0.3	4.81E+04	8.01E+00	2.40E+00	4.56E-03
12	0.4	4.38E+03	7.16E-01	2.86E-01	5.58E-04
13	0.05	2.55+04	4.12E+00	2.06+00	4.04E-03
14	0.6	5.81E+04	9.32E+00	5.60E+00	1.09E-02
15	0.8	5.85E+04	9.34E+00	7.47E+00	1.42E-02
16	1	1.08E+05	1.73E+01	1.73E+01	3.18E-02
17	1.5	2.47E+04	4.02E+00	6.02E+00	1.01E-02
18	2	5.57E+02	9.18E-02	1.84E-01	2.84E-04
19	3	6.55E+04	1.11E+01	3.31E+01	4.50E-02
TOTALS:		5.95E+05	9.35E+01	7.90E+01	1.29E-01
Group 4 of 10 0 - 36.7cm					
4	0.04	3.68E+03	4.11E-02	1.64E-03	7.27E-06
6	0.06	2.54E+03	9.77E-02	5.86E-03	1.17E-05

7	0.08	1.55E+05	1.03E+01	8.24E-01	1.30E-03
8	0.1	2.59E+04	2.17E+00	2.17E-01	3.32E-04
9	0.15	1.53E+04	1.52E+00	2.27E-01	3.75E-04
10	0.2	1.96E+05	1.98E+01	3.96E+00	6.98E-03
11	0.3	9.48E+04	9.50E+00	2.85E+00	5.41E-03
12	0.4	8.63E+03	8.57E-01	3.43E-01	6.68E-04
13	0.5	5.02E+04	4.95E+00	2.48E+00	4.86E-03
14	0.6	1.15E+05	1.13E+01	6.76E+00	1.32E-02
15	0.8	1.15E+05	1.14E+01	9.09E+00	1.73E-02
16	1	3.52E+07	2.34E+01	2.34E+01	4.31E-02
17	1.5	4.88E+04	4.95E+00	7.42E+00	1.25E-02
18	2	1.10E+03	1.14E-01	2.28E-01	3.52E-04
19	3	1.29E+05	1.38E+01	4.14E+01	5.62E-02
TOTALS:		1.17E+06	1.12E+02	9.69E+01	1.58E-01
Group 5 of 10 0 - 47.2cm					
4	0.04	6.10E+03	4.26E-02	1.70E-03	7.53E-06
6	0.06	4.22E+03	1.02E-01	6.12E-03	1.22E-05
7	0.08	2.58E+05	1.08E+01	8.67E-01	1.37E-03
8	0.1	4.29E+04	2.30E+00	2.30E-01	3.51E-04
9	0.15	2.54E+04	1.62E+00	2.43E-01	4.00E-04
10	0.2	3.25E+05	2.13E+01	4.26E+00	7.52E-03
11	0.3	1.57E+05	1.03E+01	3.09E+00	5.87E-03
12	0.4	1.43E+04	9.35E-01	3.74E-01	7.29E-04
13	0.5	8.33E+04	5.43E+00	2.71E+00	5.33E-03
14	0.6	1.90E+05	1.24E+01	7.43E+00	1.45E-02
15	0.8	1.91E+05	1.26E+01	1.00E+01	1.91E-02
16	1	3.52E+05	2.34E+01	2.34E+01	4.31E-02
17	1.5	8.09E+04	5.53E+00	8.30E+00	1.40E-02
18	2	1.82E+03	1.28E-01	2.56E-01	3.96E-04
19	3	4.48E+05	1.78E+01	5.35E+01	7.26E-02
TOTALS:		1.95E+06	1.22E+02	1.08E+02	1.76E-01
Group 6 of 10 0 - 57.8cm					
4	0.04	9.14E+03	4.35E-02	1.74E-03	7.69E-06
6	0.06	6.31E+03	1.05E-01	6.28E-03	1.25E-05
7	0.08	3.86E+05	1.12E+01	8.92E-01	1.41E-03
8	0.1	6.42E+04	2.37E+00	2.37E-01	3.63E-04
9	0.15	3.81E+04	1.68E+00	2.53E-01	4.16E-04
10	0.2	4.86E+05	2.22E+01	4.44E+00	7.83E-03
11	0.3	2.35E+05	1.08E+01	3.24E+00	6.15E-03
12	0.4	2.14E+04	9.83E-01	3.93E-01	7.66E-04
13	0.5	1.25E+05	5.73E+00	2.86E+00	5.62E-03
14	0.6	2.84E+05	1.31E+01	7.86E+00	1.53E-02

15	0.8	2.86E+05	1.33E+01	1.07E+01	2.03E-02
16	1	5.28E+05	2.49E+01	2.49E+01	4.60E-02
17	1.5	1.21E+05	5.94E+00	8.91E+00	1.50E-02
18	2	2.73E+03	1.38E-01	2.76E-01	4.27E-04
19	3	3.21E+05	1.70E+01	5.09E+01	6.91E-02
TOTALS:		2.91E+06	1.30E+02	1.16E+02	1.89E-01
Group 7 of 10 0 - 68.3cm					
4	0.04	1.28E+04	4.41E-02	1.76E-03	7.79E-06
6	0.06	8.83E+03	1.06E-01	6.37E-03	1.27E-05
7	0.08	5.40E+05	1.14E+01	9.09E-01	1.44E-03
8	0.1	8.98E+04	2.42E+00	2.42E-01	3.71E-04
9	0.15	5.33E+04	1.73E+00	2.59E-01	4.26E-04
10	0.2	6.80E+05	2.28E+01	4.56E+00	8.04E-03
11	0.3	3.29E+05	1.11E+01	3.34E+00	6.33E-03
12	0.4	3.00E+04	1.01E+00	4.06E-01	7.90E-04
13	0.5	1.74E+05	5.91E+00	2.96E+00	5.80E-03
14	0.6	3.98E+05	1.35E+01	8.13E+00	1.59E-02
15	0.8	4.00E+05	1.38E+01	1.11E+01	2.10E-02
16	1	7.38E+05	2.59E+01	2.59E+01	4.77E-02
17	1.5	1.69E+05	6.19E+00	9.29E+00	1.56E-02
18	2	3.81E+03	1.45E-01	2.89E-01	4.47E-04
19	3	4.48E+05	1.78E+01	5.35E+01	7.26E-02
TOTALS:		4.08E+06	1.34E+02	1.21E+02	1.97E-01
Group 8 of 10 0 - 78.9cm					
4	0.04	1.70E+04	4.45E-02	1.78E-03	7.87E-06
6	0.06	1.18E+04	1.07E-01	6.44E-03	1.28E-05
7	0.08	7.20E+05	1.15E+01	9.20E-01	1.46E-03
8	0.1	1.20E+05	2.46E+00	2.46E-01	3.76E-04
9	0.15	7.10E+04	1.75E+00	2.63E-01	4.33E-04
10	0.2	9.06E+05	2.32E+01	4.64E+00	8.18E-03
11	0.3	4.39E+05	1.13E+01	3.40E+00	6.45E-03
12	0.4	4.00E+04	1.04E+00	4.14E-01	8.07E-04
13	0.5	2.32E+05	6.04E+00	3.02E+00	5.93E-03
14	0.6	5.30E+05	1.39E+01	8.31E+00	1.62E-02
15	0.8	5.34E+05	1.42E+01	1.13E+01	2.15E-02
16	1	9.84E+05	2.66E+01	2.66E+01	4.90E-02
17	1.5	2.26E+05	6.37E+00	9.56E+00	1.61E-02
18	2	5.08E+03	1.49E-01	2.98E-01	4.61E-04
19	3	5.97E+05	1.85E+01	5.54E+01	7.51E-02
TOTALS:		5.43E+06	1.37E+02	1.24E+02	2.02E-01

Attachment 1
MicroShield Data Outputs

Group 9 of 10 0 - 89.4cm					
4	0.04	2.19E+04	4.49E-02	1.80E-03	7.94E-06
6	0.06	1.51E+04	1.08E-01	6.50E-03	1.29E-05
7	0.08	9.25E+05	1.16E+01	9.28E-01	1.47E-03
8	0.1	1.54E+05	2.48E+00	2.48E-01	3.79E-04
9	0.15	9.12E+04	1.77E+00	2.66E+00	4.38E-04
10	0.2	1.17E+06	2.35E+01	4.70E+00	8.29E-03
11	0.3	5.64E+05	1.15E+01	3.45E+00	6.54E-03
12	0.4	5.14E+04	1.05E+00	4.20E-01	8.19E-04
13	0.5	2.99E+05	6.14E+00	3.07E+00	6.02E-03
14	0.6	6.82E+05	1.41E+01	8.45E+00	1.65E-02
15	0.8	6.86E+05	1.44E+01	1.15E+01	2.19E-02
16	1	1.26E+06	2.71E+01	2.71E+01	4.99E-02
17	1.5	2.90E+05	6.51E+00	9.77E+00	1.64E-02
18	2	6.53E+03	1.53E-01	3.05E-01	4.72E-04
19	3	7.68E+05	1.89E+01	5.68E+01	7.71E-02
TOTALS:		6.98E+06	1.39E+02	1.27E+02	2.06E-01
Group 10 of 10 100cm					
4	0.04	2.74E+04	4.51E-02	1.81E-03	7.99E-06
6	0.06	1.89E+04	1.09E-01	6.54E-03	1.30E-05
7	0.08	1.16E+06	1.17E+01	9.34E-01	1.48E-03
8	0.1	1.92E+05	2.50E+00	2.50E-01	3.82E-04
9	0.15	1.14E+05	1.79E+00	2.68E-01	4.42E-04
10	0.2	1.46E+06	2.37E+01	4.74E+00	8.36E-03
11	0.3	7.05E+05	1.16E+01	3.48E+00	6.61E-03
12	0.4	6.42+04	1.06+00	4.25E-01	8.27E-04
13	0.5	3.74E+05	6.21E+00	3.10E+00	6.09E-03
14	0.6	8.52E+05	1.43E+01	8.55E+00	1.67E-02
15	0.8	8.58E+05	1.46E+01	1.17E+01	2.22E-02
16	1	1.58E+06	2.75E+01	2.75E+01	5.06E-02
17	1.5	3.63E+05	6.61E+00	9.92E+00	1.67E-02
18	2	8.16E+03	1.55E-01	3.11E-01	4.80E-04
19	3	9.60E+05	1.93E+01	5.80E+01	7.87E-02
TOTALS:		8.73E+06	1.41E+02	1.29E+02	2.10E-01

Attachment 2
Th-232 and Progeny

First Approximation for Th Nat

Energy increment	Na Mass attenuation coefficient (cm^2/g)	I Mass attenuation coefficient (cm^2/g)	NaI mass attenuation coefficients (cm^2/g)	Mean free path (cm)	Fluence rate at detector (photons/cm^2/s)	Detector thickness (g/cm^2)	Detector counts (photons/cm^2/s)	Detector Area (cm^2)	CPM
0.020	2.057	25.430	21.845	0.012	-	4.661	-	46.0	-
0.030	0.720	8.561	7.358	0.037	-	4.661	-	46.0	-
0.040	0.397	22.100	18.771	0.015	0.045	4.661	0.045	46.0	125
0.050	0.280	12.320	10.473	0.026	-	4.661	-	46.0	-
0.060	0.227	7.579	6.451	0.042	0.109	4.661	0.109	46.0	301
0.080	0.180	3.510	2.999	0.091	11.670	4.661	11.670	46.0	32,209
0.100	0.159	1.942	1.668	0.163	2.496	4.661	2.495	46.0	6,886
0.150	0.134	0.696	0.611	0.446	1.788	4.661	1.684	46.0	4,649
0.200	0.120	0.366	0.329	0.829	23.680	4.661	18.556	46.0	51,221
0.300	0.103	0.177	0.166	1.644	11.610	4.661	6.247	46.0	17,242
0.400	0.092	0.122	0.117	2.326	1.062	4.661	0.447	46.0	1,233
0.500	0.084	0.097	0.095	2.869	6.207	4.661	2.220	46.0	6,127
0.600	0.077	0.083	0.082	3.313	14.250	4.661	4.537	46.0	12,523
0.800	0.068	0.067	0.066	4.034	14.590	4.661	3.941	46.0	10,876
1.000	0.061	0.058	0.059	4.633	27.450	4.661	6.581	46.0	18,163
1.500	0.050	0.048	0.047	5.802	6.614	4.661	1.300	46.0	3,589
2.000	0.043	0.041	0.041	6.569	0.155	4.661	0.027	46.0	75
3.000	0.035	0.037	0.037	7.403	19.330	4.661	3.047	46.0	8,411
				First approximation	141.056		62.910		173,631

Repeat analysis of NaI probe detectability by breaking the soil contamination into concentric rings.

	Radius to:	Radius to:	Radius to:	Radius to:	Radius to:	Radius to:	Radius to:	Radius to:	NaI mass attenuation coefficients (cm^2/g)
	5.00	15.80	26.10	36.70	47.20	57.80	68.30	100.00	
Theta	26.56	64.00	76.50	81.00	83.20	84.60	85.50	86.60	
Photon path length through detector	1.42	2.89	4.00	4.00	4.00	4.00	4.00	4.00	

Energy increment	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	NaI mass attenuation coefficients (cm^2/g)	counts per energy increment per concentric ring (cm) 5	15.8	26.1	36.7	47.2	57.8	68.3	100	CPS corrected for EMC activity
0.020								-	21.845	-	-	-	-	-	-	-	-	-
0.030								-	7.358	-	-	-	-	-	-	-	-	-
0.040	0.011	0.032	0.038	0.041	0.043	0.043	0.044	0.045	18.771	0.483	0.474	0.148	0.065	0.033	0.020	0.014	0.025	1.243
0.050								-	10.473	-	-	-	-	-	-	-	-	-
0.060	0.020	0.071	0.090	0.098	0.010	0.105	0.106	0.109	6.451	0.830	1.169	0.430	0.185	(2.013)	2.171	0.037	0.064	2.873
0.080	1.712	6.950	9.300	10.030	11.083	11.160	11.360	11.670	2.999	70.483	120.474	54.050	16.790	24.219	1.771	4.600	7.130	299.517
0.100	0.317	1.383	1.929	2.171	2.297	2.373	2.424	2.496	1.668	13.061	24.511	12.558	5.566	2.898	1.748	1.173	1.656	83.171
0.150	0.193	0.896	1.312	1.156	1.621	1.684	1.725	1.788	0.611	7.620	16.143	9.667	(3.588)	10.894	1.449	0.943	1.449	44.276
0.200	2.401	11.320	16.890	19.770	21.290	22.190	22.780	23.680	0.329	80.984	198.916	127.079	65.707	34.679	20.533	13.461	20.533	561.892
0.300	1.110	5.275	8.006	9.501	10.310	10.810	11.120	11.610	0.166	26.419	79.371	57.298	31.366	16.973	10.490	6.504	10.281	238.702
0.400	0.098	0.468	0.716	0.857	0.935	0.983	1.014	1.062	0.117	1.847	6.057	4.584	2.656	1.478	0.914	0.580	0.906	19.120
0.500	0.562	2.678	4.119	4.954	5.428	5.727	5.913	6.207	0.095	9.029	30.952	24.922	14.441	6.198	5.171	3.217	5.085	101.016
0.600	1.267	6.041	9.324	11.260	12.380	13.100	13.540	14.250	0.082	18.173	64.039	52.933	31.215	18.058	11.609	7.094	11.448	214.566
0.800	1.261	6.019	9.343	11.360	12.550	13.330	13.820	14.590	0.068	15.396	56.104	48.091	29.181	17.217	11.285	7.089	11.140	195.503
1.000	2.317	11.070	17.260	21.060	23.380	24.930	25.890	27.450	0.059	25.164	93.646	82.322	50.803	30.568	20.614	12.767	20.747	336.651
1.500	0.532	2.555	4.016	4.950	5.530	5.939	6.193	6.614	0.047	4.750	18.302	16.739	10.701	6.645	4.686	2.910	4.823	69.556
2.000	0.012	0.058	0.092	0.011	0.128	0.138	0.145	0.155	0.041	0.096	0.378	0.354	(0.644)	1.222	0.107	0.067	0.113	1.494
3.000	1.428	6.935	11.050	13.810	15.610	16.980	17.830	19.330	0.037	279.317	726.133	517.275	290.945	218.087	150.369	128.756	195.400	2,149.582
	13.2	61.8	93.5	111.0	122.6	129.5	133.9	141.1	Source activity (photons/sec)	8,917	88,310	243,200	479,500	795,400	1,191,000	1,685,000	3,567,000	3,570,000
										0.03132	0.00938	0.00330						0.00060
												0.00213						

Second approximation

Attachment 2
U through U-234

First Approximation for U through U-234

Energy increment	Na Mass attenuation coefficient (cm^2/g)	I Mass attenuation coefficient (cm^2/g)	NaI mass attenuation coefficients (cm^2/g)	Mean free path (cm)	Fluence rate at detector (photons/cm^2/s)	Detector thickness (g/cm^2)	Detector counts (photons/cm^2/s)	Detector Area (cm^2)	CPM
0.020	2.057	25.430	21.845	0.012	0.000	4.661	0.000	46.000	0.019
0.030	0.720	8.561	7.358	0.037	0.000	4.661	0.000	46.000	0.104
0.040	0.397	22.100	18.771	0.015	0.010	4.661	0.010	46.000	26.427
0.050	0.280	12.320	10.473	0.026	0.006	4.661	0.006	46.000	16.764
0.060	0.227	7.579	6.451	0.042	0.338	4.661	0.338	46.000	933.432
0.080	0.180	3.510	2.999	0.091	0.097	4.661	0.097	46.000	267.747
0.100	0.159	1.942	1.668	0.163	1.188	4.661	1.188	46.000	3,277.504
0.150	0.134	0.698	0.611	0.446	0.192	4.661	0.180	46.000	497.934
0.200	0.120	0.366	0.329	0.829	0.632	4.661	0.495	46.000	1,366.601
0.300	0.103	0.177	0.166	1.644	0.084	4.661	0.045	46.000	124.588
0.400	0.092	0.122	0.117	2.326	0.004	4.661	0.002	46.000	4.636
0.500	0.084	0.097	0.095	2.569	0.003	4.661	0.001	46.000	3.261
0.600	0.077	0.083	0.082	3.313	0.014	4.661	0.004	46.000	11.934
0.800	0.068	0.067	0.066	4.034	0.077	4.661	0.021	46.000	57.379
1.000	0.061	0.058	0.059	4.633	0.251	4.661	0.060	46.000	166.149
1.500	0.050	0.046	0.047	5.802	0.008	4.661	0.001	46.000	3.017
2.000	0.043	0.041	0.041	6.569	0.001	4.661	0.000	46.000	0.363
3.000	0.035	0.037	0.037	7.403	-	4.661	-	46.000	-
			First approximation	40.25	2.90		2.45		6,757.88

Repeat analysis of NaI probe detectability by breaking the soil contamination into concentric rings.

	Radius to:	Radius to:	Radius to:	Radius to:	Radius to:	Radius to:	Radius to:	Radius to:										
	5.00	15.60	26.10	36.70	47.20	57.80	68.30	100.00										
Theta	26.56	64.00	76.50	81.00	83.20	84.60	85.50	86.60										
Photon path length through detector	1.42	2.89	4.00	4.00	4.00	4.00	4.00	4.00	counts per energy increment per concentric ring (cm)									
Energy increment	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	NaI mass attenuation coefficients (cm^2/g)	5.000	15.600	26.100	36.700	47.200	57.800	68.300	100.000	CPS corrected for EMC activity
0.020	-							0.000	21.845	-	-	-	-	-	-	-	0.000	0.000
0.030								0.000	7.358	-	-	-	-	-	-	-	0.001	0.001
0.040								0.010	18.771	-	-	-	-	-	-	-	0.220	0.220
0.050								0.006	10.473	-	-	-	-	-	-	-	0.140	0.140
0.060	0.063	0.220	0.276	0.303	0.317	0.326	0.330	0.338	6.451	2.577	3.630	1.334	0.573	0.308	0.223	0.076	0.196	8.916
0.080	0.014	0.058	0.077	0.086	0.090	0.093	0.095	0.097	2.999	0.587	1.002	0.450	0.191	0.102	0.062	0.039	0.057	2.490
0.100	0.151	0.658	0.919	1.034	1.093	1.130	1.154	1.188	1.668	6.220	11.668	5.965	2.654	1.357	0.851	0.552	0.782	30.068
0.150	0.021	0.096	0.141	0.162	0.174	0.180	0.185	0.192	0.611	0.816	1.729	1.024	0.504	0.258	0.154	0.101	0.156	4.742
0.200	0.064	0.302	0.461	0.527	0.568	0.592	0.608	0.632	0.329	2.161	5.304	3.395	1.750	0.924	0.550	0.356	0.552	14.992
0.300	0.008	0.038	0.058	0.069	0.075	0.078	0.080	0.084	0.166	0.191	0.574	0.414	0.226	0.123	0.074	0.047	0.074	1.725
0.400	0.000	0.002	0.003	0.003	0.004	0.004	0.004	0.004	0.117	0.007	0.023	0.018	0.010	0.006	0.003	0.002	0.003	0.072
0.500	0.000	0.001	0.002	0.003	0.003	0.003	0.003	0.003	0.095	0.005	0.016	0.013	0.008	0.004	0.003	0.002	0.003	0.054
0.600	0.001	0.005	0.009	0.011	0.012	0.012	0.013	0.014	0.082	0.017	0.061	0.050	0.030	0.017	0.011	0.007	0.011	0.204
0.800	0.007	0.032	0.049	0.060	0.066	0.070	0.073	0.077	0.068	0.081	0.296	0.254	0.154	0.091	0.060	0.037	0.059	1.031
1.000	0.021	0.101	0.156	0.193	0.214	0.226	0.237	0.251	0.059	0.230	0.857	0.753	0.465	0.281	0.188	0.117	0.189	3.079
1.500	0.000	0.002	0.003	0.004	0.005	0.005	0.005	0.006	0.047	0.004	0.015	0.014	0.009	0.006	0.004	0.002	0.004	0.068
2.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.041	0.000	0.002	0.002	0.001	0.001	0.001	0.000	0.001	0.007
3.000								-	0.037	17.896	40.777	39.805	43.275	50.677	59.983	69.639	102.449	67.801 Second approximation
									Source activity (photons/sec)									
	0.35	1.52	2.15	2.46	2.62	2.72	2.79	2.90		8,917	86,310	243,200	479,500	795,400	1,191,000	1,685,000	3,567,000	3,570,000
										0.00201	0.00053	0.00025						0.00002
												0.00016						

Attachment 2
Ra-226 and Progeny

First Approximation for Ra-226 and Progeny (includes contribution from Th-230)

Energy increment	Na Mass attenuation coefficient (cm^2/g)	I Mass attenuation coefficient (cm^2/g)	NaI mass attenuation coefficients (cm^2/g)	Mean free path (cm)	Fluence rate at detector (photons/cm^2/s)	Detector thickness (g/cm^2)	Detector counts (photons/cm^2/s)	Detector Area (cm^2)	CPM
0.020	2.057	25.430	21.645	0.012	0.000	4.661	0.000	46.000	0.013
0.030	0.720	8.561	7.358	0.037	0.000	4.661	0.000	46.000	0.022
0.040	0.397	22.100	18.771	0.016	0.000	4.661	0.000	46.000	0.132
0.050	0.280	12.329	10.473	0.026	0.417	4.661	0.417	46.000	1,150.920
0.060	0.227	7.579	6.451	0.042	0.059	4.661	0.059	46.000	162.454
0.080	0.160	3.510	2.999	0.091	6.418	4.661	6.418	46.000	17,713.685
0.100	0.159	1.942	1.668	0.163	0.075	4.661	0.075	46.000	207.161
0.150	0.134	0.898	0.611	0.446	0.046	4.661	0.046	46.000	127.643
0.200	0.120	0.366	0.329	0.829	4.614	4.661	3.773	46.000	10,412.818
0.300	0.103	0.177	0.166	1.644	9.381	4.661	5.048	46.000	13,932.091
0.400	0.092	0.122	0.117	2.326	17.330	4.661	7.290	46.000	20,121.157
0.500	0.084	0.097	0.095	2.869	0.811	4.661	0.290	46.000	800.987
0.600	0.077	0.083	0.082	3.313	22.010	4.661	7.008	46.000	19,342.983
0.800	0.068	0.067	0.066	4.034	4.399	4.661	1.188	46.000	3,279.307
1.000	0.061	0.058	0.059	4.633	14.840	4.661	3.558	46.000	9,819.372
1.500	0.050	0.046	0.047	5.802	9.472	4.661	1.862	46.000	5,139.334
2.000	0.043	0.041	0.041	6.569	13.890	4.661	2.442	46.000	6,739.638
3.000	0.035	0.037	0.037	7.403	-	4.661	-	46.000	-
			First approximation	40	104		39		108,950

Repeat analysis of NaI probe detectability by breaking the soil contamination into concentric rings.

	Radius to:	Radius to:	Radius to:	Radius to:	Radius to:	Radius to:	Radius to:	Radius to:
	5.00	15.60	26.10	36.70	47.20	57.80	68.30	100.00
Theta	26.56	64.00	76.50	81.00	83.20	84.60	85.50	86.60
Photon path length through detector	1.42	2.89	4.00	4.00	4.00	4.00	4.00	4.00

Energy increment	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	Fluence rate (photons/cm^2/s)	NaI mass attenuation coefficients (cm^2/g)	counts per energy increment per concentric ring (cm) 5	15.6	26.1	36.7	47.2	57.8	68.3	100	CPS corrected for EMC activity	
0.020	-							0.000	21.645	-	-	-	-	-	-	-	0.000	0.000	
0.030	-							0.000	7.358	-	-	-	-	-	-	-	0.000	0.000	
0.040	-							0.000	18.771	-	-	-	-	-	-	-	0.001	0.001	
0.050	0.090	0.284	0.349	0.377	0.392	0.401	0.407	0.417	10.473	3.695	4.474	1.490	0.646	0.345	0.212	0.138	0.221	11.222	
0.060	0.011	0.038	0.049	0.053	0.055	0.056	0.057	0.059	6.451	0.448	0.631	0.242	0.091	0.054	0.031	0.021	0.034	1.552	
0.080	0.942	3.822	5.113	5.662	5.956	6.134	6.247	6.418	2.999	38.762	66.251	29.693	12.827	6.782	4.094	2.599	3.933	164.721	
0.100	0.010	0.042	0.058	0.065	0.069	0.071	0.073	0.075	1.668	0.393	0.737	0.378	0.167	0.087	0.053	0.035	0.050	1.900	
0.150	0.005	0.025	0.036	0.042	0.045	0.046	0.047	0.049	0.611	0.209	0.443	0.263	0.129	0.086	0.040	0.026	0.040	1.216	
0.200	0.488	2.301	3.434	4.019	4.327	4.511	4.630	4.814	0.329	16.467	40.430	25.849	13.347	7.027	4.198	2.715	4.198	114.230	
0.300	0.897	4.263	6.470	7.677	8.334	8.731	8.984	9.381	0.166	21.349	64.145	46.304	25.324	13.784	8.329	5.308	8.329	192.873	
0.400	1.601	7.637	11.690	13.980	15.260	16.050	16.540	17.330	0.117	30.097	98.907	76.516	43.232	24.165	14.914	9.251	14.914	311.995	
0.500	0.073	0.350	0.536	0.648	0.710	0.749	0.773	0.811	0.095	1.180	4.046	3.257	1.890	1.071	0.675	0.420	0.666	13.205	
0.600	1.958	9.333	14.410	17.400	19.130	20.230	20.920	22.010	0.082	28.084	98.929	81.858	48.209	27.893	17.736	11.125	17.574	331.407	
0.800	0.380	1.814	2.816	3.423	3.782	4.018	4.184	4.399	0.068	4.642	16.907	14.497	8.762	5.194	3.414	2.112	3.400	58.948	
1.000	1.253	5.989	9.334	11.400	12.650	13.480	14.000	14.840	0.059	13.606	50.669	44.486	27.476	16.624	11.038	6.916	11.171	181.989	
1.500	0.762	3.659	5.751	7.088	7.920	8.506	8.869	9.472	0.047	6.804	26.210	23.968	15.318	9.532	6.714	4.159	6.909	99.612	
2.000	1.077	5.197	8.217	10.190	11.450	12.360	12.930	13.890	0.041	8.615	33.818	31.680	20.697	13.217	9.546	6.979	10.070	133.622	
3.000	-	-	-	-	-	-	-	-	0.037	179.353	522.197	406.580	254.634	173.021	138.793	119.104	181.511	1,618.484	Second approximation
									Source activity (photons/sec)										
	10	45	68	82	90	95	99	104		8,917	86,310	243,200	479,500	795,400	1,191,000	1,665,000	3,567,000	3,570,000	
										0.020113606	0.006747343	0.002591496						0.0004534	
												0.00167							

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TECHNICAL MEMORANDUM

April 3, 2001

Originator: A.H. Thatcher, CHP, Senior HP Scientist

Subject: ***Derivation of Indoor Scan Thresholds for KMTC***

Revision: 1

ENDORSEMENT: This document contains the results of research and technical analysis which have been reviewed and approved for publication by the Technical Director, NEXTEP Environmental, Inc

HJNewman 4/4/01

Harry J. Newman, CHP, Technical Director — Date

Introduction

The purpose of this memo is to calculate the Scan MDC for the Ludlum 2224 detector with a 43-89 probe, and to ensure that the scan MDC is below the $DCGL_{EMC}$.

Scan MDC Methods

Scans will be utilized during Final Status Surveys in order to ensure that elevated areas of activity are not missed. The Scan MDC is required to be less than the EMC. Equation 1 is used to calculate the Scan MDC.

$$ScanMDC = \frac{MDCR}{\sqrt{p} * \varepsilon_i * \varepsilon_s * \frac{probearea}{100cm^2}}$$ Equation 1

Where

MDCR = minimum detectable count rate

ε_i = instrument efficiency. A value of 0.14 is typical for the 43-89 probe.

ε_s = surface efficiency. A value of 0.54 is typical[1].

p = surveyor efficiency. A value of 0.5 will be used per the recommendations of MARSSIM[1].

The effective area of the 43-89 probe is 110 cm^2 and accounts for geometry in the efficiency of the instrument so the probe area divided by 100 cm^2 becomes 1.1.

The MDCR is calculated using Equation 2.

$$MDCR = s_i * (60 / i) \qquad \text{Equation 2}$$

Where:

s_i = minimum detectable number of net source counts in the assumed interval

i = Probe interval

Equation 3 is needed to calculate the MDCR.

$$s_i = d' \sqrt{b_i} \qquad \text{Equation 3}$$

Where:

d′ = desired scanning performance[2]. A value of 1.38 will be used, which corresponds to 95% correct detections and 60% false positives.

b_i = number of background counts in the probe observation interval

Scan MDC Calculations

The following calculations are based upon an assumed scan (probe) interval (over the elevated area) of 10 seconds for concrete block. The gross concrete block beta-gamma background for the Ludlum 43-89 probe average is 427 cpm.

b_i = 427 cpm * (10 sec /60 sec) = 71.2 counts/sec

$$s_i = 1.38\sqrt{71.2} = 11.6$$

$$MDCR = 11.6 * (60/3) = 69.8 cpm$$

[1] MARSSIM page 6-43.

[2] For a first pass scan, one would generally accept a higher number of false positives in order to obtain a high rate of true positives. See Table 6.5 of MARSSIM.

$$ScanMDC = \frac{69.8}{\sqrt{0.5} * 0.14 * 0.54 * 1.1} = 1{,}187 dpm/100 cm^2$$

The corresponding Scan MDC in terms of βpm_{100} is:[3]

- 4,285 βpm/100cm^2 for the Th-232 and progeny,
- 2,410 βpm/100cm^2 for the uranium series to uranium 234, and
- 3,930 βpm/100cm^2 for Ra-226 and progeny (includes Th-230).

The above scan MDCs are less than the $DCGL_{EMC}$ thresholds for each radionuclide series.

Conclusions/Recommendations

The Scan MDCs calculated in this technical memo are based upon typical background in the affected areas and a reasonable probe interval. In all instances, the calculated Scan MDC is less than the $DCGL_{EMC}$. Since the requirement is for the Scan MDC to be less than the corresponding EMC value, possible corrections to the grid spacing calculated using the MARSSIM statistical process will not be required.

[3] For the natural thorium series 3.61 betas + ice/dpm, for uranium 238 to uranium 234, 2.03 betas + ice/dpm, and 3.31 betas + ice/dpm is used for thorium 230 and progeny.