CALCULATION TITLE PAGE

Building Surface Derived Concentration Guideline Levels (DCGL)

Title

YA-CALC-00-004-03

Calculation Number

Executive Summary:

Approvals	(Print & Sign Name)	
Preparer: Cynthia Harrington	Cynthia L Harrington	Date: 12/18/03
Preparer: Estella Keefer		Date:
Reviewer:		Date:
Approver (Cognizant Manager):	Jim Baldwin	Date: 1/19/04

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SIGNATURES:
PAGE 1 OF 3

CALCULATION TITLE PAGE

Building Surface Derived Concentration Guideline Levels (DCGL)

Title

YA-CALC-00-004-03

Calculation Number

Executive Summary:

Approvals	(Print & Sign Name)	
Preparer: Cynthia Harrington		Date:
Preparer: Estella Keefer	Estella Keefer	Date: 12/16/03
Reviewer:		Date:
Approver (Cognizant Manager):		Date:

DCM FORM 1.5-1A
Page 1

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CALCULATION TITLE PAGE

Building Surface Derived Concentration Guideline Levels (DCGL)

Title

YA-CALC-00-004-03

Calculation Number

Executive Summary:
Nuclide specific building surface Derived Concentration Guideline Level (DCGL) values have been calculated by the use of the building occupancy scenario and the RESRAD-BUILD v3.21 dose modeling code.

Approvals	(Print & Sign Name)	
Preparer: Cynthia Harrington		Date:
Preparer: Estella Keefer		Date:
Reviewer: PETER LITTLEFIELD	PS Littlefield	Date: 12/22/03
Approver (Cognizant Manager):		Date:

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PURPOSE:

The purpose of this calculation is to determine nuclide specific building surface Derived Concentration Guideline Level (DCGL) values using the peak of the mean dose determined by the use of the building occupancy scenario and the RESRAD-BUILD v3.21 dose modeling code. This methodology is in accordance with the NRC guidance provided in NUREG-1727 and NUREG-1757 [Ref. 1, Ref. 2].

SUMMARY OF RESULTS:

NUREGs-1727 and -1757 both discuss the application of the peak of the mean dose to derive nuclide specific DCGL values. The probabilistic module of the RESRAD-BUILD code v3.21 was used to perform nuclide specific sensitivity analyses and to identify the input parameters that have the greatest potential to affect the dose from residual building surface contamination. The list of nuclides of interest at the YNPS is based on historical site information, laboratory analyses and NUREG guidance and is discussed in Ref. 3. The methodology for choosing parameter values and the results of the sensitivity analysis are discussed in Ref. 4. Based on these results, sensitive and non-sensitive parameter values were determined according to the process flowcharted in Figure 1. In summary, either the 25th or 75th percentiles of the probability distribution or the probability distribution itself, were chosen for sensitive and non-sensitive parameters, respectively. The BUILD code was used to determine the mean dose per unit activity concentration. In cases where all input parameters were constants, the deterministic models were used to determine the dose. This Dose Conversion Factor (DCF) was then used to calculate the corresponding DCGL.

Table 1 summarizes the nuclide specific Building Surface DCGL values based on the regulatory dose limit of 25 mrem/yr.

Table 1–Building Surface DCGL Values

Nuclide	DCGL pCi/m^2	DCGL dpm/100cm^2	Nuclide	DCGL pCi/m^2	DCGL dpm/100cm^2
H-3	1.5E+10	3.4E+08	Cs-134	1.3E+06	2.9E+04
C-14	4.6E+08	1.0E+07	Cs-137	2.8E+06	6.3E+04
Fe-55	1.8E+09	4.0E+07	Eu-152	1.7E+06	3.7E+04
Co-60	8.1E+05	1.8E+04	Eu-154	1.6E+06	3.4E+04
Ni-63	1.7E+09	3.7E+07	Eu-155	2.9E+07	6.5E+05
Sr-90	6.3E+06	1.4E+05	Pu-238	2.6E+05	5.7E+03
Nb-94	1.2E+06	2.6E+04	Pu-239	2.3E+05	5.1E+03
Tc-99	6.5E+08	1.4E+07	Pu-241	1.1E+07	2.5E+05
Ag-108m	1.1E+06	2.5E+04	Am-241	2.2E+05	5.0E+03
Sb-125	4.5E+06	1.0E+05	Cm-243	3.2E+05	7.2E+03

REFERENCES:

1. NUREG-1727. "NMSS Decommissioning Standard Review Plan," September 2000.

2. NUREG-1757. "Consolidated NMSS Decommissioning Guidance," Volume 2: Characterization, Survey and Determination of Radiological Criteria," September 2003.

3. YA-REPT-00-001-03, "Radionuclide Selection for DCGL Determination," November 2003.

4. YA-CALC-00-003-03, "RESRAD-BUILD v3.21 Sensitivity Analysis for Building Occupancy," November 2003.

5. Code of Federal Regulations, Title 10, Section 20.1402, "Radiological Criteria for Unrestricted Uses."

ASSUMPTIONS

The comprehensive demolition and dismantling strategy defined for the YNPS site will result in some structures remaining on site at the time of license termination. The remaining parts of buildings will generally consist of support walls, tank rooms and floor slabs. All existing ceilings will be replaced with new uncontaminated materials. The dimensions of an average room that might remain on site were determined by considering the demolition plans and the identification of walls/rooms to remain intact, and are discussed in Ref. 4.

METHOD / BODY OF CALCULATION

Dose Model

The DCGLs for building surfaces were calculated using the building occupancy scenario in the RESRAD-BUILD v 3.21 dose modeling code. The residual radioactivity was assumed to be uniformly distributed over the floor and four walls. The critical group for this scenario are adults performing light industrial work in the building. The pathways used to estimate the potential exposure to occupants of a building from residual radioactivity on surfaces include the following:

- External exposure directly from the source
- External exposure to deposited material
- External exposure due to air submersion
- Inhalation of airborne radioactive particulates
- Inadvertent ingestion of radioactive material directly from the sources.

Conceptual Model

The conceptual model consists of a room with fixed dimensions, uniform concentrations of residual radioactivity on five surfaces and a receptor located in the center of the room at a height of one meter.

Using the results of the sensitivity analysis [Ref. 4] and the process outlined in Figure 1, values were assigned to parameters identified as sensitive ($|PRCC| \geq 0.1$) as follows;

- negatively correlated parameters were assigned the 25th percentile value and
- positively correlated parameters were assigned the 75th percentile value from the probability distribution. In addition, the value of the 75th percentile was compared to the mean of the distribution and the higher value was then assigned.
- Non-sensitive parameters, those that did not affect the value of the dose over the range of the probability distribution, maintain the distribution as the input.

The values assigned to the input parameters are presented in Attachment 1, Table 1-1. Attachment 2 provides a summary of the method used to determine the quantile values for the probability distributions used for each parameter from NUREG/CR-6697 or 6755.

DCGL Determination

The annual doses per 1 pCi/m^2 calculated by RESRAD-BUILD v3.21 are listed in Table 2. The nuclides followed by an (*) denotes a run that used one or more probability distributions as a parameter input and for which the annual dose is the peak of the mean as determined by the probabilistic report. All other nuclide runs used assigned 25/75 percentile values. The normalized annual dose or dose conversion factor (DCF) is used to derive the DCGL in pCi/m^2

and dpm/100cm^2 as shown in the equations below. The resulting DCGL values are also listed in Table 2.

$$DCGL\,(pCi/m^2) = \frac{25\ mrem/yr}{DCF\,(mrem/yr\ /\ pCi/m^2)} \qquad \text{(Equation 1)}$$

OR,

$$DCGL\,(dpm/cm^2) = DCGL\,(pCi/m^2) \times (0.037\ dps/pCi) \times (60\ sec/min) \times (m/100cm)^2 \qquad \text{(Equation 2)}$$

$$DCGL\,(dpm/100cm^2) = DCGL\,(pCi/m^2) \times (2.22\ dpm/pCi) \times (m/100cm)^2 \times 100 \qquad \text{(Equation 3)}$$

Table 2 - Building Surface Annual Dose per Unit Concentration and DCGL Results

Nuclide	DCF mrem/yr per pCi/m^2	DCGL pCi/m^2	DCGL dpm/100cm^2
H-3	1.6E-09	1.5E+10	3.4E+08
C-14*	5.4E-08	4.6E+08	1.0E+07
Fe-55	1.4E-08	1.8E+09	4.0E+07
Co-60	3.1E-05	8.1E+05	1.8E+04
Ni-63*	1.5E-08	1.7E+09	3.7E+07
Sr-90	4.0E-06	6.3E+06	1.4E+05
Nb-94	2.1E-05	1.2E+06	2.6E+04
Tc-99*	3.9E-08	6.5E+08	1.4E+07
Ag-108m	2.2E-05	1.1E+06	2.5E+04
Sb-125	5.5E-06	4.5E+06	1.0E+05
Cs-134	1.9E-05	1.3E+06	2.9E+04
Cs-137	8.8E-06	2.8E+06	6.3E+04
Eu-152*	1.5E-05	1.7E+06	3.7E+04
Eu-154	1.6E-05	1.6E+06	3.4E+04
Eu-155*	8.5E-07	2.9E+07	6.5E+05
Pu-238*	9.7E-05	2.6E+05	5.7E+03
Pu-239*	1.1E-04	2.3E+05	5.1E+03
Pu-241	2.3E-06	1.1E+07	2.5E+05
Am-241*	1.1E-04	2.2E+05	5.0E+03
Cm-243	7.7E-05	3.2E+05	7.2E+03

Table 3 provides a summary of the dose by pathway. Table 4 presents the fraction of the total dose represented by each pathway.

Table 3 – Annual Dose, by Pathway, from 1.0 pCi/m^2 Area Sources

Nuclide	Total	External	Deposition	Immersion	Inhalation	Radon	Ingestion
H-3	1.64E-09	0.00E+00	0.00E+00	0.00E+00	5.47E-11	0.00E+00	1.59E-09
C-14*	5.39E-08	3.02E-10	1.72E-14	3.02E-17	2.95E-11	0.00E+00	5.37E-08
Fe-55	1.38E-08	0.00E+00	0.00E+00	0.00E+00	3.35E-11	0.00E+00	1.37E-08
Co-60	3.07E-05	3.00E-05	4.28E-09	1.24E-11	2.27E-09	0.00E+00	6.47E-07
Ni-63*	1.49E-08	0.00E+00	0.00E+00	0.00E+00	2.56E-10	0.00E+00	1.46E-08
Sr-90	3.98E-06	7.67E-08	6.05E-15	7.63E-14	5.27E-08	0.00E+00	3.85E-06
Nb-94	2.14E-05	2.12E-05	2.76E-08	1.04E-11	5.84E-09	0.00E+00	1.83E-07
Tc-99*	3.86E-08	1.07E-09	6.32E-14	2.19E-16	1.18E-10	0.00E+00	3.74E-08
Ag-108m	2.22E-05	2.20E-05	2.15E-08	9.85E-12	3.74E-09	0.00E+00	1.95E-07
Sb-125	5.51E-06	5.43E-06	4.28E-10	1.85E-12	1.34E-10	0.00E+00	8.27E-08
Cs-134	1.94E-05	1.78E-05	1.06E-09	6.64E-12	4.26E-10	0.00E+00	1.60E-06
Cs-137	8.82E-06	7.54E-06	4.05E-09	3.11E-12	3.81E-10	0.00E+00	1.27E-06
Eu-152*	1.51E-05	1.50E-05	1.76E-10	7.37E-12	3.02E-09	0.00E+00	1.62E-07
Eu-154	1.61E-05	1.58E-05	3.51E-09	6.37E-12	3.10E-09	0.00E+00	2.35E-07
Eu-155*	8.49E-07	8.09E-07	1.60E-11	8.95E-13	1.56E-09	0.00E+00	3.64E-08
Pu-238*	9.72E-05	3.20E-08	7.00E-14	1.90E-15	1.60E-05	2.47E-21	8.11E-05
Pu-239*	1.08E-04	1.62E-08	3.48E-12	1.65E-15	1.75E-05	0.00E+00	9.01E-05
Pu-241	2.26E-06	6.77E-09	5.48E-16	3.93E-15	4.33E-07	0.00E+00	1.82E-06
Am-241*	1.11E-04	5.65E-07	1.81E-05	7.32E-11	3.19E-13	9.27E-05	0.00E+00
Cm-243	7.73E-05	1.74E-06	1.37E-13	2.27E-12	1.24E-05	0.00E+00	6.32E-05

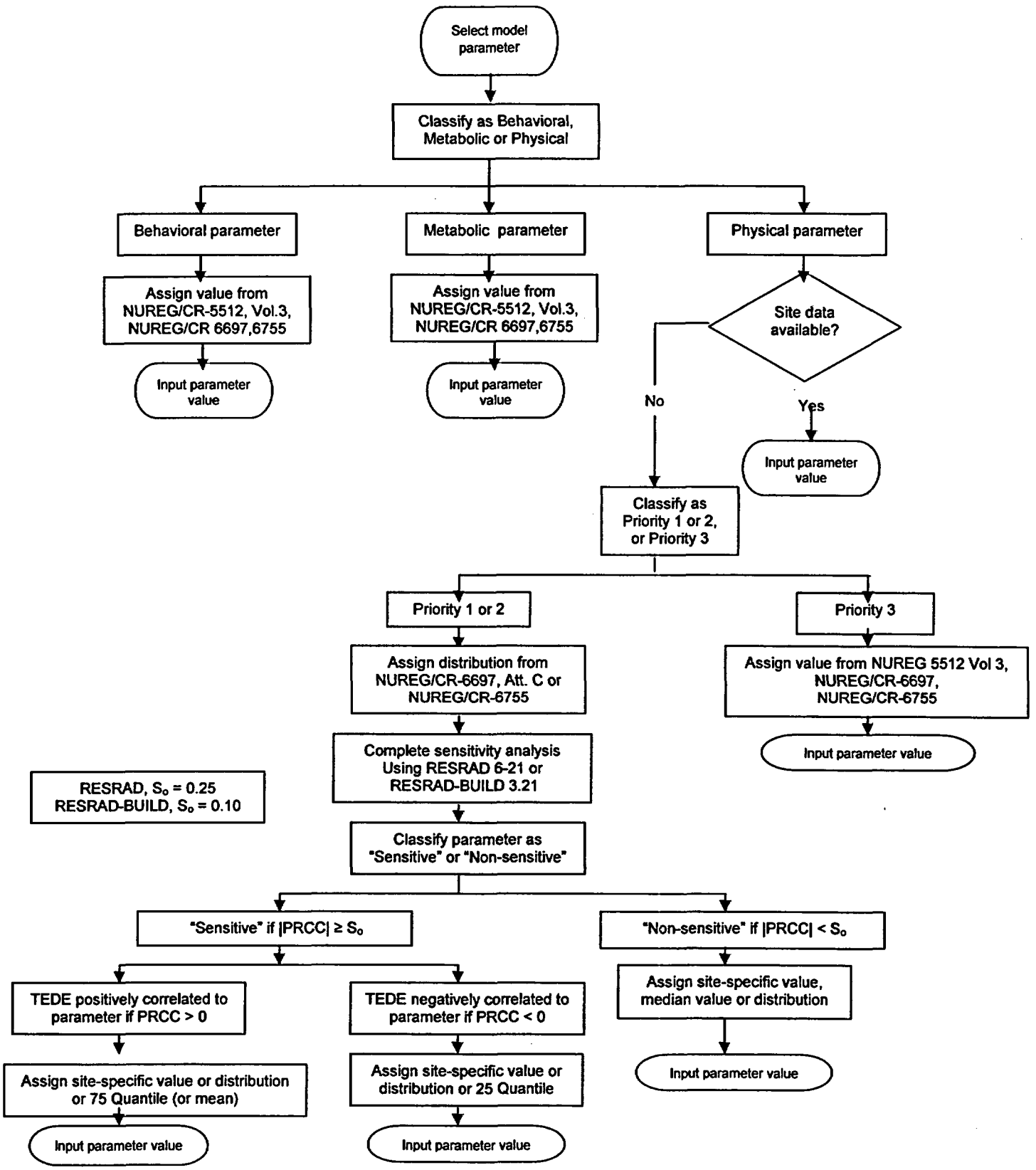
Table 4 – Fraction of Total Annual Dose, by Pathway, from 1.0 pCi/m^2 Area Sources [a]

Nuclide	Total	External	Deposition	Immersion	Inhalation	Radon	Ingestion
H-3	1.000	0.000	0.000	0.000	0.033	0.000	0.967
C-14*	1.000	0.006	0.000	0.000	0.001	0.000	0.998
Fe-55	1.000	0.000	0.000	0.000	0.002	0.000	0.998
Co-60	1.000	0.979	0.000	0.000	0.000	0.000	0.021
Ni-63*	1.000	0.000	0.000	0.000	0.017	0.000	0.983
Sr-90	1.000	0.019	0.000	0.000	0.013	0.000	0.967
Nb-94	1.000	0.990	0.001	0.000	0.000	0.000	0.009
Tc-99*	1.000	0.028	0.000	0.000	0.003	0.000	0.969
Ag-108m	1.000	0.990	0.001	0.000	0.000	0.000	0.009
Sb-125	1.000	0.985	0.000	0.000	0.000	0.000	0.015
Cs-134	1.000	0.918	0.000	0.000	0.000	0.000	0.082
Cs-137	1.000	0.856	0.000	0.000	0.000	0.000	0.144
Eu-152*	1.000	0.989	0.000	0.000	0.000	0.000	0.011
Eu-154	1.000	0.985	0.000	0.000	0.000	0.000	0.015
Eu-155*	1.000	0.951	0.000	0.000	0.002	0.000	0.043
Pu-238*	1.000	0.000	0.000	0.000	0.164	0.000	0.833
Pu-239*	1.000	0.000	0.000	0.000	0.162	0.000	0.835
Pu-241	1.000	0.003	0.000	0.000	0.192	0.000	0.805
Am-241*	1.000	0.005	0.163	0.000	0.000	0.833	0.000
Cm-243	1.000	0.022	0.000	0.000	0.160	0.000	0.817

[a] Due to rounding, the sum of the fractions may not total 1.

* denotes a run that used one or more probability distributions as a parameter input and for which the annual dose is the peak of the mean as determined by the probabilistic report. All other nuclide runs used assigned 25/75 percentile values.

Figure 1
Parameter Selection Process



Attachment 1

RESRAD-BUILD v3.21
Input Parameters to DCGL Runs
Building Occupancy

Table 1-1 RESRAD-BUILD v3.21 Input Parameters for DCGL Runs Building Occupancy

Parameter (unit)	Type[a]	Nuclide[b]	Treatment[c]	Value/[d] Distribution	Basis	Distribution's Statistical Parameters				
						1	2	3	4	Median
Exposure Duration (days)	B	All	D	365.25	NUREG/CR-5512, Vol.3, 5.2.1	NR	NR	NR	NR	NR
Indoor Fraction	B	All		0.267	NUREG/CR-5512, Vol. 3, 5.2.2	NR	NR	NR	NR	NR
Evaluation Time (year)	P	All	D	0	t=0 corresponds maximum dose over the first year (year 9 for Pu-241)	NR	NR	NR	NR	NR
Number of Rooms	P	All	D	1	NUREG/CR-5512	NR	NR	NR	NR	NR
Deposition Velocity (m/sec)	P	H-3	D	1.51E-05	25th percentile value	NR	NR	-	-	-
	P	Fe-55	D	1.51E-05	25th percentile value	NR	NR	-	-	-
	P	Co-60	D	4.79E-04	75th percentile value	NR	NR	-	-	-
	P	Sr-90	D	1.51E-05	25th percentile value	NR	NR	-	-	-
	P	Nb-94	D	4.79E-04	75th percentile value	NR	NR	-	-	-
	P	Ag-108m	D	4.79E-04	75th percentile value	NR	NR	-	-	-
	P	Sb-125	D	4.79E-04	75th percentile value	NR	NR	-	-	-
	P	Cs-134	D	4.79E-04	75th percentile value	NR	NR	-	-	-
	P	Cs-137	D	4.79E-04	75th percentile value	NR	NR	-	-	-
	P	Eu-154	D	4.79E-04	75th percentile value	NR	NR	-	-	-
	P	Pu-241	D	1.51E-05	25th percentile value	NR	NR	-	-	-
	P	Cm-243	D	1.51E-05	25th percentile value	NR	NR	-	-	-
	P	All others	S	Loguniform	NUREG/CR-6755, 3.3	2.70E-06	2.70E-03	-	-	8.53E-05
Resuspension Rate (sec^{-1})	P	H-3	D	1.02E-06	Mean value	NR	NR	-	-	-
	P	Fe-55	D	1.02E-06	Mean value	NR	NR			
	P	Co-60	D	6.75E-10	25th percentile value	NR	NR	-	-	-
	P	Ni-63	D	1.02E-06	Mean value	NR	NR	-	-	-
	P	Sr-90	D	1.02E-06	Mean value	NR	NR	-	-	-
	P	Nb-94	D	6.75E-10	25th percentile value	NR	NR	-	-	-
	P	Ag-108	D	6.75E-10	25th percentile value	NR	NR	-	-	-
	P	Sb-125	D	6.75E-10	25th percentile value	NR	NR	-	-	-
	P	Cs-134	D	6.75E-10	25th percentile value	NR	NR	-	-	-
	P	Cs-137	D	6.75E-10	25th percentile value	NR	NR	-	-	-
	P	Eu-154	D	6.75E-10	25th percentile value	NR	NR	-	-	-
	P	Pu-238	D	1.02E-06	Mean value	NR	NR	-	-	-

Table 1-1 RESRAD-BUILD v3.21 Input Parameters for DCGL Runs Building Occupancy

Parameter (unit)	Type[a]	Nuclide[b]	Treatment[c]	Value/[d] Distribution	Basis	Distribution's Statistical Parameters				
						1	2	3	4	Median
	P	Pu-241	D	1.02E-06	Mean value	NR	NR	-	-	-
	P	Cm-243	D	1.02E-06	Mean value	NR	NR	-	-	-
	P	All others	S	Loguniform	NUREG/CR-6755, 3.1	2.5E-11	1.3E-5	-	-	1.83E-08
Air exchange rate for room (1/ h)	B	All	D	1.52	NUREG/CR-6697, Att.C, 7.4 and NUREG/CR-6755, 3.2	NR	NR	NR	NR	NR
Room area (m^2)	P	All	D	19.71	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
Room height (m)	P	All	D	3.51	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
Time fraction	B	All	D	1	NUREG/CR-5512	NR	NR	NR	NR	NR
Breathing rate (m^3/day)	B	All	D	33.6	NUREG/CR-5512 Vol. 3 5.3	NR	NR	NR	NR	NR
Indirect ingestion rate (m^2/hr)	B	All	D	0	NUREG/CR-5512 Vol. 3 5.2.3 Indirect ingestion is not modeled	NR	NR	NR	NR	NR
Receptor location: x,y,z (m)	B	All	D	2.22, 2.22, 1	NUREG/CR-5512	NR	NR	NR	NR	NR
Shielding thickness (cm)	P	All	D	0	Site-specific model- No Shielding assumed	NR	NR	NR	NR	NR
Shielding density (g/cc)	P	All	D	0	Site-specific model - No shielding assumed	NR	NR	NR	NR	NR
Shielding material	P	All	D	None	Site-specific model - No shielding assumed	NR	NR	NR	NR	NR
Number of sources	P	All	D	5	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
External dose conversion factor ((mrem/yr)/(dpm/m^2))	M	All	D	RESRAD-BUILD default	FGR 12	NR	NR	NR	NR	NR
Air submersion dose conversion factor ((mrem/yr)/(pCi/m^3))	M	All	D	RESRAD-BUILD default	FGR 12	NR	NR	NR	NR	NR
Inhalation dose conversion factor (mrem/pCi/g)	M	All	D	RESRAD-BUILD default	FGR 11	NR	NR	NR	NR	NR
Ingestion dose conversion factor (mrem/pCi/g)	M	All	D	RESRAD-BUILD default	FGR 11	NR	NR	NR	NR	NR
Source 1. Floor										
Type	P	All	D	Area	NUREG/CR-5512	NR	NR	NR	NR	NR
Direction	P	All	D	Z	NUREG/CR-5512	NR	NR	NR	NR	NR
Location of center of source: x,y,z (m)	P	All	D	2.22, 2.22, 0	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
Area (m2)	P	All	D	19.71	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
Air fraction for H-3	B	All	D	1	NUREG/CR-6697, Att. C, 8.6	NR	NR	NR	NR	NR

Table 1-1 RESRAD-BUILD v3.21 Input Parameters for DCGL Runs Building Occupancy

Parameter (unit)	Type[a]	Nuclide[b]	Treatment[c]	Value/[d] Distribution	Basis	Distribution's Statistical Parameters				
						1	2	3	4	Median
Air fraction (for all nuclides except H-3)	B	All	D	0.07	NUREG/CR-6697, Att. C, 8.6	NR	NR	NR	NR	NR
Direct ingestion (hr-1)	B	All	D	1.34E-6	NUREG/CR-5512, Vol. 3, 5.2.3 1.1E-04m^2/h / 82.03 m^2	NR	NR	NR	NR	NR
Removable fraction	P	All	D	0.1	NUREG-1727 Table C 7.1 / NUREG/CR-6755, 3.5	NR	NR	NR	NR	NR
Time for source removal (days)	P	H-3	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	C-14	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Fe-55	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Co-60	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Ni-63	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Sr-90	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Nb-94	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Tc-99	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Ag-108m	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Sb-125	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Cs-134	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Cs-137	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-152	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-154	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-155	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-238	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-239	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-241	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Am-241	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Cm-243	D	18240	25th percentile value	NR	NR	NR	NR	NR
Radionuclide concentration (pCi/m^2)	P	All	D	1	Allows for proportional DCGL calculation	NR	NR	NR	NR	NR
Source 2. West Wall										
Type	P	All	D	Area	NUREG/CR-5512	NR	NR	NR	NR	NR

Table 1-1 RESRAD-BUILD v3.21 Input Parameters for DCGL Runs Building Occupancy

Parameter (unit)	Type[a]	Nuclide[b]	Treatment[c]	Value/[d] Distribution	Basis	Distribution's Statistical Parameters				
						1	2	3	4	Median
Direction	P	All	D	X	NUREG/CR-5512	NR	NR	NR	NR	NR
Location of center of source: x,y,z (m)	P	All	D	0, 2.22, 1.76	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
Area (m2)	P	All	D	15.58	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
Air fraction for H-3	B	All	D	1	NUREG/CR-6697 Att C, 8.6	NR	NR	NR	NR	NR
Air fraction (for all nuclides except H-	B	All	D	0.07	NUREG/CR-6697 Att C, 8.6	NR	NR	NR	NR	NR
Direct ingestion (hr-1)	B	All	D	1.34E-6	NUREG/CR-5512 Vol 3, 5.2.3 1.1E-04m^2/h / 82.03m^2	NR	NR	NR	NR	NR
Removable fraction	P	All	D	0.1	NUREG-1727 Table C 7.1 / NUREG/CR-6755, 3.5	NR	NR	NR	NR	NR
Time for source removal (days)	P	H-3	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	C-14	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Fe-55	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Co-60	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Ni-63	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Sr-90	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Nb-94	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Tc-99	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Ag-108m	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Sb-125	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Cs-134	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Cs-137	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-152	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-154	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-155	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-238	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-239	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-241	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Am-241	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Cm-243	D	18240	25th percentile value	NR	NR	NR	NR	NR
Radionuclide concentration (pCi/m^2)	P	All	D	1	Allows for proportional DCGL calculation	NR	NR	NR	NR	NR
Source 3, North Wall										
Type	P	All	D	Area	NUREG/CR-5512	NR	NR	NR	NR	NR
Direction	P	All	D	Y	NUREG/CR-5512	NR	NR	NR	NR	NR

Table 1-1 RESRAD-BUILD v3.21 Input Parameters for DCGL Runs Building Occupancy

Parameter (unit)	Type[a]	Nuclide[b]	Treatment[c]	Value/[d] Distribution	Basis	Distribution's Statistical Parameters				
						1	2	3	4	Median
Location of center of source: x,y,z (m)	P	All	D	2.22, 4.44, 1.76	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
Area (m2)	P	All	D	15.58	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
Air fraction for H-3	B	All	D	1	NUREG/CR-6697 Att C, 8.6	NR	NR	NR	NR	NR
Air fraction (for all nuclides except H-3)	B	All	D	0.07	NUREG/CR-6697 Att C, 8.6	NR	NR	NR	NR	NR
Direct ingestion (hr-1)	B	All	D	1.34E-6	NUREG/CR-5512 Vol 3,5.2.3 1.1E-04m^2/h / 82.03m^2	NR	NR	NR	NR	NR
Removable fraction	P	All	D	0.1	NUREG-1727 Table C 7.1 / NUREG/CR-6755, 3.5	NR	NR	NR	NR	NR
Time for source removal (days)	P	H-3	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	C-14	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Fe-55	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Co-60	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Ni-63	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Sr-90	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Nb-94	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Tc-99	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Ag-108m	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Sb-125	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Cs-134	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Cs-137	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-152	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-154	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-155	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-238	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-239	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-241	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Am-241	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Cm-243	D	18240	25th percentile value	NR	NR	NR	NR	NR

Table 1-1 RESRAD-BUILD v3.21 Input Parameters for DCGL Runs Building Occupancy

Parameter (unit)	Type[a]	Nuclide[b]	Treatment[c]	Value/[d] Distribution	Basis	Distribution's Statistical Parameters				
						1	2	3	4	Median
Radionuclide concentration (pCi/m^2)	P	All	D	1	Allows for proportional DCGL calculation	NR	NR	NR	NR	NR
Source 4: East Wall										
Type	P	All	D	Area	NUREG/CR-5512	NR	NR	NR	NR	NR
Direction	P	All	D	X	NUREG/CR-5512	NR	NR	NR	NR	NR
Location of center of source: x,y,z (m)	P	All	D	4.44, 2.22, 1.76	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
Area (m2)	P	All	D	15.58	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
Air fraction for H-3	B	All	D	1	NUREG/CR-6697, Att C, 8.6	NR	NR	NR	NR	NR
Air fraction (for all nuclides except H-3)	B	All	D	0.07	NUREG/CR-6697, Att C, 8.6	NR	NR	NR	NR	NR
Direct ingestion (hr-1)	B	All	D	1.34E-6	NUREG/CR-5512, 5.2.3 1.1E-04m^2/h / 82.03m^2	NR	NR	NR	NR	NR
Removable fraction	P	All	D	0.1	NUREG-1727 Table C 7.1 / NUREG/CR-6755, 3.5	NR	NR	NR	NR	NR
Time for source removal (days)	P	H-3	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	C-14	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Fe-55	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Co-60	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Ni-63	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Sr-90	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Nb-94	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Tc-99	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Ag-108m	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Sb-125	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Cs-134	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Cs-137	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-152	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-154	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-155	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-238	D	18240	25th percentile value	NR	NR	NR	NR	NR

Table 1-1 RESRAD-BUILD v3.21 Input Parameters for DCGL Runs Building Occupancy

Parameter (unit)	Type[a]	Nuclide[b]	Treatment[c]	Value/[d] Distribution	Basis	Distribution's Statistical Parameters				
						1	2	3	4	Median
	P	Pu-239	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-241	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Am-241	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Cm-243	D	18240	25th percentile value	NR	NR	NR	NR	NR
Radionuclide concentration (pCi/m^2)	P	All	D	1	Allows for proportional DCGL calculation	NR	NR	NR	NR	NR
Source 5. South Wall										
Type	P	All	D	Area	NUREG/CR-5512	NR	NR	NR	NR	NR
Direction	P	All	D	Y	NUREG/CR-5512	NR	NR	NR	NR	NR
Location of center of source: x,y,z (m)	P	All	D	2.22, 0, 1.76	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
Area (m2)	P	All	D	15.58	Site-specific model, Ref. 4	NR	NR	NR	NR	NR
Air fraction for H-3	B	All	D	1	NUREG/CR-6697 Att C, 8.6	NR	NR	NR	NR	NR
Air fraction (for all nuclides except H-3)	B	All	D	0.07	NUREG/CR-6697 Att C, 8.6	NR	NR	NR	NR	NR
Direct ingestion (hr-1)	B	All	D	1.34E-6	NUREG/CR-5512, 5.2.3 1.1E-04m^2/h / 82.03m^2	NR	NR	NR	NR	NR
Removable fraction	P	All	D	0.1	NUREG-1727 Table C 7.1 / NUREG/CR-6755, 3.5	NR	NR	NR	NR	NR
Time for source removal (days)	P	H-3	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	C-14	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Fe-55	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Co-60	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Ni-63	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Sr-90	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Nb-94	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Tc-99	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Ag-108m	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Sb-125	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Cs-134	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Cs-137	D	52777	75th percentile value	NR	NR	NR	NR	NR

Table 1-1 RESRAD-BUILD v3.21 Input Parameters for DCGL Runs Building Occupancy

Parameter (unit)	Type[a]	Nuclide[b]	Treatment[c]	Value/[d] Distribution	Basis	Distribution's Statistical Parameters				
						1	2	3	4	Median
	P	Eu-152	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-154	D	52777	75th percentile value	NR	NR	NR	NR	NR
	P	Eu-155	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-238	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-239	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Pu-241	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Am-241	D	18240	25th percentile value	NR	NR	NR	NR	NR
	P	Cm-243	D	18240	25th percentile value	NR	NR	NR	NR	NR
Radionuclide concentration (pCi/m^2)	P	All	D	1	Allows for proportional DCGL calculation	NR	NR	NR	NR	NR

NOTES
[a] P = physical, B = behavioral, M = Metabolic (NUREG/CR-6697 Att B, Table 4.3)
[b] 1 = high priority parameter, 2 = medium priority parameter, 3 = low priority parameter (NUREG/CR-6697 Att B, Table 4.3)
[c] D = deterministic, S = stochastic (Figure 1)
[d] Statistical Parameters
Loguniform 1 = minimum, 2 = maximum
NR - None Required
Input Correlations used only if both distributions used as inputs:
Resuspension Rate and Deposition Velocity = 0.9
Run Specifications: Random Seed = 1000
Number of Observations = 300
Number of Repetitions = 1
Dose Integrations = 5

Attachment 2

Quantile Determination from RESRAD-BUILD Cumulative Density Functions

Objective:

Determine the 25th, 75th, 50th percentiles and the mean for the probability density functions used in the probabilistic modules of the RESRAD Build code.

Method:

The Uncertainty Graphics module of the RESRAD-BUILD code provides graphical representations of various Statistical Objects used in a probabilistic run. For each probability density function entered as an input, the RESRAD–BUILD code integrates the area under curve and plots the cumulative density distribution. The probability density functions are the parametric distributions published in NUREG/CR-6697 and 6755.

Within the RESRAD-BUILD code, the 'Results, Graphics" output displays a plot of the cumulative density (or cumulative probability) for each Input Vector as determined by the number of observations chosen by the user. For the purpose of using these graphs to obtain the quantile values for sensitive RESRAD-BUILD parameters, the maximum number of observations, 2000, was used. This means that 2000 integration points were used to develop the graph. Right clicking the mouse inside the plot area brings up the plotted x and y data; parameter value vs. cumulative density. Figure 2-1 shows the RESRAD-BUILD "Uncertainty Graphics, Result, Graphics" window with the data visible in the "Data Grid Editor" window.

Figures 2-1, 2-2 and 2-3 show the Cumulative Probability for Deposition Velocity (UD).

NUREG/CR-6755 Probability Density Distribution Parameters
Distribution Type: Loguniform
Minimum: 2.7E-06 m/sec
Maximum: 2.7E-03 m/sec

The results of the sensitivity analysis indicate that the deposition velocity is a sensitive parameter and depending on the nuclide can be either negatively or positively correlated to the dose. The 25th percentile is the conservative value assigned if the parameter is negatively correlated and is obtained from the "Data Grid Editor" corresponding to the cdf value of 0.25. The 75th percentile is the conservative value assigned if the parameter is positively correlated is obtained from the same graph corresponding to a cdf value of 0.75.

Conservative Values:
25%-tile: 1.514E-05 m/sec
50%-tile: 8.533e-05 m/sec
75%-tile: 4.786E-04 m/sec

The mean value for the resuspension rate distribution was calculated by exporting the 2000 data points corresponding to the DKSUS input vector and calculating an average.

Figure 2-1 RESRAD-BUILD Uncertainty Graphics
Cumulative Density Plot and 25%-tile Value

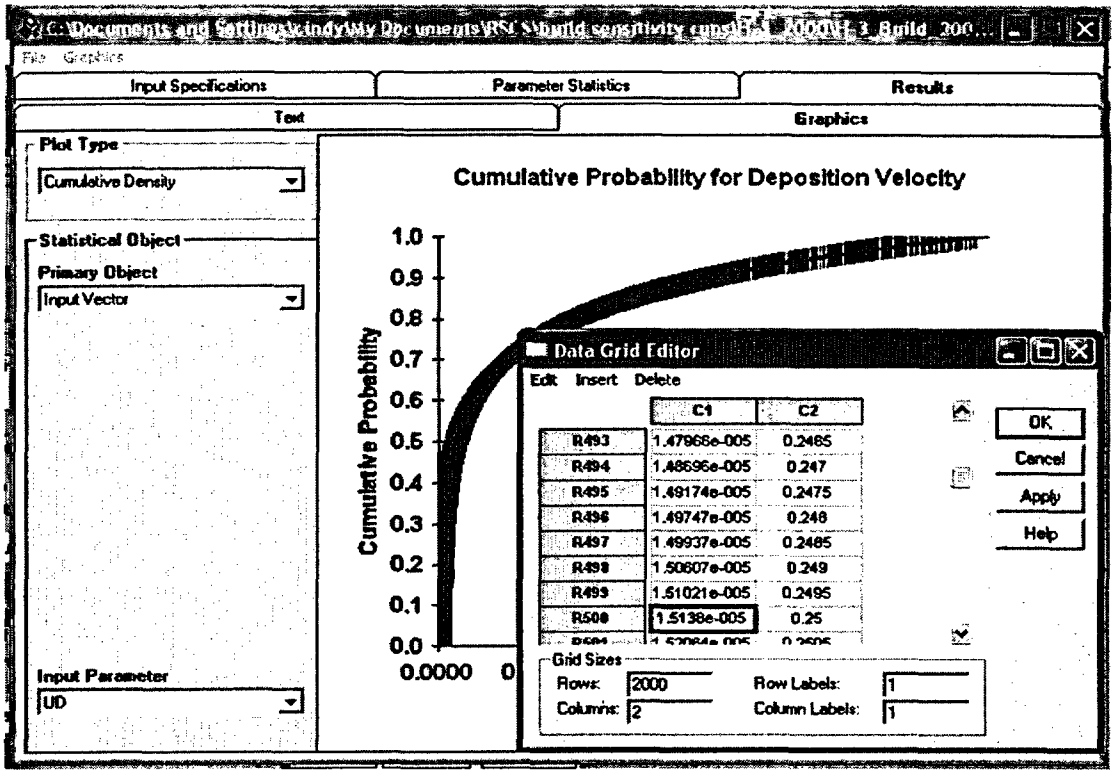


Figure 2-2 RESRAD-BUILD Uncertainty Graphics
Cumulative Density Plot and 75%-tile Value

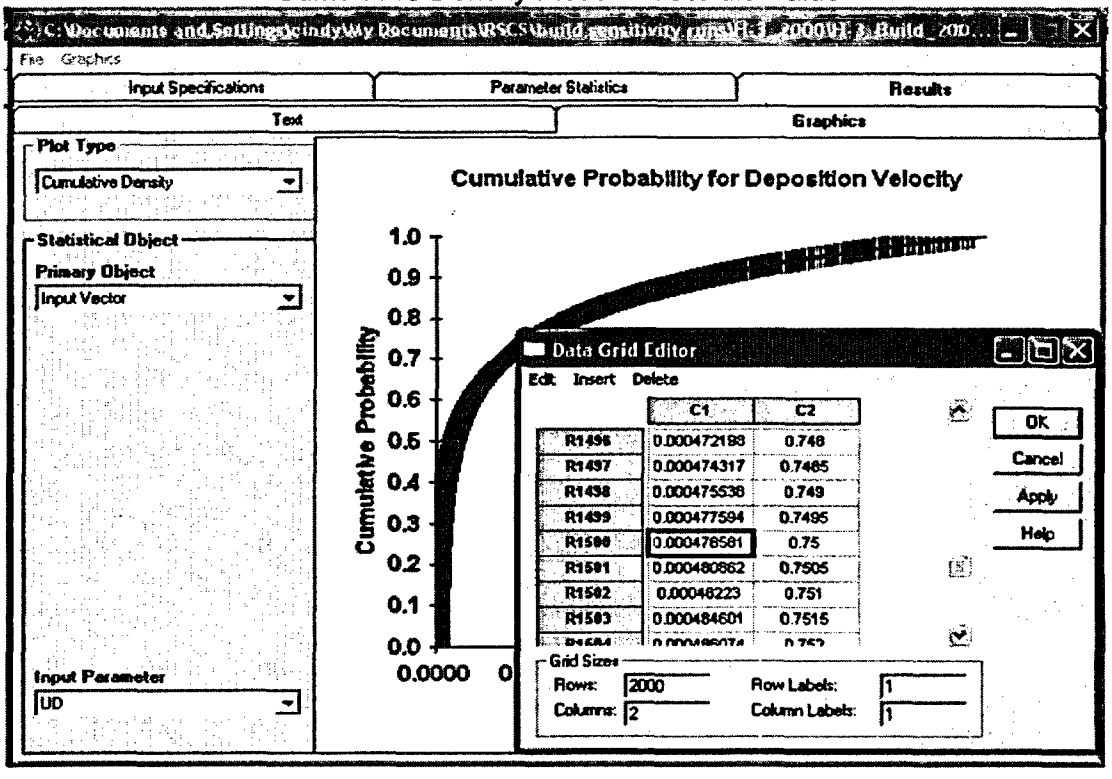
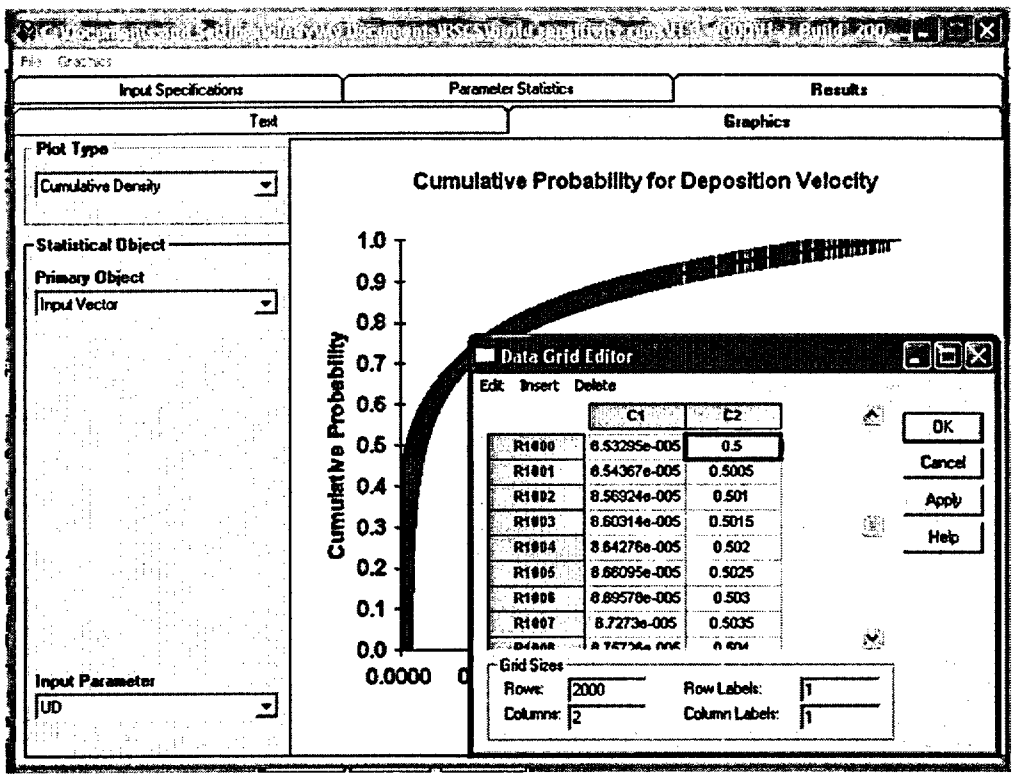


Figure 2-3 RESRAD-BUILD Uncertainty Graphics
Cumulative Density Plot and 50%-tile Value



The table below summarizes the percentiles for the RESRAD-BUILD distributions and provides a comparison of the median value with published NUREG/CR-6755 median values to validate the approach for other distributions.

Table 2-1: YR Distribution Percentile Values and Comparison of Median with Those Published in NUREG 6755

Parameter	Build Values [a]			NUREG/CR- 6755 Values		
	0.25	0.5	0.75	0.25	0.5	0.75
UD - 2000	1.5138e-005	8.53295e-005	4.78581e-004	N/A	8.55E-05	N/A
DKSUS-2000[b]	6.74988e-010	1.8314e-008	4.95357e-007	N/A	N/A	N/A
RF0(1,1) –2000[c]	18233.5	33241.1	52760	N/A	33255	N/A
RF0(2,1) – 2000[c]	18244.6	33253.1	52789	N/A	33255	N/A
RF0(3,1) – 2000[c]	18243	33253.9	52766.7	N/A	33255	N/A
RF0(4,1) – 2000[c]	18232	33226.1	52792.3	N/A	33255	N/A
RF0(5,1) – 2000[c]	18247.5	33240.5	52777	N/A	33255	N/A
Average source removal time (5 sources) – 2000[c]	18240.12	33242.94	52777.00	N/A	33255	N/A

[a] The BUILD values were compared for multiple radionuclide runs and were found to be the same, when the numbers of observations were the same.
[b] The median value in NUREG/CR-6755 doses not reflect the updated distribution for the resuspension rate (DKSUS). Values for this distribution were determined by the same method as was validated for the other distributions.
[c] The average median source removal time for all five sources, for the 2000 observation run, was 33243 days, which compares favorably with the NUREG/CR- 6755 parent distribution value of 33255 days (0.04% difference).

Attachment 3

YA-CALC-00-004-03 CD

The enclosed CD contains the electronic image files containing the RESRAD-BUILD resradb.rpt and resbmc.rpt report output pages that can be used to verify deterministic inputs and probabilistic inputs and outputs, respectively.

CD Name: YA-CALC-00-004-03

File: Deterministic Appendix.Build DCGLs.pdf
Probabilistic Appendix.Build DCGLs.pdf