ATTACHMENT 1
COMPILATION OF RESRAD PARAMETERS FOR LOW-LEVEL RADIOACTIVE MATERIALS DEPLETED URANIUM INVESTIGATIONS

COMPILATION OF RESRAD PARAMETERS FOR LOW-LEVEL RADIOACTIVE MATERIALS DEPLETED URANIUM INVESTIGATIONS

CONTRACT NO. DACW45-94-D-0002
DELIVERY ORDER NO. 12

Prepared For
Eglin Air Force Base
Air Armament Center
Air Force Materiel Command
Eglin AFB, Florida

Prepared By
Rust Environment & Infrastructure, Inc.
Fort Walton Beach, Florida

Under Contract To
U.S. Army Corps of Engineers
Omaha, Nebraska

March 1999

COMPILATION OF RESRAD PARAMETERS FOR LOW-LEVEL RADIOACTIVE MATERIALS DEPLETED URANIUM INVESTIGATIONS

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I hereby submit that I am currently registered in good standing as a Professional Geologist in the state of Florida. To the best of my knowledge, all work associated with this Interim Corrective Measures was performed in accordance with applicable state and federal regulations, project Work Plans, and accepted professional practices.

Richard L. Burdine, P.G.
Florida P.G. # 1863

TABLE OF CONTENTS

LIST OF TABLES ii

LIST OF ACRONYMS iii

1.0 OBJECTIVES 1

2.0 LAND USE SCENARIOS 1

3.0 SOURCES OF INPUT EXPOSURE PARAMETERS 2

4.0 EXPOSURE PATHWAYS 2

5.0 RESRAD PARAMETERS 3

5.1 INDUSTRIAL AND CONSTRUCTION WORKER RESRAD PARAMETERS 4

5.2 RESIDENTIAL SCENARIO RESRAD PARAMETERS 6

6.0 CONCLUSIONS 8

7.0 REFERENCES 9

LIST OF TABLES

TABLE NO.	TITLE
3.1	RESRAD HUMAN HEALTH EXPOSURE PARAMETERS CONSTRUCTION AND INDUSTRIAL SCENARIOS
3.2	GENERAL RADIONUCLIDE TRANSPORT-TYPE RESRAD PARAMETERS CONSTRUCTION AND INDUSTRIAL SCENARIOS
3.3	RESRAD HUMAN HEALTH EXPOSURE PARAMETERS RESIDENTIAL SCENARIO
3.4	GENERAL RADIONUCLIDE TRANSPORT-TYPE RESRAD PARAMETERS RESIDENTIAL SCENARIO

LIST OF ACRONYMS

AFCEE	Air Force Center for Environmental Excellence
DCGL	Derived Concentration Guideline Level
DU	depleted uranium
Eglin	Eglin Air Force Base
EMR	Environmental Management Restoration
EPA	Environmental Protection Agency
FDEP	Florida Department of Environmental Protection
LLRM	Low-Level Radioactive Materials
mg/d	milligrams per day
RESRAD	Residual Radioactivity
RME	Reasonable Maximum Exposure
SI	Site Investigation
USACE	U.S. Army Corps of Engineers
UXO	unexploded ordnance

1.0 OBJECTIVES

The objectives of this document are to present the input exposure parameters that will be used in the Residual Radioactivity (RESRAD) computer model. This model will be used to evaluate the risks potentially associated with the Low-Level Radioactive Materials (LLRM) sites at Eglin Air Force Base, Florida (Eglin). For the Site Investigations (SIs) scheduled to be performed at several Eglin sites in 1999, the RESRAD code will be used to establish the risk level posed by contamination that may be present at the site (if any) and the associated Derived Concentration Guideline Level (DCGL). Therefore, the input exposure parameters play a large role in the disposition of each site after the completion of the SI.

2.0 LAND USE SCENARIOS

The anticipated future use of LLRM sites is an important consideration in determining the extent of remediation necessary to achieve the required degree of protectiveness. The most probable land use scenario for the Eglin LLRM sites is an industrial setting. Conversely, future residential construction at Eglin is improbable. Eglin is an active facility where pilot training and ammunition testing is frequently conducted. Additionally, unexploded ordnance (UXO) exists at certain areas. These conditions will require Eglin to evaluate these areas extensively before changing their land use. Eglin will continue to restrict access to these areas for the foreseeable future, thereby minimizing the potential for residential construction.

Eglin will use the RESRAD model to calculate risks and associated DCGLs for a maximum of three land use scenarios: industrial, construction worker, and residential. These risk evaluation data will then be used as a basis for future land use decisions. The industrial scenario will be evaluated to determine DCGLs that would need to be attained to clear a site for industrial use, generally its most likely future land use designation. A construction scenario will be evaluated to determine the DCGLs to be attained to allow future construction activities at the site. Finally, the residential scenario will be used to calculate the most conservative DCGL values. These values will be used for comparative purposes, because, as noted above, it is unlikely that Eglin will clear the LLRM sites for residential land use. However, a site which meets residential DCGLs can automatically be released for unrestricted use, if so desired.

This document presents the input exposure parameters for these three land use scenarios.

3.0 SOURCES OF INPUT EXPOSURE PARAMETERS

The RESRAD model uses two types of exposure parameters, human health and general radionuclide transport-type parameters. For purposes of this document, the human health exposure parameters are distinguished from the general parameters, because the former parameters directly reflect the amount of dose and risk to an individual due to duration times, shielding, ingestion rates, and inhalation rates.

For the human health exposure parameters, Eglin plans to use the values that are presented in two sources. The first source is the *Basewide Risk Assessment Guidance – Revision 1* (O'Brien & Gere, 1998; Tables 6-5, 6-7, 6-8, and 6-9). This is a guidance document specific to Eglin, which is used to prepare consistent technically defensible risk assessment reports, to support risk management decisions, and to facilitate document regulatory review. The document has been negotiated and approved by the Eglin Tier I Partnering Team, whose members include representatives of the U.S. Environmental Protection Agency (EPA), Florida Department of Environmental Protection (FDEP), Eglin Environmental Management Restoration (EMR) Project Managers, the U.S. Army Corps of Engineers (USACE), the Air Force Center for Environmental Excellence (AFCEE), and EMR Contractors. Most of the applicable parameter values from this source are equivalent to those presented in an EPA document entitled *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors" (EPA, 1991a).*

The second source of human health exposure parameters is the *Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil* (Argonne, 1998). This document provides the RESRAD default parameters.

Information for the second type of exposure parameter, the general radionuclide transport-type parameters, will be obtained from site-specific or Eglin-specific sources, as appropriate, or from Argonne (1998).

Tables 3.1 through 3.4 present the value and source of each input exposure parameter.

4.0 EXPOSURE PATHWAYS

The primary pathways to evaluate the industrial worker and the construction worker are as follows:

- Exposure to direct gamma radiation,
- Exposure to soils through incidental ingestion, and
- Inhalation of windblown dust.

Other exposure pathways for the industrial scenario are not appropriate (i.e., they are incomplete). An on-site worker (industrial or construction) at LLRM sites would not be exposed to drinking water from a supply well, meat and milk from livestock or fish, or grown produce. These pathways are generally reserved for residential scenarios.

The primary pathways proposed for the evaluation relative to the hypothetical future resident (adult and child) are as follows:

- Exposure to direct gamma radiation,
- Exposure to soils through incidental ingestion,
- Inhalation of windblown dust,
- Ingestion of homegrown fruits, vegetables, and grains,
- Ingestion of homegrown leafy vegetables, and
- Ingestion of drinking water from a supply well.

Residential scenario pathways considered incomplete or insignificant regarding the overall risk at LLRM depleted uranium (DU) sites include ingestion of livestock and ingestion of milk. Aquatic food ingestion may be appropriate at sites that contain surface water bodies capable of sustaining edible aquatic habitats. This pathway will be evaluated on a site-specific basis and is not addressed further in this document.

5.0 RESRAD PARAMETERS

Exposure parameters are based on Reasonable Maximum Exposure (RME). RME is defined as the highest exposure that is reasonably expected to occur at a site (EPA, 1989). EPA allows a central tendency (average) exposure evaluation; however, the results of a central tendency risk evaluation are rarely utilized in risk management decisions. Therefore, this document focuses on the RME exposure parameters that will be used in the upcoming SIs. Section 5.1 discusses the RESRAD parameters for the industrial and construction worker scenarios. Section 5.2 discusses the RESRAD parameters for the residential scenario.

As discussed in Section 3.0, with the exception of site radionuclide concentrations, the RESRAD computer code provides default values for all input parameters to execute the program. The default values, although based on well-documented research, are adjustable to site-specific data and/or values that have been accepted by regulatory agencies.

5.1 INDUSTRIAL AND CONSTRUCTION WORKER RESRAD PARAMETERS

Table 3.1 provides the industrial and construction scenario human health exposure parameters that Eglin will use in the RESRAD code for the LLRM sites. The table also includes, for comparative purposes, the default values for the RESRAD exposure parameters utilized in predicting committed effective dose equivalent (CEDE) and risk. The exposure parameters and values are discussed below.

Exposure Duration is the number of years over which exposure occurs. The RESRAD default value for Exposure Duration is 30 years, which is based more on a complete residential scenario. Under the industrial scenario, an Exposure Duration of 25 years is used to estimate RME risks (O'Brien & Gere, 1998). This RME value represents the national upper-bound (95th percentile) time working at the same location and corresponds to the value presented in EPA (1991a). For the construction worker, a value of 1 year was accepted by the Eglin Tier I Partnering Team for RCRA hazardous waste sites at Eglin and hence is used here (O'Brien & Gere, 1998).

Ingestion Rates and Inhalation Rates are specific to the ingestion and the inhalation exposure pathways, respectively. Soil Ingestion is the amount of soil incidentally ingested during working activities. The RESRAD default value for Soil Ingestion is 100 milligrams per day (mg/d). However, the Eglin Tier I Partnering Team accepted a value of 100 mg/d for the industrial scenario and 290 mg/d for the construction scenario (O'Brien & Gere, 1998).

The RESRAD default value for the inhalation rate is 1 cubic meter per hour (m^3/hr). For both the industrial and construction work scenarios the default values are adjusted because of an increased respiration rate during work activities. An Inhalation Rate of 2.5 m^3/hr is used for the RME exposure under both scenarios. This value is based on a reasonable upper-bound inhalation rate of 20 m^3/8-hour workday (O'Brien & Gere, 1998; EPA, 1991a) for an adult male working at a moderate level of activity (i.e., 20 m^3/d ÷ 8 hours/d = 2.5 m^3/hr).

Under the construction scenario, a RESRAD exposure parameter termed Mass Loading for Inhalation, which increases the rate of dust resuspension during construction activity, will be greater than that of light industrial activity. The RESRAD default value for the Mass Loading for Inhalation is 2E-04 grams per cubic meter (g/m^3). This value is adopted for the industrial worker scenario, however, the value will be increased to 6E-04 g/m^3 for the construction worker scenario (Table 3.1; Argonne, 1998).

The Shielding Factor for External Gamma Radiation describes the effect of the building structure on the level of gamma radiation existing indoors. Specifically, the shielding factor is the fraction of outdoor gamma radiation that will be available indoors. The default value for this dimensionless parameter is 0.7, which corresponds to a 30% reduction in gamma radiation due to shielding. The RESRAD default value for this parameter is adopted for the upcoming evaluations.

RESRAD also incorporates a Shielding Factor for the Inhalation Pathway parameter, which is the ratio of airborne dust concentration indoors to the concentration outdoors. The parameter is based on the fact that a building provides shielding against entry of wind-blown dust particles. The default RESRAD Shielding Factor for the Inhalation Pathway is 0.4, which assumes that the dust level indoors is 40% of the outdoor level (Argonne, 1998). For purposes of this work, no adjustment is made to the default RESRAD value.

Both the Shielding Factor for External Gamma Radiation and the Shielding Factor for the Inhalation Pathway are applied to the Occupancy Factor in RESRAD and is described as follows. The Occupancy Factor describes the situation as to the amount of time an individual is exposed to external gamma radiation and inhaling contaminated dust in both indoor and outdoor situations. The Fraction of Time Spent Indoors on site is defined as the average fraction of time in a year during which an individual stays inside a building on the contaminated site. The Fraction of Time Spent Outdoors on site is defined as the average fraction of time in a year during which an individual stays outdoors on the site. The sum of the Fraction of Time Spent Indoors on site, the Fraction of Time Spent Outdoors on site should equal one. (The Fraction of Time Spent Off-Site is not used in RESRAD, i.e., $TF_3 = 0$.) In RESRAD, the Shielding Factor for External Gamma Radiation is applied only for the Fraction of Time Spent Indoors on-site. RESRAD uses these parameters within the estimation of external dose and risk to estimate the Occupancy Factor, which is obtained from Equation 1 below:

$$FO = (TF_1 \times Sf) + (TF_2 \times 1) + (TF_3 \times 0) \qquad (1)$$

Where:

FO	=	Occupancy Factor (unitless)
TF_1	=	Fraction of Time Spent Indoors On-Site (unitless)
TF_2	=	Fraction of Time Spent Outdoors On-Site (unitless)
TF_3	=	Fraction of Time Spent Off-Site (unitless)
Sf	=	Shielding Factor for Gamma Radiation (unitless)

The gamma exposure time is based on the amount of time in hours of a day that a construction or industrial worker is on-site. The assumption is that the individual is exposed outdoors for this fraction of a day, which has been accepted as 8 hours out of a 24-hour day and gives a factor of 0.33. The default value of the Fraction of Time Spent Outdoors on-site in RESRAD is 0.25, which takes into account the time an individual is not working (i.e., weekends, holidays, and vacations). The EPA adopted value for an exposure frequency under an industrial worker scenario is 250 days out of 365 days or 0.7 (EPA, 1991b). Applying this percentage to the 0.33 factor gives approximately 0.25 or 25% of the time is spent outdoors. Therefore, the RESRAD default value for Fraction of Time Spent Outdoors will be adopted for the upcoming SIs. For a construction worker, the Eglin Tier I Partnering Team has adopted an exposure frequency of 180 days out of 365 days or 0.50 (O'Brien &

Gere, 1998). Applying this percentage to the 0.33 factor gives 0.17 or 17% of the time spent outdoors. This value may appear low, however, the Fraction of Time Spent Indoors for a construction worker is zero and, therefore, the remaining time out of the year is spent away from a site.

The RESRAD default value for the Fraction of Time Spent Indoors is 0.5 or 50% of the time. For purposes of the SIs, the construction worker is assumed to spend no time indoors and, therefore, will be exposed to radiation and contaminated dust for the entire workday. For the industrial worker, the RESRAD default value of 0.5 will be accepted.

Table 3.2 provides the values for the general RESRAD parameters that will be utilized in the code to predict the transport of radionuclides in the air, water, and vadose zone. The general parameters given in Table 3.2 are listed with default values, the adjusted values, the adjusted value reference, and the relative importance of the parameter. If the adjusted value is not listed, then the table indicates that the value could be adjusted through site-specific information.

5.2 RESIDENTIAL SCENARIO RESRAD PARAMETERS

Table 3.3 provides the residential scenario human health exposure parameters that Eglin will use in the RESRAD code for the LLRM sites. The table also includes, for comparative purposes, the default values for the RESRAD exposure parameters utilized in predicting CEDE and risk. The exposure parameters (Table 3.3) are defined below.

The RESRAD default value for Exposure Duration, 30 years, is based more on a complete residential scenario. The Eglin Tier I Partnering Team, however, has separated the Exposure Duration into components of an adult and a child. The adopted Exposure Duration value for purposes of the SIs is 24 years for the adult and 6 years for the child (O'Brien & Gere, 1998; EPA, 1991a).

Ingestion Rates and Inhalation Rates are specific to the ingestion and the inhalation exposure pathways, respectively. The RESRAD default value for incidental Soil Ingestion is 100 mg/d. The Eglin Tier I Partnering Teams uses that default value for adult ingestion; however, the ingestion rate of a child will be 200 mg/d (O'Brien & Gere, 1998; EPA, 1991a).

The ingestion of drinking water from an on-site potable supply well is a residential exposure scenario. The RESRAD default value for the Ingestion Rate of Drinking Water parameter is 510 liters per year (L/yr). However, the Eglin Tier I Partnering Team utilizes an adult and a child drinking water ingestion rate of 730 L/yr and 365 L/yr, respectively (O'Brien & Gere, 1998; EPA, 1991a). For purposes of the SIs, the latter values will be utilized. The Fraction of Contaminated Drinking Water in RESRAD is defaulted to a value of 1. This value will not be adjusted for the SIs.

The residential exposure scenario includes the ingestion of homegrown produce. RESRAD utilizes an Ingestion Rate of Fruits, Vegetables, and Grains parameter and an Ingestion Rate of Leafy Vegetables. The default value for the Ingestion of Fruits, Vegetables, and Grains is 160 kg/yr, and that for the Ingestion of Leafy Vegetables is 14 kg/yr. However, Argonne (1998) indicates values that

can be used separately for the adult and child. For the adult the adjusted values for the Ingestion of Fruits, Grains, and Vegetables and for the Ingestion of Leafy Vegetables are 190 kg/yr and 64 kg/yr, respectively. For the child the adjusted values of the parameters are 200 kg/yr and 26 kg/yr, respectively. RESRAD calculates the Fraction of Contaminated Fruits, Vegetables, and Grains and the Fraction of Contaminated Leafy Vegetables based on the size of the contaminated site. If a site is greater than 1,200 m^2 then all homegrown produce is considered contaminated. This leads to excessive conservatism, because not all fruits, vegetables, and grains will be obtained from a garden. EPA has adopted certain values that compensate for this fact; however, the Eglin Tier I Partnering Team has not determined the values for the RCRA hazardous waste sites to date. Therefore, Table 3.3 indicates that the values for the two contaminated fraction parameters are pending.

The RESRAD default value for the inhalation rate is 1 m^3/hr. The value adopted by the Eglin Tier I Partnering Team is 0.83 m^3/hr for the adult and 1 m^3/hr for the child (O'Brien & Gere, 1998; EPA, 1991a). The Fraction of Contaminated Soil in RESRAD is defaulted to a value of 1. This value has not been adjusted. The Mass Loading for Inhalation parameter in RESRAD is defaulted to 2E-04 g/m^3. This value also is adopted for used in the upcoming SIs.

As with the industrial and construction scenarios, the default value for the Shielding Factor for External Gamma Radiation is 0.7, which corresponds to a 30% reduction in gamma radiation due to shielding. The RESRAD default value for this parameter is adopted for the upcoming SIs.

Again, like the other two scenarios, the default RESRAD Shielding Factor for the Inhalation Pathway is 0.4, which assumes that the dust level indoors is 40% of the outdoor level (Argonne, 1998). For purposes of this work, no adjustment is made to the default RESRAD value.

The gamma exposure time is based on the amount of time in hours of a day that a resident is on-site, which has been accepted as 15 hours out of a 24-hour day for an adult and 18 hours out of a 24-hour day for a child. The default value of the Fraction of Time Spent Outdoors on-site in RESRAD is 0.25 and the default value for the Fraction of Time Spent Indoors is 0.5 or 50% of the time. With the exception of the Time Spent Outdoors for the child, the RESRAD default values will be accepted. The child generally stays outdoors for a greater time period than the adult. Given that the child is on-site (at home) approximately 10% of the time (18 hr/24 hrs versus 15 hrs/24 hrs), the Fraction of Time Outdoors for the child will be adjusted by 10% giving a value of 0.35 (35%) for purposes of the SIs.

Table 3.4 provides the values for the general RESRAD parameters that will be utilized in the code to predict the transport of radionuclides in the air, water, and vadose zone. The general parameters given

in Table 3.4 are listed with default values, the adjusted values, the adjusted value reference, and the relative importance of the parameter. If the adjusted value is not listed, then the table indicates that the value could be adjusted through site-specific information.

6.0 CONCLUSIONS

Tables 3.1 through 3.4 present the input parameters that Eglin plans to use for the RESRAD modeling during the LLRM SIs. The values presented in this document are the values adopted by the Eglin Tier I Partnering Team, the default values used in RESRAD, or the adjusted values which reflect either the type of site activity (e.g., construction work) on existing site-specific. In addition, certain general radionuclide transport-type parameters could be adjusted using future site-specific data obtained from the SIs. For these parameters (Tables 3.2 and 3.4), Eglin will consider the importance of the individual parameters in relation to the most prominent risk pathways to determine if adjustment is warranted.

7.0 REFERENCES

Argonne, 1993. *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD*, Version 5.0, ANL/EAD/LD-2, Environmental Assessment Division, Argonne, Illinois.

Argonne, 1998. *Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil*, C.Yu, et. al., Argonne National Laboratory, Argonne, Illinois.

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EPA (U.S. Environmental Protection Agency), 1990, *Exposure Factors Handbook*, EPA/600/8-80/043, Office of Health & Environmental Assessment, Washington, DC.

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EPA (U.S. Environmental Protection Agency), 1991b, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual, (Part B, Development of Risk-based Preliminary Remediation Goals),* Publication 9285.7-01B, Office of Emergency and Remedial Response, Washington, DC.

NOAA (National Oceanic and Atmospheric Administration), 1992, *Local Climatological Data: Annual Summaries for 1992, Part II – Southern Region*, National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Asheville, NC.

O'Brien & Gere, Inc., 1998, *Draft Baseline Risk Assessment Guidance*, Revision 1, Installation Restoration Program, Eglin Air Force Base.

TABLES

TABLE 3.1
RESRAD HUMAN HEALTH EXPOSURE PARAMETERS
CONSTRUCTION AND INDUSTRIAL SCENARIOS
LOW-LEVEL RADIOACTIVE MATERIAL INVESTIGATION
EGLIN AFB, FLORIDA

Input Parameter	Units	Industrial Worker[1]	Construction Worker[2]	Input Reference	RESRAD Default[3]
Exposure Duration	yr	25	1	OBG, 1998; EPA, 1991a	30
Ingestion Rate	mg/d	100	290	OBG, 1998	100
Inhalation Rate	m^3/hr	2.5	2.5	OBG, 1998; EPA, 1991a	1
Mass Loading for Inhalation	g/m^3	2E-04	6E-04	Argonne, 1998	2E-04
Shielding Factor for External Gamma Radiation	Unitless	0.7	0.7	Argonne, 1998	0.7
Shielding Factor for Inhalation Pathway	Unitless	0.4	0.4	Argonne, 1998	0.4
Fraction of Time Outdoors	Unitless	0.25	0.17	Argonne, 1998	0.25
Fraction of Time Indoors	Unitless	0.5	0	Argonne, 1998	0.5

[1]The values listed in these columns will be used as the input parameters for the industrial worker scenario.
[2]The values listed in these columns will be used as the input parameters for the construction worker scenario.
[3]Argonne, 1993 and 1998

TABLE 3.2
GENERAL RADIONUCLIDE TRANSPORT-TYPE RESRAD PARAMETERS
CONSTRUCTION AND INDUSTRIAL SCENARIOS
LOW-LEVEL RADIOACTIVE MATERIAL INVESTIGATION
EGLIN AFB, FLORIDA

Parameter	RESRAD Default Value[1]	Value Adjustment/Comments	Adjustment Sources	Parameter Importance
Area of Contaminated Zone	10,000 m^2	Modify to site specific conditions	Site-specific characteristics or Preliminary Assessment (PA) Reports	Not important for areas over 1,200 m^2
Thickness of Contaminated Zone	2 m	0.15 m (6 inches) generally for DU sites	Site-specific characteristics or PA Reports	Important for attenuation effects and groundwater impact
Density of Contaminated Zone	1.5 g/cm^3	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites	Important for soil transport properties
Uranium Distribution Coefficient (K_d)	50 g/cm^3	Modify to site specific conditions if available	Pertinent literature or a site-specific soil column study	Critical for uranium leaching through unsaturated zone
Erosion Rate	0.0001 m/yr	8E-07 to 3E-06 m/yr for humid regions east of the Mississippi River	Argonne, 1998	Important for soil transport properties and runoff
Total Porosity	0.4	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites	Important for soil transport properties

TABLE 3.2
GENERAL RADIONUCLIDE TRANSPORT-TYPE RESRAD PARAMETERS
CONSTRUCTION AND INDUSTRIAL SCENARIOS
LOW-LEVEL RADIOACTIVE MATERIAL INVESTIGATION
EGLIN AFB, FLORIDA

Parameter	RESRAD Default Value[1]	Value Adjustment/Comments	Adjustment Sources	Parameter Importance
Effective Porosity	0.2	Modify to site specific conditions if available	Site specific characteristics or information from nearby sites	Important for soil transport properties
Hydraulic Conductivity	10 m/yr	Modify to site specific conditions if available; estimated as one order of magnitude less than the saturated hydraulic conductivity	Site specific characteristics or information from nearby sites	Important for soil transport properties
Evapotranspiration Coefficient	0.5	Can be estimated by utilizing equation for the evapotranspiration rate which includes evaporation rate (Argonne, 1998), runoff coefficient, precipitation rate (NOAA, 1992), and the irrigation rate	NOAA, 1992 Argonne, 1998	Affects the amount of water available for leaching depleted uranium through soil and runoff
Wind Speed	2 m/s	3.8 m/s	NOAA, 1992	Affects the amount of dust in air and thus the inhalation pathway

TABLE 3.2
GENERAL RADIONUCLIDE TRANSPORT-TYPE RESRAD PARAMETERS
CONSTRUCTION AND INDUSTRIAL SCENARIOS
LOW-LEVEL RADIOACTIVE MATERIAL INVESTIGATION
EGLIN AFB, FLORIDA

Parameter	RESRAD Default Value[1]	Value Adjustment/Comments	Adjustment Sources	Parameter Importance
Precipitation	1 m/yr	1.5 m/yr	NOAA, 1992	Affects the amount of water available for leaching depleted uranium through soil and runoff
Irrigation	0.2 m/yr	0 m/yr; unless otherwise specified	Ranges are not being irrigated	Affects the amount of water available for leaching depleted uranium through soil and runoff
Runoff Coefficient	0.2	Modify to site specific conditions if available through topography information	Site specific characteristics or information from nearby sites	Affects the amount of water available for leaching depleted uranium through soil and runoff

[1]Argonne 1993 and 1998

TABLE 3.3
RESRAD HUMAN HEALTH EXPOSURE PARAMETERS
RESIDENTIAL SCENARIO
LOW-LEVEL RADIOACTIVE MATERIAL INVESTIGATION
EGLIN AFB, FLORIDA

Input Parameter	Units	Adult[3]	Child[3]	Input Value Reference	RESRAD Default[1]
Exposure Duration	yr	24	6	OBG, 1998; EPA, 1991a	30
Ingestion Rate (Soil)	g/yr	100	200	OBG, 1998; EPA, 1991a	100
Ingestion Rate (Drinking Water)	L/yr	730	365	OBG, 1998; EPA, 1991a	510
Ingestion Rate (Fruit, Vegetable, and Grain)	kg/yr	190	200	Argonne, 1998	160
Ingestion Rate (Leafy Vegetable)	kg/yr	64	26	Argonne, 1998	14
Fraction Contaminated (Soil)	Unitless	1	1	Argonne, 1998 EPA, 1990	1
Fraction Contaminated (Drinking Water)	Unitless	1	1	Argonne, 1998 EPA, 1990	1
Fraction Contaminated (Fruit, Vegetable, and Grain)	Unitless	Pending[2]	Pending[2]	NA	Calculated
Fraction Contaminated (Leafy Vegetable)	Unitless	Pending[2]	Pending[2]	NA	Calculated
Inhalation Rate	m^3/hr	0.83	0.625	OBG, 1998; EPA, 1991a	1
Mass Loading for Inhalation	g/m^3	2E-04	2E-04	Argonne, 1998	2E-04
Shielding Factor for External Gamma Radiation	Unitless	0.7	0.7	Argonne, 1998	0.7
Shielding Factor for Inhalation Pathway	Unitless	0.4	0.4	Argonne, 1998	0.4
Fraction of Time Outdoors	Unitless	0.25	0.35	Modified based on Argonne, 1998 and EPA, 1991a[2]	0.25
Fraction of Time Indoors	Unitless	0.5	0.5	Argonne, 1998	0.5

NA = Not Applicable
[1]Argonne, 1993 and 1998
[2]See Section 5.2
[3]The values listed in these columns will be used as the input parameters for the residential scenario.

TABLE 3.4
GENERAL RESRAD PARAMETERS
RESIDENTIAL SCENARIO
LOW-LEVEL RADIOACTIVE MATERIAL INVESTIGATION
EGLIN AFB, FLORIDA

Parameter	RESRAD Default Value[1]	Value Adjustment/Comments	Adjustment Reference	Parameter Importance
Area of Contaminated Zone	10,000 m^2	Modify to site specific conditions	Site-specific characteristics or PA Reports	Not important for areas over 1,200 m^2
Thickness of Contaminated Zone	2 m	0.15 m (6 inches) generally for depleted uranium sites	Site-specific characteristics or PA Reports	Important for attenuation affects and groundwater impact
Density of Contaminated Zone	1.5 g/cm^3	Modify to site specific conditions if available	Site-specific characteristics or PA Reports	Important for soil transport properties
Uranium Distribution Coefficient	50 g/cm^3	Modify to site specific conditions if available	Pertinent literature or an on-site soil column study	Critical for DU leaching through unsaturated zone
Erosion	0.0001 m/yr	8E-07 – 3 E-06 m/yr for humid regions east of the Mississippi River	Argonne, 1998	Important for soil transport properties and runoff
Total Porosity (Unsaturated Zone)	0.4	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites	Important for soil transport properties

TABLE 3.4
GENERAL RESRAD PARAMETERS
RESIDENTIAL SCENARIO
LOW-LEVEL RADIOACTIVE MATERIAL INVESTIGATION
EGLIN AFB, FLORIDA

Parameter	RESRAD Default Value[1]	Value Adjustment/Comments	Adjustment Reference	Parameter Importance
Effective Porosity (Unsaturated Zone)	0.2	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites	Important for soil transport properties
Total Porosity (Saturated Zone)	0.4	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites	Important for transport of DU in groundwater
Effective Porosity (Unsaturated Zone)	0.2	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites	Important for transport of DU in groundwater
Hydraulic Conductivity (Unsaturated Zone)	10 m/yr	Modify to site specific conditions if available; estimated as one order of magnitude less than the saturated hydraulic conductivity	Site-specific characteristics or information from nearby sites	Important for soil transport properties
Hydraulic Conductivity (Saturated Zone)	100 m/yr	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites	Important for transport of DU in groundwater

TABLE 3.4
GENERAL RESRAD PARAMETERS
RESIDENTIAL SCENARIO
LOW-LEVEL RADIOACTIVE MATERIAL INVESTIGATION
EGLIN AFB, FLORIDA

Parameter	RESRAD Default Value[1]	Value Adjustment/Comments	Adjustment Reference	Parameter Importance
Hydraulic Gradient	0.02	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites	Important for transport of DU in groundwater
Length of Contaminated Zone Parallel to Aquifer Flow	100 m	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites	Important for transport of DU in groundwater
Watershed Area for Nearby Stream or Pond	1E06 m^2	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites	Important for transport of DU in groundwater with discharge to a surface water body
Water Table Drop Rate	0.001 m/yr	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites	Increases unsaturated zone thickness
Well Pump Intake Depth	10 m	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites s	Determination of where groundwater is extracted from within an aquifer for consumptive use

TABLE 3.4
GENERAL RESRAD PARAMETERS
RESIDENTIAL SCENARIO
LOW-LEVEL RADIOACTIVE MATERIAL INVESTIGATION
EGLIN AFB, FLORIDA

Parameter	RESRAD Default Value[1]	Value Adjustment/Comments	Adjustment Reference	Parameter Importance
Evapotranspiration Coefficient	0.5	Can be estimated by utilizing equation for the evapotranspiration rate which includes evaporation rate (Argonne, 1998), runoff coefficient, precipitation rate (NOAA, 1992), and the irrigation rate	NOAA, 1992 Argonne, 1998	Affects the amount of water available for leaching DU through soil and runoff
Depth of Roots	0.9 m	Modify to site specific conditions if available	Site-specific characteristics or information from nearby sites	Determines at what depth plant roots draw nutrients, water, and contamination within the contaminated zone
Wind Speed	2 m/s	3.8 m/s	NOAA, 1992	Affects the amount of dust in air and thus the inhalation pathway
Precipitation	1 m/yr	1.5 m/yr	NOAA, 1992	Affects the amount of water available for leaching DU through soil and runoff

TABLE 3.4
GENERAL RESRAD PARAMETERS
RESIDENTIAL SCENARIO
LOW-LEVEL RADIOACTIVE MATERIAL INVESTIGATION
EGLIN AFB, FLORIDA

Parameter	RESRAD Default Value[1]	Value Adjustment/Comments	Adjustment Reference	Parameter Importance
Irrigation	0.2 m/yr	0 m/yr; unless otherwise specified	Ranges are not being irrigated	Affects the amount of water available for leaching DU through soil and runoff
Runoff Coefficient	0.2	Modify to site specific conditions if available through topography information	Site-specific characteristics or information from nearby sites	Affects the amount of water available for leaching DU through soil and runoff

[1]Argonne 1993 and 1998

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary 3
Summary of Pathway Selections 7
Contaminated Zone and Total Dose Summary 8
Total Dose Components
Time = 0.000E+00 9
Time = 1.000E+00 10
Time = 3.000E+00 11
Time = 1.000E+01 12
Time = 3.000E+01 13
Time = 1.000E+02 14
Time = 3.000E+02 15
Time = 1.000E+03 16
Dose/Source Ratios Summed Over All Pathways 17
Single Radionuclide Soil Guidelines 17
Dose Per Nuclide Summed Over All Pathways 18
Soil Concentration Per Nuclide 18

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

Menu	Parameter	Current Value	Default	P
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Pb-210+D	2.320E-02	2.320E-02	DC
B-1	Ra-226+D	8.600E-03	8.600E-03	DC
B-1	Th-230	3.260E-01	3.260E-01	DC
B-1	U-234	1.320E-01	1.320E-01	DC
B-1	U-238+D	1.180E-01	1.180E-01	DC
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Pb-210+D	7.270E-03	7.270E-03	DC
D-1	Ra-226+D	1.330E-03	1.330E-03	DC
D-1	Th-230	5.480E-04	5.480E-04	DC
D-1	U-234	2.830E-04	2.830E-04	DC
D-1	U-238+D	2.690E-04	2.690E-04	DC
D-34	Food transfer factors:			
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RT
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RT
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RT
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RT
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RT
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RT
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RT
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RT
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RT
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RT
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RT
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RT
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RT
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RT
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RT
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BI
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BI
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BI
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BI
D-5	Th-230 , fish	1.000E+02	1.000E+02	BI
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BI
D-5	U-234 , fish	1.000E+01	1.000E+01	BI
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BI
D-5	U-238+D , fish	1.000E+01	1.000E+01	BI
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BI

Summary : RESRAD Default Parameters File: C74LDECO.RAD

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used (If different
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	
R011	Thickness of contaminated zone (m)	1.500E-01	2.000E+00	
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	
R011	Times for calculations (yr)	1.000E+00	1.000E+00	
R011	Times for calculations (yr)	3.000E+00	3.000E+00	
R011	Times for calculations (yr)	1.000E+01	1.000E+01	
R011	Times for calculations (yr)	3.000E+01	3.000E+01	
R011	Times for calculations (yr)	1.000E+02	1.000E+02	
R011	Times for calculations (yr)	3.000E+02	3.000E+02	
R011	Times for calculations (yr)	1.000E+03	1.000E+03	
R011	Times for calculations (yr)	not used	0.000E+00	
R011	Times for calculations (yr)	not used	0.000E+00	
R012	Initial principal radionuclide (pCi/g): U-238	6.000E+02	0.000E+00	
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	
R013	Cover depth (m)	0.000E+00	0.000E+00	
R013	Density of cover material (g/cm**3)	not used	1.500E+00	
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	
R013	Contaminated zone erosion rate (m/yr)	3.000E-06	1.000E-03	
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	
R013	Average annual wind speed (m/sec)	3.800E+00	2.000E+00	
R013	Humidity in air (g/m**3)	not used	8.000E+00	
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	
R013	Precipitation (m/yr)	1.500E+00	1.000E+00	
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	
R013	Irrigation mode	overhead	overhead	
R013	Runoff coefficient	2.000E-01	2.000E-01	
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	
R013	Accuracy for water/soil computations	not used	1.000E-03	
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	
R014	Saturated zone total porosity	not used	4.000E-01	
R014	Saturated zone effective porosity	not used	2.000E-01	
R014	Saturated zone field capacity	not used	2.000E-01	
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	
R014	Saturated zone hydraulic gradient	not used	2.000E-02	
R014	Saturated zone b parameter	not used	5.300E+00	
R014	Water table drop rate (m/yr)	not used	1.000E-03	
R014	Well pump intake depth (m below water table)	not used	1.000E+01	
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	
R015	Number of unsaturated zone strata	not used	1	

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used (If different
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	
R015	Unsat. zone 1, total porosity	not used	4.000E-01	
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	
R015	Unsat. zone 1, field capacity	not used	2.000E-01	
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	
R016	Distribution coefficients for U-238			
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	
R016	Saturated zone (cm**3/g)	not used	5.000E+01	
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.3
R016	Solubility constant	0.000E+00	0.000E+00	not
R016	Distribution coefficients for daughter Pb-210			
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+02	
R016	Saturated zone (cm**3/g)	not used	1.000E+02	
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.6
R016	Solubility constant	0.000E+00	0.000E+00	not
R016	Distribution coefficients for daughter Ra-226			
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	
R016	Saturated zone (cm**3/g)	not used	7.000E+01	
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.7
R016	Solubility constant	0.000E+00	0.000E+00	not
R016	Distribution coefficients for daughter Th-230			
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	
R016	Saturated zone (cm**3/g)	not used	6.000E+04	
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.4
R016	Solubility constant	0.000E+00	0.000E+00	not
R016	Distribution coefficients for daughter U-234			
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	
R016	Saturated zone (cm**3/g)	not used	5.000E+01	
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.3
R016	Solubility constant	0.000E+00	0.000E+00	not
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	
R017	Mass loading for inhalation (g/m**3)	2.000E-04	1.000E-04	
R017	Exposure duration	2.500E+01	3.000E+01	
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows c

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used (If different
R017	Radii of shape factor array (used if FS = -1):			
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	
R017	Fractions of annular areas within AREA:			
R017	Ring 1	not used	1.000E+00	
R017	Ring 2	not used	2.732E-01	
R017	Ring 3	not used	0.000E+00	
R017	Ring 4	not used	0.000E+00	
R017	Ring 5	not used	0.000E+00	
R017	Ring 6	not used	0.000E+00	
R017	Ring 7	not used	0.000E+00	
R017	Ring 8	not used	0.000E+00	
R017	Ring 9	not used	0.000E+00	
R017	Ring 10	not used	0.000E+00	
R017	Ring 11	not used	0.000E+00	
R017	Ring 12	not used	0.000E+00	
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	
R018	Milk consumption (L/yr)	not used	9.200E+01	
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	
R018	Fish consumption (kg/yr)	not used	5.400E+00	
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	
R018	Drinking water intake (L/yr)	not used	5.100E+02	
R018	Contamination fraction of drinking water	not used	1.000E+00	
R018	Contamination fraction of household water	not used	1.000E+00	
R018	Contamination fraction of livestock water	not used	1.000E+00	
R018	Contamination fraction of irrigation water	not used	1.000E+00	
R018	Contamination fraction of aquatic food	not used	5.000E-01	
R018	Contamination fraction of plant food	not used	-1	
R018	Contamination fraction of meat	not used	-1	
R018	Contamination fraction of milk	not used	-1	
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	
R019	Livestock soil intake (kg/day)	not used	5.000E-01	
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used (If different
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	
R019	Depth of roots (m)	not used	9.000E-01	
R019	Drinking water fraction from ground water	not used	1.000E+00	
R019	Household water fraction from ground water	not used	1.000E+00	
R019	Livestock water fraction from ground water	not used	1.000E+00	
R019	Irrigation fraction from ground water	not used	1.000E+00	
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	
R19B	Growing Season for Leafy (years)	not used	2.500E-01	
R19B	Growing Season for Fodder (years)	not used	8.000E-02	
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	
R19B	Translocation Factor for Leafy	not used	1.000E+00	
R19B	Translocation Factor for Fodder	not used	1.000E+00	
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	
C14	Fraction of vegetation carbon from air	not used	9.800E-01	
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	
C14	Fraction of grain in milk cow feed	not used	2.000E-01	
C14	DCF correction factor for gaseous forms of C14	not used	1.234E+02	
STOR	Storage times of contaminated foodstuffs (days):			
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	
STOR	Leafy vegetables	1.000E+00	1.000E+00	
STOR	Milk	1.000E+00	1.000E+00	
STOR	Meat and poultry	2.000E+01	2.000E+01	
STOR	Fish	7.000E+00	7.000E+00	
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	
STOR	Well water	1.000E+00	1.000E+00	
STOR	Surface water	1.000E+00	1.000E+00	
STOR	Livestock fodder	4.500E+01	4.500E+01	
R021	Thickness of building foundation (m)	not used	1.500E-01	
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	
R021	Total porosity of the cover material	not used	4.000E-01	
R021	Total porosity of the building foundation	not used	1.000E-01	
R021	Volumetric water content of the cover material	not used	5.000E-02	

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used (If different
R021	Volumetric water content of the foundation	not used	3.000E-02	
R021	Diffusion coefficient for radon gas (m/sec):			
R021	in cover material	not used	2.000E-06	
R021	in foundation material	not used	3.000E-07	
R021	in contaminated zone soil	not used	2.000E-06	
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	
R021	Height of the building (room) (m)	not used	2.500E+00	
R021	Building interior area factor	not used	0.000E+00	
R021	Building depth below ground surface (m)	not used	-1.000E+00	
R021	Emanating power of Rn-222 gas	not used	2.500E-01	
R021	Emanating power of Rn-220 gas	not used	1.500E-01	
TITL	Number of graphical time points	32	---	
TITL	Maximum number of integration points for dose	17	---	
TITL	Maximum number of integration points for risk	257	---	

Summary of Pathway Selections

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

Summary : RESRAD Default Parameters File: C74LDECO.RAD

Contaminated Zone Dimensions

Area:	10000.00 square meters
Thickness:	0.15 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g

U-238	6.000E+02

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	1.0
TDOSE(t):	5.142E+01	4.876E+01	4.384E+01	3.023E+01	1.045E+01	2.538E-01	6.753E-06	5.4
M(t):	2.057E+00	1.950E+00	1.754E+00	1.209E+00	4.180E-01	1.015E-02	2.701E-07	2.1

Maximum TDOSE(t): 5.142E+01 mrem/yr at t = 0.000E+00 years

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

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
U-238	4.179E+01	0.8127	5.329E+00	0.1036	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000
Total	4.179E+01	0.8127	5.329E+00	0.1036	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

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

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
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	0.000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
U-238	3.962E+01	0.8127	5.053E+00	0.1036	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000
Total	3.962E+01	0.8127	5.053E+00	0.1036	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
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	0.000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat	
Radio-										
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
U-238	3.563E+01	0.8127	4.544E+00	0.1036	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000
Total	3.563E+01	0.8127	4.544E+00	0.1036	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

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

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat	
Radio-										
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
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	0.000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat	
Radio-										
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
U-238	2.457E+01	0.8127	3.133E+00	0.1036	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000
Total	2.457E+01	0.8127	3.133E+00	0.1036	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

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

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat	
Radio-										
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
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	0.000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
U-238	8.494E+00	0.8127	1.083E+00	0.1036	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000
Total	8.494E+00	0.8127	1.083E+00	0.1036	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
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	0.000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
U-238	2.063E-01	0.8129	2.628E-02	0.1035	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000
Total	2.063E-01	0.8129	2.628E-02	0.1035	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
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	0.000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

*Sum of all water independent and dependent pathways.

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

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
U-238	5.375E-06	0.7959	7.735E-07	0.1145	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000
Total	5.375E-06	0.7959	7.735E-07	0.1145	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

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

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
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	0.000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
U-238	3.293E-07	0.6089	1.274E-07	0.2357	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000
Total	3.293E-07	0.6089	1.274E-07	0.2357	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract
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	0.000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.000

*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*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E
U-238	U-238	1.000E+00	8.569E-02	8.126E-02	7.307E-02	5.038E-02	1.742E-02	4.230E-04	1.031E
U-238	U-234	1.000E+00	2.488E-08	7.119E-08	1.496E-07	3.097E-07	3.110E-07	2.487E-08	1.807E
U-238	Th-230	1.000E+00	1.694E-13	1.150E-12	5.681E-12	4.001E-11	1.779E-10	3.568E-10	3.627E
U-238	Ra-226	1.000E+00	2.534E-15	3.686E-14	4.014E-13	8.317E-12	1.029E-10	4.896E-10	5.695E
U-238	Pb-210	1.000E+00	5.659E-19	1.694E-17	3.954E-16	2.343E-14	7.647E-13	8.166E-12	1.104E
U-238	äDSR(j)		8.569E-02	8.126E-02	7.307E-02	5.038E-02	1.742E-02	4.231E-04	1.125E

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(
The DSR includes contributions from associated (half-life ó 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
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
U-238	2.917E+02	3.076E+02	3.421E+02	4.962E+02	1.435E+03	5.909E+04	*3.360E+05

*At specific activity limit

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

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
U-238	6.000E+02	0.000E+00	8.569E-02	2.917E+02	8.569E-02	2.917E+02

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E
U-238	U-238	1.000E+00	5.142E+01	4.876E+01	4.384E+01	3.023E+01	1.045E+01	2.538E-01	6.186E
U-234	U-238	1.000E+00	1.493E-05	4.271E-05	8.977E-05	1.858E-04	1.866E-04	1.492E-05	1.084E
Th-230	U-238	1.000E+00	1.016E-10	6.902E-10	3.409E-09	2.401E-08	1.067E-07	2.141E-07	2.176E
Ra-226	U-238	1.000E+00	1.520E-12	2.211E-11	2.408E-10	4.990E-09	6.174E-08	2.938E-07	3.417E
Pb-210	U-238	1.000E+00	3.395E-16	1.017E-14	2.372E-13	1.406E-11	4.588E-10	4.900E-09	6.622E

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

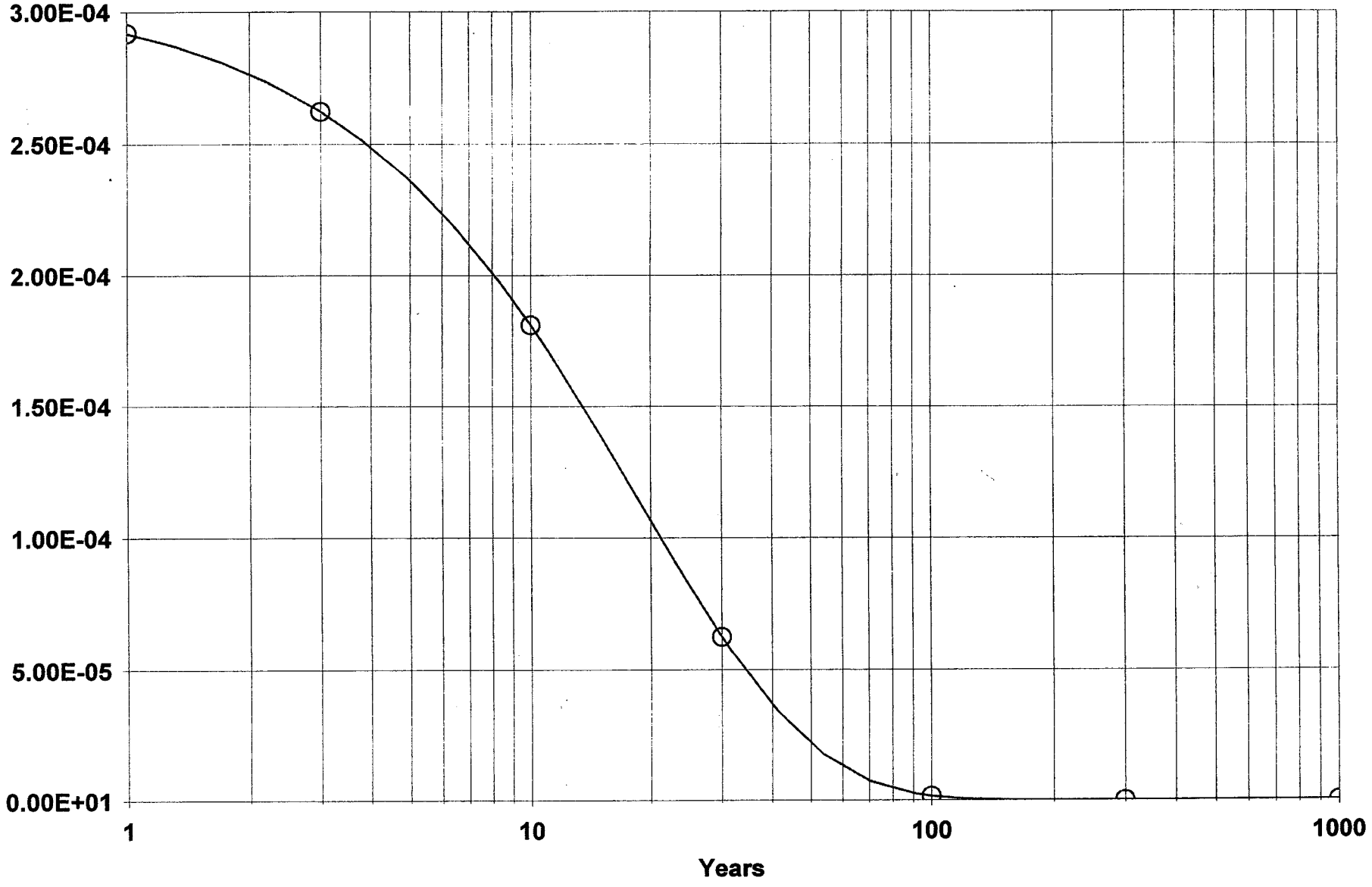
Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E
U-238	U-238	1.000E+00	6.000E+02	5.690E+02	5.116E+02	3.528E+02	1.220E+02	2.964E+00	7.235E
U-234	U-238	1.000E+00	0.000E+00	1.613E-03	4.351E-03	1.000E-02	1.037E-02	8.402E-04	6.151E
Th-230	U-238	1.000E+00	0.000E+00	7.390E-09	6.200E-08	5.416E-07	2.566E-06	5.242E-06	5.354E
Ra-226	U-238	1.000E+00	0.000E+00	1.066E-12	2.679E-11	7.737E-10	1.055E-08	5.178E-08	6.046E
Pb-210	U-238	1.000E+00	0.000E+00	8.251E-15	6.165E-13	5.754E-11	2.143E-09	2.391E-08	3.260E

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

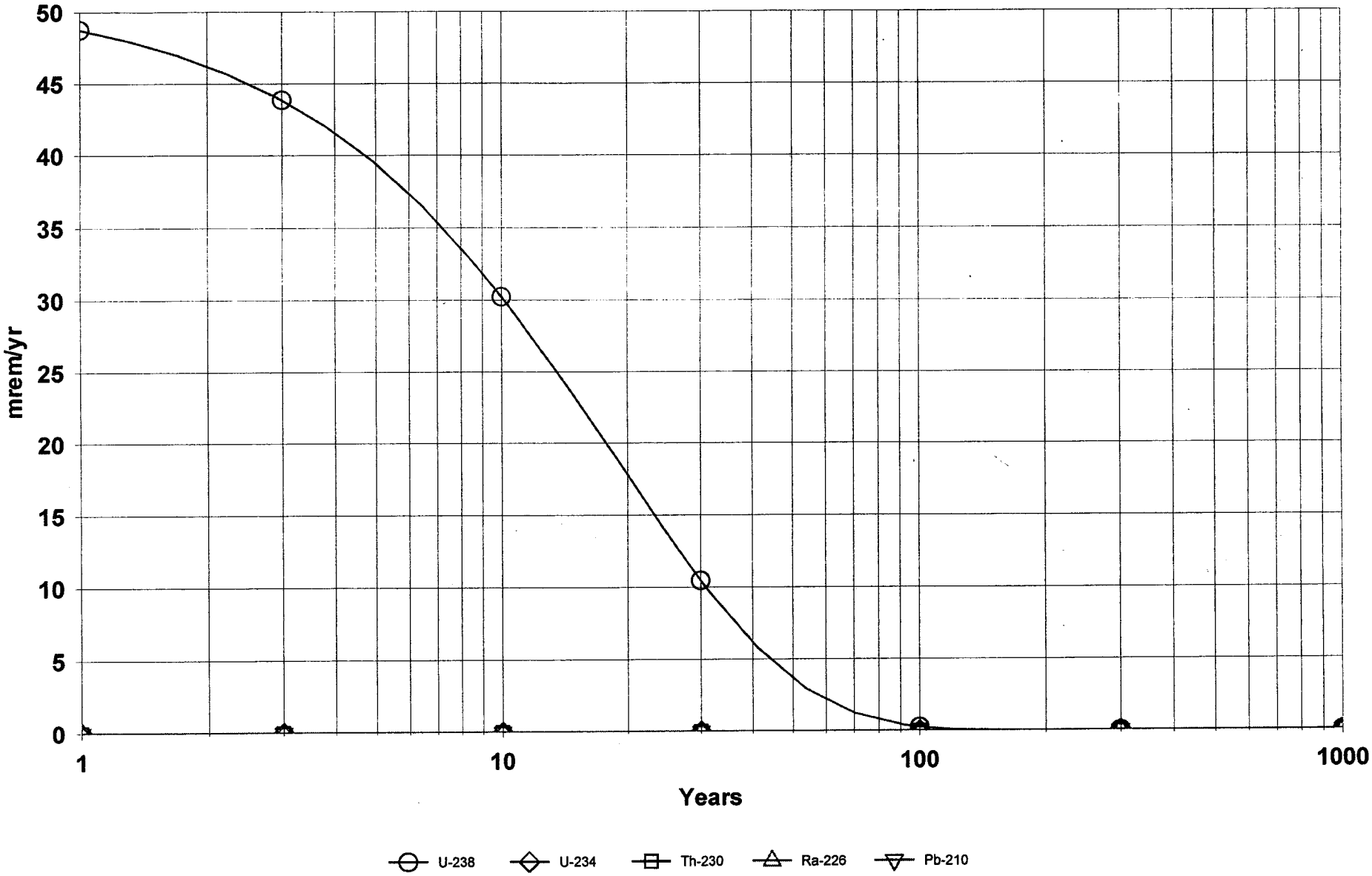
RESMAIN5.EXE execution time = 2.79 seconds

EXCESS CANCER RISK: U-238, All Pathways Summed



C74LDECO.RAD 10/17/2002 09:18 Includes All Pathways

DOSE: U-238, With Ingrowth Progeny, All Pathways Summed



C74LDECO.RAD 10/17/2002 09:18 Includes All Pathways