ENERGYSOLUTIONS

CS-HP-PN-008

Final Status Survey Plan for NIST Boulder Campus Building 1 Affected Rooms

Revision 1

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- [ ] New Plan
- [ ] Title Change
- [X] Plan Revision
- [ ] Plan Rewrite

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TABLE OF ACRONYMS

CPM	Counts Per Minute
DCGLs	Derived Concentration Guideline Levels
DOE	Department of Energy
DQO	Data Quality Objective
DPM	Disintegrations Per Minute
FSS	Final Status Survey
FSSP	Final Status Survey Plan
MDA	Minimum Detectible Activity
NIST	National Institute of Standards and Technology
PM	Project Manager
PTM	Project Technical Manager
QAPP	Quality Assurance Project Plan
RPP	Radiation Protection Program
RPS	Radiation Protection Supervisor
RPT	Radiation Protection Technician
RSO	Radiation Safety Officer

1.0 SITE INFORMATION

Site History

On June 9, 2008, researchers ruptured a glass vial of 0.25 grams of mixed plutonium isotopes in the form of $PuSO_4$-$4H_2O$ (Certified Reference Material 138 as supplied by the Department of Energy New Brunswick Laboratory) resulting in the contamination of laboratory rooms 2124, 2124A, 2120, 2120A and 2007 in Building 1 on the NIST campus in Boulder, Colorado. A map of this area is shown in Figure 1. Room 1-2007 is the researcher's office down the hall from the affected lab rooms.

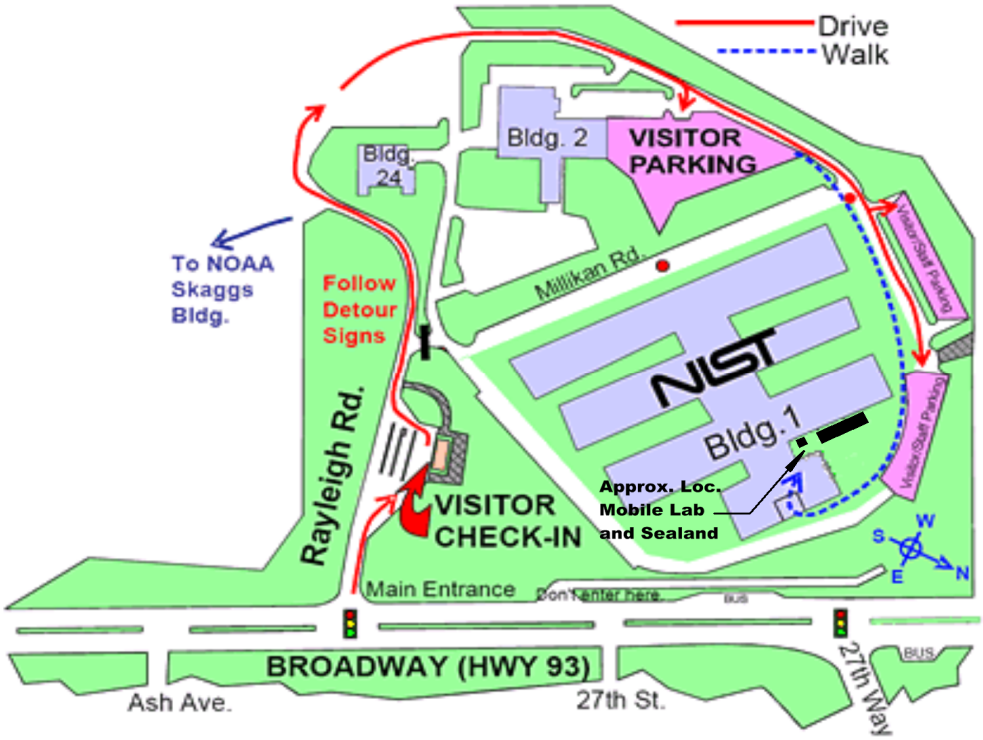


Figure 1: NIST Boulder Colorado Campus Building 1 Area

Energy*Solutions* mobilized personnel, equipment, and instrumentation to stabilize the area, recover and return eligible source material to the Department of Energy (DOE), decontaminate as appropriate, and survey the potentially affected rooms (2124, 2124A, 2120, 2120A, and 2007), shown in Figure 2, and package and ship any contaminated materials and waste for disposal at a licensed disposal facility. The areas used for operations, storage and waste are indicated in Figure 3. The work areas included rooms 2120, 2120A, 2124 and 2124A. Entries to the work areas were through the room 2120 doorway.

Radioactive Waste storage was within the 20-ft long "Sealand" (TM) intermodal container, accessed via the cement walkway. The container was placed inside the secured, fenced area as shown, monitored with a security camera, and locked with a high security lock.

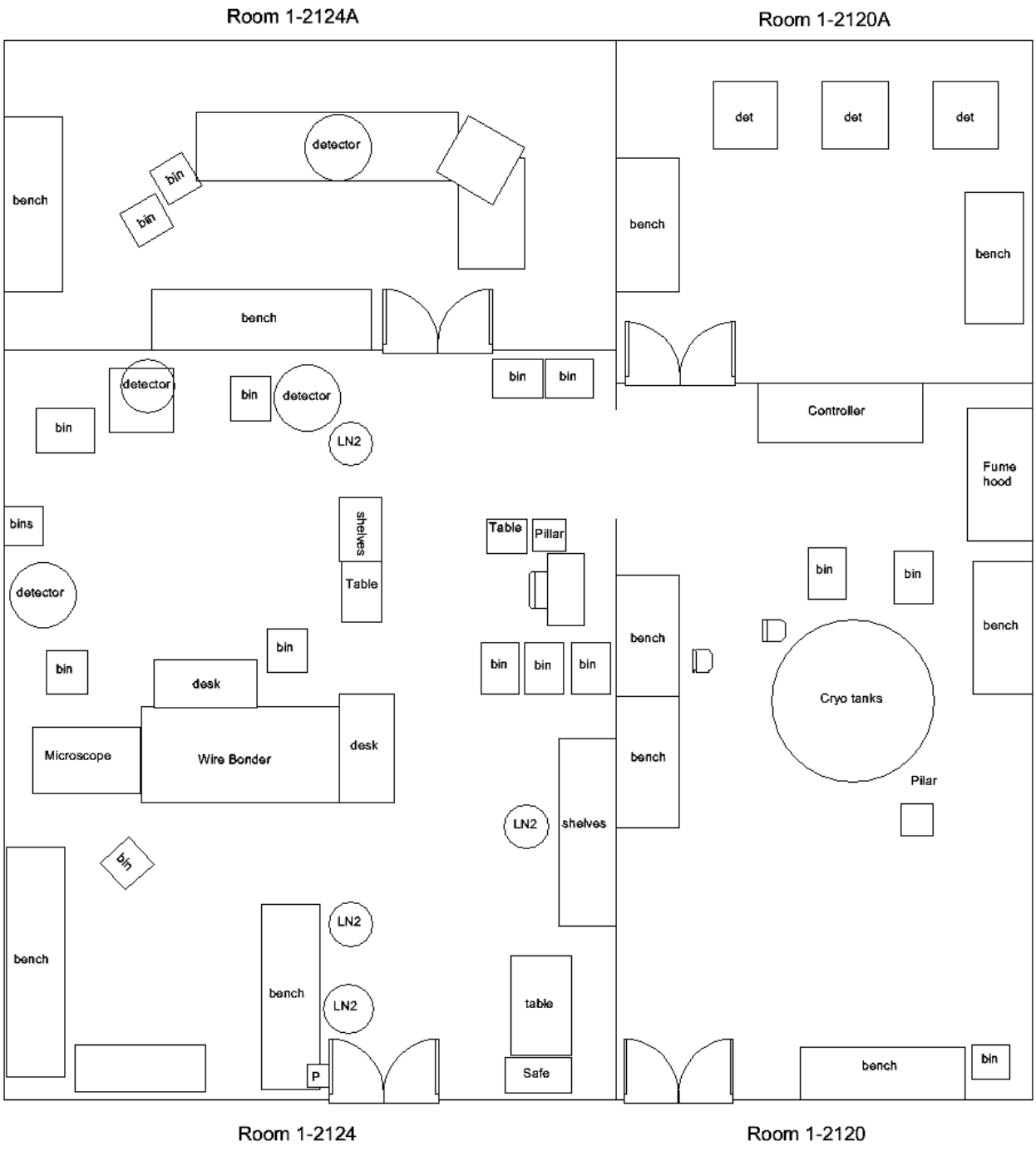


Figure 2: Building 1 Potentially Affected Rooms

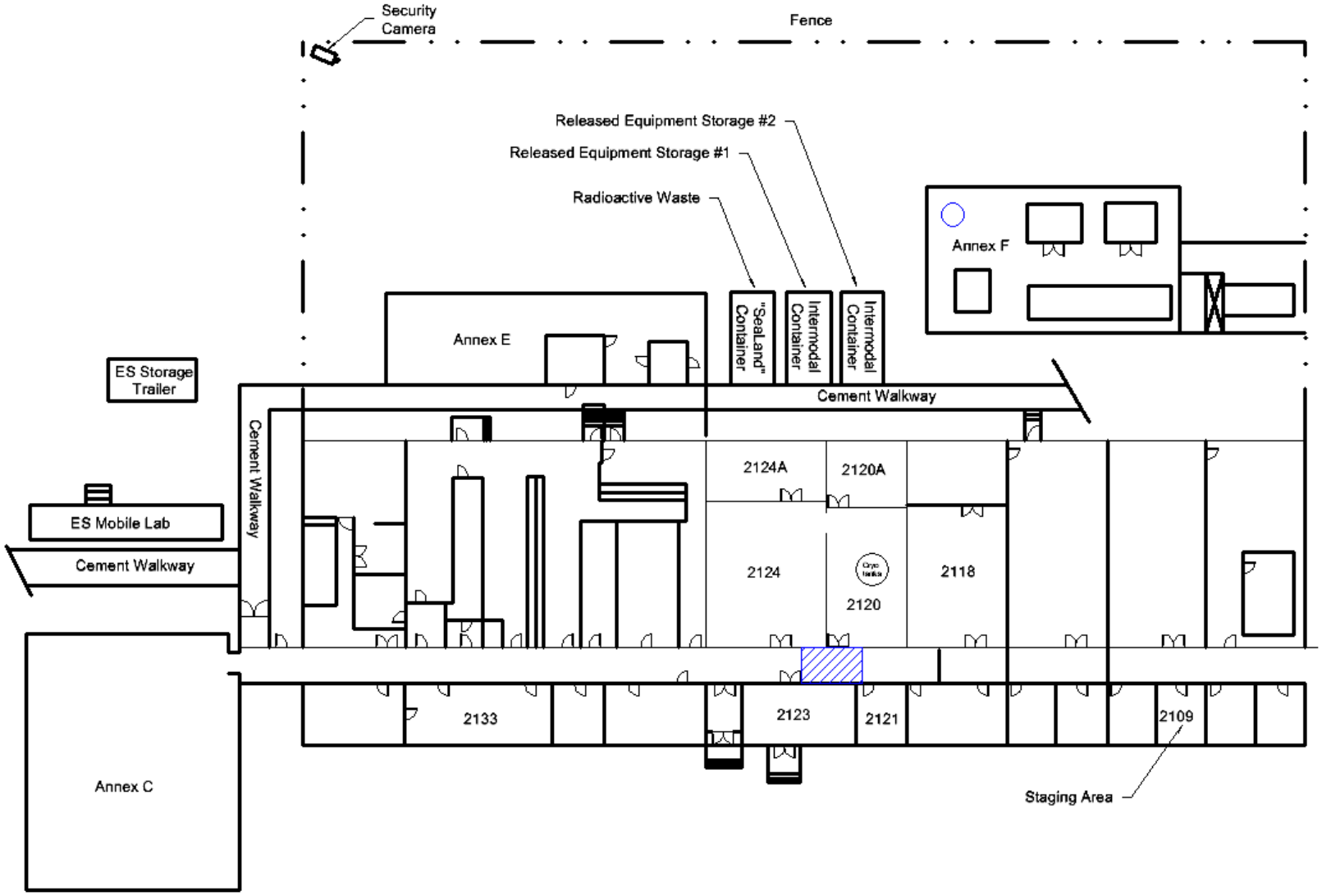


Figure 3: Operations, Storage and Waste Areas

Two additional intermodal containers, adjacent to the "Sealand" (TM) container, were used to temporarily store items that have been cleared for unrestricted release and removed from the work areas to open space within those areas.

The staging areas for the initial entries into room 2120 included room 2109, down the hall, and the full-width of the hallway, between the doors to rooms 2123 and 2121. That section of hallway was temporarily demarcated and blocked to traffic during the initial entries. That area of the hallway was restored to traffic after post-operational surveys were completed. Room 2109 was reserved for the exclusive use of Energy*Solutions* for the duration of the project and served as the crew supervisor's office.

After the initial decontamination of room 2120, it became the staging area for further entries into room 2124, and the hallway was no longer blocked to traffic.

A 47-ft L x 8-ft W mobile laboratory was located 40 ft outside the entrance to Wing 1/Annex C. It was used for analyzing low activity samples, and instrument storage.

Of the four laboratory rooms, the maximum contamination level was detected in room 2124 during a survey performed by DOE, and was greater than 500,000 cpm (full scale) using a Ludlum Model 3 with scintillation detector (alpha efficiency 24.3%) in the localized area of the spill. The other three rooms were treated as potentially contaminated as part of the recovery operations (as was room 2007).

2.0 SURVEY OVERVIEW

2.1 Organization and Responsibilities

Energy*Solutions* (ES) will perform this Final Status Survey (FSSP) scope under the Energy*Solutions Quality Assurance Project Plan* (Reference 8.1), the Energy*Solutions Radiation Protection Program Commercial Services Projects* (Reference 8.2), the Energy*Solutions Health and Safety Plan for the Plutonium Spill Recovery for NIST Campus Boulder, Colorado* (Reference 8.3), and Energy*Solutions* approved procedures (Attachment 9.1). The resources of Energy*Solutions*, including professional engineering and quality assurance staff, will support the ES project manager (PM) and the onsite ES team to ensure successful survey execution and completion.

This FSS plan complies with the guidelines of NUREG-1757, “Consolidated Decommissioning Guidance” (Reference 8.4) and NUREG 1575, “MARSSIM” (Reference 8.5).

The onsite team, consisting of an Energy*Solutions* PM, PTM, RPS and Energy*Solutions* Radiation Protection technicians will be trained, qualified, and experienced in applicable field radiological survey procedures designed to support the overall decommissioning process.

2.1.1 Energy*Solutions* Project Manager (PM)

The PM will be the main site point of contact. The PM has overall responsibility for the day to day management of the decommissioning and survey activities and ensuring that all Energy*Solutions* employees and sub-contractors have the proper training and experience to perform their assigned duties.

2.1.2 Energy*Solutions* Project Technical Manager (PTM)

The PTM reports to the PM and prepare technical documents, provide technical support for work activities and serve as an alternate PM if required.

2.1.3 Energy*Solutions* Radiation Protection Supervisor (RPS)

The RPS is responsible for the overall implementation of the RPP and will report to the PM and the license RSO.

2.1.4 Energy*Solutions* Radiation Protection Technicians (RPT)

The Radiation Protection Technicians are responsible for performing surveys and collecting samples. They will be qualified in the use of the survey instruments and surveying in accordance with this plan.

2.2 Data Quality Objectives

The purpose of this Final Status Survey Plan is to demonstrate the unconditional release of the rooms affected by the ruptured glass vial of mixed plutonium isotopes at the NIST Boulder Campus in Boulder Colorado.

1. Problem Statement

   To gain sufficient information on the surface activity levels in the rooms affected by the radioactive material from the ruptured glass vial to demonstrate that activity levels meet the site release limits established such that the total effective dose equivalent (TEDE) to an average member of the critical group from residual contamination will not exceed 25 mrem/year.

2. Identify the Decision

   This data collection effort will result in a specific decision that the affected rooms are acceptable for unrestricted release.

3. Identify the Inputs to the Decision

   - Obtain alpha and gamma surface activity measurements inside of non-impacted Building 1 rooms in order to obtain background activity information that may be utilized to adjust final status survey results for background surface activity.
   - Utilize radionuclide distribution data from the ruptured glass vial of 0.25 grams of mixed plutonium isotopes (Certified Reference Material 138 as supplied by the Department of Energy New Brunswick

Laboratory) in the development of release limits and the selection of survey instrumentation.

- Obtain soil samples from the soil surrounding excavated drain lines from room 2124 to demonstrate compliance with the unrestricted soil release criteria.
- Obtain interior scale/sediment samples downstream of the room 2124 sink drain line to verify that source material is not in the drains.

4. Define the Boundaries of the Study

   This study is limited to those portions of the impacted area that includes the interior of Building 1 rooms 2120, 2120A, 2124, 2124A, 2007, the Roof of Building 1 within 20 feet of affected rooms, soil surrounding excavated drain lines and the sink drain line from room 2124.

5. Develop a Decision Rule

   Surface and soil activity measurements less than the proposed building and soil DCGLs will be an indicator that contamination is not present.

   Scale/sediment sample activity from drains less than 20% of the soil DCGLs or less than the MDA will be an indicator that contamination is not present. This criterion is based on the MARSSIM Class 3 investigation level (MARSSIM table 5.8) of a "fraction of $DCGL_W$". A fraction equal to 20% was utilized for scale and sediment.

6. Specify Limits on Decision Errors

   The probability of making Type I and Type II decision errors is set at 0.05

7. Optimize the Design for Collecting Data

   The COMPASS program (Ref. 8.9) was used to determine the minimum number of sample points required for measurements to meet building survey objectives. For example, based on a survey data obtained from Room 2120 after preliminary decontamination (Attachment 9.2) the average activity level was estimated to be 32 ± 46 dpm (6.4± 9.2 cpm)/100cm^2 with a proposed DCGL of 696 dpm (44 cpm alpha)/100cm^2 for mixture of radionuclides from the broken vial Attachment 9.6). The minimum number of samples, N, was determined to be 15 (including the 20% increase recommended by MARSSIM).

   The COMPASS program (Ref. 8.9) was also used to determine the minimum number of soil sample points required for measurements to meet soil survey objectives There was no sample data available so the average activity level (sum of fractions) was estimated to be 0.25 ± 0.5 with a DCGL of 1. The minimum number of samples, N, was determined to be 14 (including the 20% increase recommended by MARSSIM).

2.3 Radionuclides of Concern

The radionuclide distribution is well known for this Final Status Survey because the activity was from a standard with an established radionuclide distribution. The radionuclide distribution and decay mode information is provided in Table 2-1. The activity is based on decay of the Broken Vial material from the time of its initial preparation and characterization in 1966 to 2008. However, only those radionuclides contributing 1% or more to the final DCGL value are included in DGGL calculations. As a result all uranium radionuclides and Np-237 are excluded.

Plutonium 241 is a low energy beta emitter that is very difficult to detect in direct beta surveys, however the beta to alpha activity ratio is known and constant. Therefore surface surveys for alpha activity only (no beta activity surveys) will be performed as part of the Final Status Survey.

Table 2-1 Broken Vial Activity Information

Radionuclide	Activity (μCi)	Activity (%)	Decay mode	Radionuclide of Concern (Y/N?)
Pu-238	3.64E+02	0.81%	Alpha	Yes
Pu-239	1.41E+04	31.32%	Alpha	Yes
Pu-240	4.48E+03	9.95%	Alpha	Yes
Pu-241	2.15E+04	47.76%	Beta	Yes
Pu-242	3.28E-01	0.00%	Alpha	Yes
U-234	5.15E-02	0.00%	Alpha	No
U-235	5.85E-04	0.00%	Alpha	No
U-236	5.40E-03	0.00%	Alpha	No
Am-241	4.57E+03	10.15%	Alpha	Yes
Np-237	3.16E-02	0.00%	Alpha	No
U-238	4.46E-06	0.00%	Alpha	No
Total	**4.50E+04**	**100.00%**		

2.4 Release Criteria for Unrestricted Use

The unrestricted release criteria given in 10 CFR 20 is a dose based standard where residual radioactivity, distinguishable from background radiation and resulting in a Total Effective Dose Equivalent (TEDE) to an average member of the critical group will not exceed 25 mrem/y. Levels of residual radioactivity that correspond to the allowable radiation dose are calculated (derived) by analysis of various scenarios and pathways.

The release criteria for Building Surfaces equivalent to the 25 mrem/y were obtained using the NRC DandD code (Reference 8.7) and **all default parameter values except for the resuspension factor (RF)**. The justification for modifying the resuspension factor was based on NUREG-1720 (Reference 8.8). NUREG-1720 states "*Based on the current analysis and re-evaluation, staff recommends using an RF value of 10^{-6} m^{-1} in the screening analysis of the inhalation dose calculation for the building occupancy scenario. The staff believes that the newly*

proposed RF default value is more realistic that the current value in DandD code, and sufficiently conservative for screening analysis". **RF values of 10^{-6} m^{-1} were used to develop the DCGLs using the DandD code version 2.1.0**.

Smear samples will be used as a diagnostic tool and not for determining compliance. This approach is consistent with section 8.5.4 of MARSSIM, which states: "*Some regulatory agencies may require that smear samples be taken at indoor grid locations as an indication of removable surface activity. The percentage of removable activity assumed in the exposure pathway models has a great impact on dose calculations. However, measurements of smears are very difficult to interpret quantitatively. Therefore, the results of smear samples should not be used for determining compliance. Rather, they should be used as a diagnostic tool to determine if further investigation is necessary."*

The release criteria for soils equivalent to the 25 mrem/y were obtained using the NRC DandD code (Reference 8.7) and **all default parameter values**.

2.4.1 Use of DandD Code

Calculation of Building Surface DCGLs

The DandD code version 2.1.0 was run for each radionuclides of concern listed in Table 2-1 using the "Building Occupancy Scenario". Initial activities were set at 100 dpm/100 cm^2 for an unlimited area and the **RF was set to 10^{-6} m^{-1}** as discussed in the section 0 above. An annual exposure rate, TEDE, was generated based on the surface activity of 100 dpm/100 cm^2. An Excel spreadsheet was used to calculate the equivalent surface concentration equivalent to an annual exposure of 25 mrem per year for each radionuclide. The radionuclide specific concentrations determined are the $DCGL_W$ values that will be used to develop survey plans and gauge the effectiveness of decontamination efforts.

The results of the DandD code runs and a table that includes the $DCGL_W$ calculations is included as Attachment 9.3. The DCGL values developed are included in Table 2-2 below.

Table 2-2 Building Surface DCGL Development and DandD Code Results

$DCGL_W$ Values for NIST Boulder Building Surfaces (Resuspension factor changed to a constant 1 x 10^{-6} m^{-1})*

Radionuclide	DandD Code TEDE** for 100 dpm/100 cm^2 (mrem/year)	$DCGL_W$ (dpm/100 cm^2)	Activity (%)	Decay mode
Pu-238	6.14	407	0.81%	alpha
Pu-239	6.74	370	31.32%	Alpha
Pu-240	6.74	370	9.95%	Alpha
Pu-241	0.13	18,939	47.76%	Beta
Pu-242	6.45	387	0.00%	Alpha
U-234	1.99	1,256	0.00%	Alpha
U-235	1.87	1,336	0.00%	Alpha
U-236	1.88	1,329	0.00%	Alpha

Radionuclide	DandD Code TEDE** for 100 dpm/100 cm^2 (mrem/year)	$DCGL_W$ (dpm/100 cm^2)	Activity (%)	Decay mode
Am-241	6.97	358	10.15%	Alpha
Np-237	8.52	293	0.00%	Alpha
U-238	1.78	1,404	0.00%	Alpha

* Justification for modification: Based on NUREG-1720 which states…"*staff recommends using an RF value of 10^{-6} m^{-1} in the screening analysis of the inhalation dose calculation for the building occupancy scenario.*"

** 90% of the 100 calculated TEDE values are less than the reported value

A gross activity DCGL was developed to allow field measurement of gross activity as determination of surface activity by individual radionuclide is not practical.

The gross activity DCGL for surfaces was calculated using the COMPASS program and the DCGLs and activity fractions listed in Table 2-2. This calculation yielded the result 696 dpm/100cm^2, as indicated in the COMPASS report (Attachment 9.6). The input parameters used for the COMPASS program are provided in Attachments 9.8 to 9.10. Attachment 9.8 provides the Site input parameters, Attachment 9.9 provides Building Surface Survey Plan input parameters, and Attachment 9.10 provides Surface Soil Survey Plan input parameters.

The COMPASS program performs a calculation which is similar to the MARSSIM equation 4-4 (Reference 8.5) shown below:

$$Gross\ Activity\ DCGL = \frac{1}{\left(\frac{f_1}{DCGL_1} + \frac{f_2}{DCGL_2} + \ldots \frac{f_n}{DCGL_n}\right)}$$

The results of this calculation are shown is Table 2-3 below. The result of 692 dpm/100 cm^2 is slightly different from the result obtained from COMPASS (696 dpm/100 cm^2) due to rounding.

Table 2-3 $DCGL_W$ Values for NIST Boulder Building Surfaces Calculated Using MARSSIM Equation 4-4

Radionuclide	$DCGL_W$ (dpm/100 cm^2)	Activity Fraction (f_i)	$\frac{fi}{DCGL_i}$
Pu-238	407	0.008	1.99E-05
Pu-239	370	0.313	8.46E-04
Pu-240	370	0.100	2.69E-04
Pu-241	18,939	0.478	2.52E-05
Pu-242	387	0.000	0.00E+00
U-234	1,256	0.000	0.00E+00
U-235	1,336	0.000	0.00E+00
U-236	1,329	0.000	0.00E+00
Am-241	358	0.102	2.84E-04

Radionuclide	$DCGL_W$ (dpm/100 cm^2)	Activity Fraction (f_i)	fi $DCGL_i$
Np-237	293	0.000	0.00E+00
U-238	1,404	0.000	0.00E+00
	Sum	1.000	1.44E-03

Gross Activity $DCGL_W$ (1/sum{f_i/$DCGL_i$)}: 692

The COMPASS program also generates a gross activity DCGL in terms of cpm/100 cm^2 based on instrument area, total instrument efficiency, and activity fractions. As indicated in the COMPASS Building Surface Survey Plan (Attachment 9.6), this DCGL is 44 cpm/100 cm2, which is the product of DCGLW (696 dpm/100 cm2), the ratio of instrument area to 100 cm^2 (1.26) and the weighted instrument efficiency (calculated and presented by COMPASS as the rounded number 0.05).

Calculation of Surface Soil DCGLs

It is anticipated that there will be no contaminated soil at this site. However, to be conservative, the soil will be sampled where exposed during excavation and removal of a drain pipe. Soil DCGLs were established and surveys plans included to document the soil surveys. The DandD code version 2.1.0 was run for each radionuclide of concern listed in Table 2-1 using the "Residential Scenario" to generate soil DCGLs. Initial activities were set at 1 pCi/g for an unlimited area and all default values were utilized. An annual exposure rate, TEDE, was generated based on the surface soil activity of 1 pCi/g. An Excel spreadsheet was used to calculate the equivalent surface concentration equivalent to an annual exposure of 25 mrem per year for each radionuclide. The radionuclide specific concentrations determined are the $DCGL_W$ values that will be used to develop survey plans and gauge the effectiveness of decontamination efforts.

The results of the DandD code runs and a table that includes the $DCGL_W$ calculations is included as Attachment 9.4. The DCGL values developed are included in Table 2-4 below.

Table 2-4 Surface Soil $DCGL_W$ Development and DandD Code Results

Radionuclide	DandD Code TEDE[a] for 1 pCi/g (mrem/year)	$DCGL_W$[b] (pCi/g)	Activity (%)
Pu-238	9.7	2.5	0.81%
Pu-239	11.1	2.2	31.32%
Pu-240	10.8	2.3	9.95%
Pu-241	0.34	73	47.76%
Pu-242	10.3	2.4	0.00%
U-234	2.75	9.0	0.00%

Radionuclide	DandD Code TEDE[a] for 1 pCi/g (mrem/year)	$DCGL_W$[b] (pCi/g)	Activity (%)
U-235	3.17	7.8	0.00%
U-236	1.83	13.6	0.00%
Am-241	11.8	2.1	10.15%
Np-237	260	0.10	0.00%
U-238	2.49	10.0	0.00%

[a] 90% of the 100 calculated TEDE values are less than the reported value
[b] These values represent surficial surface soil concentrations of individual radionuclides that would be deemed in compliance with the 25 mrem/y (0.25 mSv/y) unrestricted release dose limit in 10 CFR 20.1402. For radionuclides in a mixture, the "sum of fractions" rule applies.

A gross activity DCGL was developed based on activity ratios because the radionuclides of interest are not detectable using gamma spectroscopy (at low activity levels) except for Am-241. The gross activity DCGL for surface soil was calculated using the COMPASS program and the DCGLs and activity fractions listed in Table 2-4, yielding the result 0.42 pCi/g.

The COMPASS program performs a calculation which is similar to the MARSSIM equation I-14 (Reference 8.5) shown below. As indicated in Table 2-5, the resulting limit for A-241 becomes 0.42 pCi/g with no other radionuclides being measured in agreement with the result from COMPASS.

$$D_{total} = \frac{1}{\frac{1}{D_1} + \frac{R_2}{D_2} + \frac{R_3}{D_3} + \ldots + \frac{R_n}{D_n}}$$

where:

D_{total} = $DCGL_W$ for the surrogate radionuclide, Am-241, when the concentration of Am-241 represents all radionuclides that are present
C_i = concentration of radionuclide i
D_i = DCGL of radionuclide i
R_i = Ratio of radionuclide i to Am-241

Table 2-5 $DCGL_{total}$ Values for NIST Boulder Surface Soil

Radionuclide	$DCGL_i$ (pCi/g)	Ratio to Am-241 (R_i)	Ri / $DCGL_i$
Pu-238	2.5	0.08	3.2E-02
Pu-239	2.2	3.09	1.40E-00
Pu-240	2.3	0.98	4.26E-01
Pu-241	73	4.7	6.45E-02
Pu-242	2.4	0.000	0.00E+00
U-234	9.0	0.000	0.00E+00
U-235	7.8	0.000	0.00E+00

Radionuclide	$DCGL_i$ (pCi/g)	Ratio to Am-241 (R_i)	$\frac{Ri}{DCGL_i}$
U-236	13.6	0.000	0.00E+00
Am-241	2.1	1.00	4.762-01
Np-237	0.10	0.000	0.00E+00
U-238	10.0	0.000	0.00E+00
		Sum	2.40

Gross Activity $DCGL_{total}$ $[1 \div \sum(R_i/DCGL_i)]$: 0.42

2.4.2 RESRAD-Build and Area Factors for Building Surface Surveys

Area factors are needed to determine the required scan MDCs. However, such factors cannot be calculated by using the DandD computer code. Therefore, as indicated in Appendix O of NUREG-1757, "*when screening DCGL values are used, which were derived from DandD, an alternative approach must be used to calculate area factors for residual radioactivity on building surfaces. One approach that has been successfully used is to develop the area factors by using the RESRAD-BUILD computer code*". With this approach, the screening DCGL values are converted into the appropriate concentration unit for RESRAD-BUILD (i.e., from dpm/100 cm^2 to dpm/m^2).

The first step was to establish the parameters to be used for RESRAD-Build. The parameters used are provided in Appendix A, Table A-1. The largest room to be surveyed, 2124, was used as the default room size, 89.3 square meters and the maximum room height is 17 feet (5.2 meters). The receptor and source were located in the center of the room with the floor surface used as the source. The room and source information is provided in Appendix A, Table A-2. The ingestion factors are provided in Appendix A, Table A-3. Other parameters used default values. The RESRAD-Build results and calculated area factors are provided in Appendix A, Table A-4. The RESRAD-Build Case Reports for each combination of five different radionuclides and seven different hot spot sizes are included in the back of Appendix A.

The building surface area factors are provided in Table 2-6 below. Area factors were not generated for soil surveys as the scanning MDC is at least ten times the $DCGL_W$.

No increase in the number of building surface sample points was required because the building surface scanning will be effective in detecting activity at levels below the release limit. However the number of surface soil samples was increased to compensate for the fact that soil scanning is not effective. The "Building Surface Survey Plan" from COMPASS for room 2124 floor is included in Attachment 9.6 and the "Surface Soil

Survey Plan" from COMPASS for room 2124 drain excavation soil is included in Attachment 9.7.

Table 2-6 Building Surface Area Factors

Radionuclide	Area Factors for Various Elevated Area Sizes					
	36 m^2	25 m^2	16 m^2	9 m^2	4 m^2	1 m^2
Am-241	1.99	2.49	3.16	3.99	4.90	5.68
Pu-238	1.98	2.50	3.16	3.99	4.90	5.69
Pu-239	1.98	2.50	3.17	3.99	4.89	5.67
Pu-240	1.98	2.50	3.17	3.99	4.90	5.67
Pu-241	1.98	2.48	3.13	3.94	4.82	5.57

2.4.3 Survey Areas

Survey areas include Building 1 laboratory rooms 2124, 2124A, 2120, 2120A and 2007 and soil related to the excavation of the room 2124 drain line. A list of the survey units is included in Attachment 9.5. The sampling of soils around the room 2124 sink drain is an important aspect of this FSS as the drain line was installed over 40 years ago, radioactive material was found in the sink drain and due the age of the drain it may have leaked activity into the surround soil.

In general, the survey will consist of the following elements:

- Perform 100% alpha scan surveys of Class 1 rooms and at least 10% scan surveys for Class 2 and 3 rooms.
- Perform 100% alpha scan surveys of a portion of the roof area outside the windows in Rooms 2120 and 2124 and around the HEPA exhaust stack.
- Obtain systematic direct alpha measurements from floors walls and ceilings in all affected rooms.
- Soil samples will be obtained from the trench where the room 2124 sink drain pipe was removed.
- No survey of building exterior walls is planned.
- Perform biased surveys for elevated radiation levels in all affected rooms using a μR and/or NaI focusing on joints, cracks and penetrations through walls, floors and ceilings.
- Perform systematic surveys for radiation levels in all affected rooms using a μR and/or NaI.

3.0 SURVEY INSTRUMENTATION

Radiation detection and measurement instrumentation will be selected based on the type and quantity of radiation to be measured. The instruments used for direct measurements will be capable of detecting the radiation of concern to a MDC between 10% and 50% of

the applicable DCGL values to the maximum extent practical. The use of 10% to 50% of the DCGL is an administrative limit only. Any value below the DCGL is acceptable in survey areas. The instrumentation currently proposed for use is listed in Table 3-1.

Energy*Solutions* plans to use the Ludlum Model 2350-1 Data Logger or equivalent with gas flow proportional detectors (Ludlum 43 68) for surface scans and direct measurements of total alpha activity. Sodium Iodide (NaI) scintillation detectors will be used for gamma radiation scans. The Data Logger is a portable micro-processor computer based counting instrument capable of operation with NaI gamma scintillation, gas-flow proportional, GM, and ZnS scintillation detectors. The Data Logger is capable of retaining in memory the survey results and instrument/detector parameters for up to 1,000 measurements. This data is then downloaded to a computer for subsequent reporting and analysis.

The Ludlum Model 43-68 (126 cm^2), gas-flow proportional detector with 0.8 mg/cm^2 Mylar windows will be used for surface scans and direct alpha measurements and a Ludlum Model 44-10, a 2"× 2" NaI gamma scintillation detector for gamma radiation scans. Other instruments and detectors may be used based on the progress of survey activities. Removable surface activity measurements will be taken wherever fixed activity measurements are taken and they will be analyzed using a Tennelec XLB Series 5 or equivalent. The results of smear samples will not be used for determining compliance but will be used as a diagnostic tool to determine if further investigation is necessary.

Table 3-1: Survey Instrumentation

Instrument/Detector	Detector Type	Radiation Detected	Calibration Source	Use
Ludlum Model 2350/43-68 or equivalent	Gas-flow proportional (126 cm^2)	alpha + beta	^{230}Th (α) ^{99}Tc (β)	alpha + beta scans & direct measurements
Ludlum Model 2350/43-37 or equivalent	Gas-flow proportional (584 cm^2)	alpha + beta	^{230}Th (α) ^{99}Tc (β)	alpha + beta scans & direct measurements
Ludlum Model 2350/44-10	2" × 2" NaI scintillator	gamma	^{137}Cs (γ)	Gamma radiation scans & core screening
E-520 or equivalent	GM Tube	beta-gamma	^{137}Cs (γ)	Gamma exposure rate measurements
Tennelec XLB Series 5	Gas-flow proportional	alpha and/or beta	^{230}Th (α) ^{99}Tc (β)	Smear counting

3.1 Instrument Calibration

Survey instruments, counting devices, and other equipment used for radioactivity detection and measurement shall be cared for and maintained as discussed in CS-FO-PR-002 (Listed in Attachment 9.1).

Energy*Solutions* calibrates the instruments and associated detectors on a semi-annual basis using National Institute of Standards and Technology (NIST) traceable sources and industry standard calibration equipment.

The instrument calibration includes:

- high voltage calibration,
- discriminator/threshold calibration,
- window calibration,
- alarm operation verification, and
- scaler calibration verification.

The detector calibration includes:

- operating voltage determination,
- calibration constant determination, and
- dead time correction determination.

Calibration labels showing the instrument identification number, calibration date, and calibration due date are attached to all portable field instruments. The user will check the instrument calibration label before each use.

3.2 Response Checks and Radioactive Sources

Prior to use on-site, all project instrument calibrations will be verified and initial response data collected. These initial measurements may be used to establish instrument control charts and performance standards (response ranges) in which the instruments can be tested against on a daily basis when in use. An acceptable response for field instrumentation is an instrument reading within ±20% of the established check source value.

The daily response tests results will be documented and compared to these operating parameters and ranges to ensure that the instrumentation was functioning properly. When an instrument fails a response check, the results will be investigated to determine the cause of failure. In the event that the instrument is not functioning properly, the instrument will be removed from service for repair and re-calibration.

All radioactive sources used for calibration or efficiency determinations for this project will be representative or conservative to the instrument's response of the identified nuclides that are present at the site and are traceable to NIST.

3.3 Minimum Detectable Concentration Calculations

3.3.1 Static Measurements for Total Alpha Surface Activity

The MDC is defined as the smallest concentration of radioactive material in a sample that will yield a net positive count with a 5% probability of falsely interpreting background responses as true activity and a 95 % probability of correctly interpreting activity above background as true activity. The MDC is dependent upon the counting time, geometry,

sample size, detector efficiency, and background count rate. The equation used for calculating the MDC, in dpm/100 cm^2, for total surface activity is:

$$MDC = \frac{\frac{3}{t_s} + 3.29\sqrt{\frac{R_B}{t_s} + \frac{R_B}{t_B}}}{(\varepsilon_i)(\varepsilon_s)\left(\frac{A}{100\ cm^2}\right)} \qquad \text{(Equation 3-1)}$$

where:

R_B = background count rate (counts per minute [cpm])
t_s = sample count time (min)
t_B = background count time (min)
ε_s = surface efficiency (determined using ISO-7503)
ε_i = 2π instrument efficiency
A = detector area (cm^2)

The COMPASS program (Ref. 8.9) was utilized to determine a Final Status Survey MDC of 184 dpm/100 cm^2, a total weighted survey instrument efficiency of 0.05 counts per decay and a Gross Activity DCGLw of 696 dpm/100 cm^2 (44 cpm/100 cm^2). Hand calculations were also performed to demonstrate how COMPASS performs these calculations. The hand calculations produced slightly different results than the COMPASS program due to rounding error. The hand calculation results are presented for information only. The static MDC for a Ludlum Model 43-68 gas proportional detector with a thin Mylar window (0.8 mg/cm^2), a probe area of 126 cm^2 and a nominal background count rate of 2 counts per minutes (cpm) is calculated to be 162 dpm/100 cm^2as shown below. The total weighted efficiency determination for the alpha radiation emitted from the broken plutonium vial is provided in Table 3-2 and is 0.047 counts per decay (c/d).

$$MDC = \frac{\frac{3}{1} + 3.29 \times \sqrt{\frac{2}{1} + \frac{2}{1}}}{0.047 \times \left(\frac{126}{100}\right)} = 162\ \text{dpm/100}\,\text{cm}^2$$

Table 3-2: Weighted Efficiency

Physical Detector Area (cm^2): 126

Radionuclide	Radiation/Maximum Energy (MeV)[a]	Activity Fraction	Instrument Efficiency[b]	Surface Efficiency[c]	Yield[a]	Weighted Efficiency
Am-241	Alpha/5.388	0.102	0.36	0.25	1.40%	0.000128
	Alpha/5.442	0.102	0.36	0.25	12.80%	0.001169

	Alpha/5.486	0.102	0.36	0.25	85.20%	0.007783
	Alpha/5.512	0.102	0.36	0.25	0.20%	1.83E-05
	Alpha/5.544	0.102	0.36	0.25	0.34%	3.11E-05
Pu-238	Alpha/5.358	0.008	0.36	0.25	0.10%	7.29E-07
	Alpha/5.457	0.008	0.36	0.25	28.30%	0.000206
	Alpha/5.499	0.008	0.36	0.25	71.60%	0.000522
Pu-239	Alpha/5.105	0.313	0.36	0.25	11.50%	0.003242
	Alpha/5.143	0.313	0.36	0.25	15.10%	0.004256
	Alpha/5.155	0.313	0.36	0.25	73.30%	0.020662
Pu-240	Alpha/5.123	0.100	0.36	0.25	26.39%	0.002363
	Alpha/5.168	0.100	0.36	0.25	73.50%	0.006582
Pu-241	Beta/0.0208	0.478	0	0.25	100%	0.0000
					Total Weighted Efficiency:	0.047
					Gross Activity $DCGL_w$ (dpm/100 cm^2):	692
					Gross Activity $DCGL_w$ (cpm/100 cm^2):	41

[a]Data from Radioactive Decay Data Tables, David C. Kocher, 1981
[b]Typical values for a 126 cm^2 gas-flow proportional detector (0.8 mg/cm^2) window in the α mode.
[c]Based on guidance provided in ISO-7503-1.

3.3.2 Removable Surface Activity

The equation for determining the MDC, in dpm, for smear counters (removable surface activity) with Type I and Type II error rates set at 5% and the associated critical values set to 1.645 is provided below (Equation 3-2). The probe area is not variable (smears are collected from an area of 100 cm^2) and the surface efficiency, ε_s, is conservatively estimated to be 0.25 as indicated in ISO-7503 for alpha activity smear samples. Refer to variable definitions for Equation 3-1.

$$MDC_{Smear} = \frac{\frac{3}{t_S} + 3.29\sqrt{\frac{R_B}{t_S} + \frac{R_B}{t_B}}}{(\varepsilon_s)(\varepsilon_i)} \qquad \text{(Equation 3-2)}$$

3.3.3 Scan Surveys

Building Surfaces and Structures

In the case of the scan measurements, the counting interval will be the time the probe is over a specific source of radioactivity. This time depends upon the scan speed, the size of the source, and the fraction of the detector's sensitive area that passes over the source; with the latter

depending on the direction of probe travel. The scan speed is typically one probe width per second so the observation interval is 1 second.

The scan MDC for alpha scanning where there are elevated alpha count rates (i.e., >10 cpm) and observing an individual event is not required, the MDC is determined using the traditional method that is used for beta scans. The COMPASS Building Surface Survey Plan (Attachment 9.6) indicates a required scan MDC of 64 cpm. The MDC equation is as follows:

$$MDC_{Scan} = \frac{d' * \sqrt{b_i} * \frac{60}{i}}{\sqrt{p} * \varepsilon_i * \varepsilon_s * \frac{A}{100}} \qquad \text{(Equation 3-3)}$$

Where:

d'	=	Decision error taken from Table 6-5 of MARSSIM
b_i	=	Background counts per observation interval
i	=	Observation counting interval in seconds (detector width divided by the scan speed)
p	=	Surveyor Efficiency (typically 50%)
A	=	Detector Area (cm^2)

This scan MDC for the Ludlum Model 43-68 discussed above was calculated to be 373 dpm/100 cm^2 as shown below. The COMPASS Building Surface Survey Plan (Attachment 9.6) indicated a required scan MDC of 1,597 dpm or less.

$$MDC_{Scan} = \frac{1.42 * \sqrt{0.033} * \frac{60}{1}}{\sqrt{0.5} * 0.047 * \frac{126}{100}} = 373 \; dpm/100 \; cm^2$$

3.3.4 Exposed Soils

Scan MDCs for various soil contaminants are listed in NUREG 1507, Table 6.4. Am-241 is the only nuclide from the broken vial that has the potential to be detected by scanning based on its abundance and gamma emissions. NUREG 1507, Table 6.4 lists a scan MDCs for a 2" × 2" NaI scintillation detector for Am-241of 31.5 pCi/g. With a soil DCGL for Am-241 of 0.42 pCi/g scanning for activity will not be effective. In order to compensate for ineffective scanning, the sample size will be increased. The estimated are of the soil excavation is 28 m^2 and one sample will be obtained for each square meter of excavated area. This is approximately twice the normal sample density.

4.0 SURVEY/SAMPLING DESIGN

4.1 Introduction

Energy*Solutions* will perform surveys according to procedures (Attachment 9.1), this plan and the project Health and Safety Plan (Reference 8.3). The procedures identify survey instrument requirements, calibration, measurement and sample collection, data reduction, and evaluation methods. Implementation of this plan will include the following:

- Survey personnel will collect samples and measurements with the results analyzed and/or calculated as defined in the plan.
- Direct field measurements and scan surveys will be performed using appropriately calibrated instruments as per CS-FO-PR-002 (Attachment 9.1).
- Daily instrument quality control (QC) checks will be performed before and after each day's work and as outlined in Section 0 of this plan and CS-FO-PR-004 (Attachment 9.1).
- Survey personnel will mark and/or detail on a survey map the sample and measurement locations to ensure reference back to a sample or measurement.
- All instrument logged data will be downloaded from the survey instrument into a database for storage, analysis, and reporting on a daily basis.
- Supervisory personnel will review completed survey packages to ensure that all required surveys have been performed in compliance with this plan and the QAPP (Reference 8.1). In addition, the review will ensure that the completed survey packages contain all the necessary information to evaluate the data to the DQO decision rules listed in Section 2.2(5).
- All sample and measurement results will be evaluated by the Energy*Solutions* Project Technical Manager or designee and additional samples and/or measurements may be considered depending on the location and results as they relate to the DQO decision rules listed in Section 2.2(5).

4.2 Survey Requirements

Building 1 affected areas were classified in accordance with MARSSIM, (Reference 8.5). The affected areas and associated classifications are illustrated on Figures 4-1 through 4-4 and the survey type, percentage, and classification of these areas are listed specifically in Table 4-1.

Upon completion of this FSS, the selected systematic alpha measurement and soil sample locations will be displayed on maps for each survey unit work package. If interferences exist at these locations, including overhead and/or underground, the locations will be offset to avoid the interference as necessary.

Soil sampling will be performed in and around the Building 1 soil excavation area. The anticipated excavation area is shown in Figure 4-4.

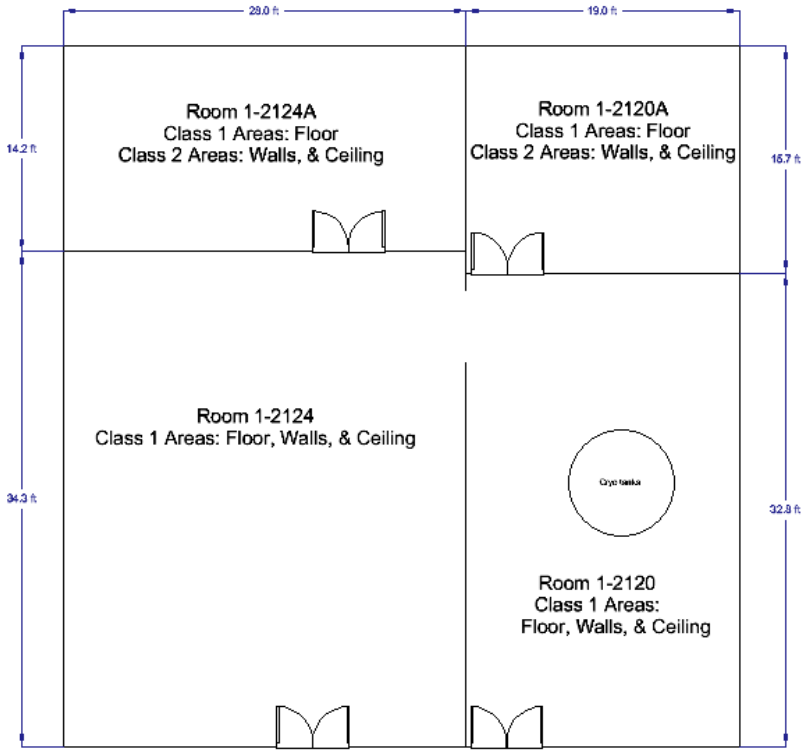


Figure 4-1: Room 2120 and 2124 Area Classifications

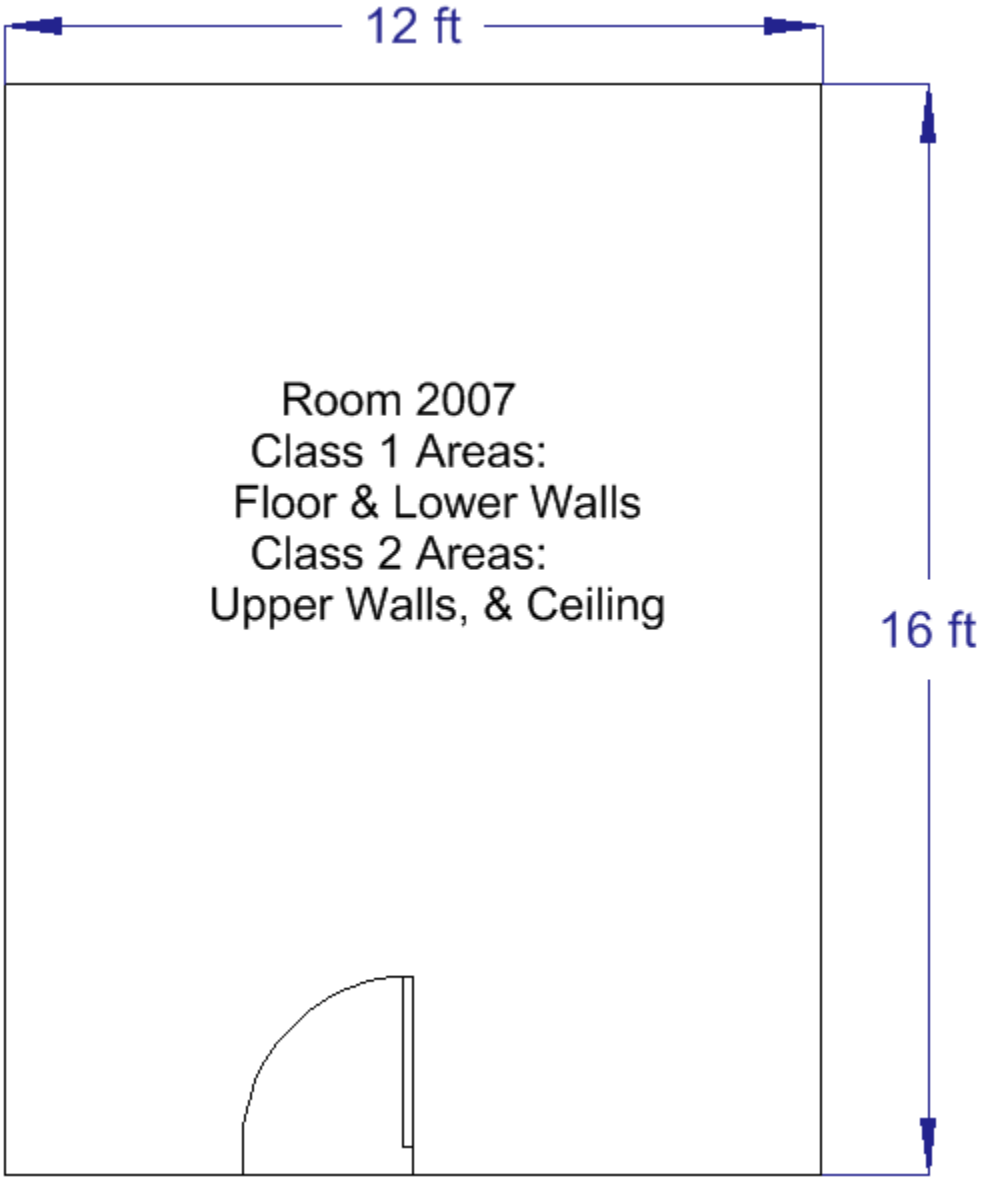


Figure 4-2: Room 2007 Area Classification

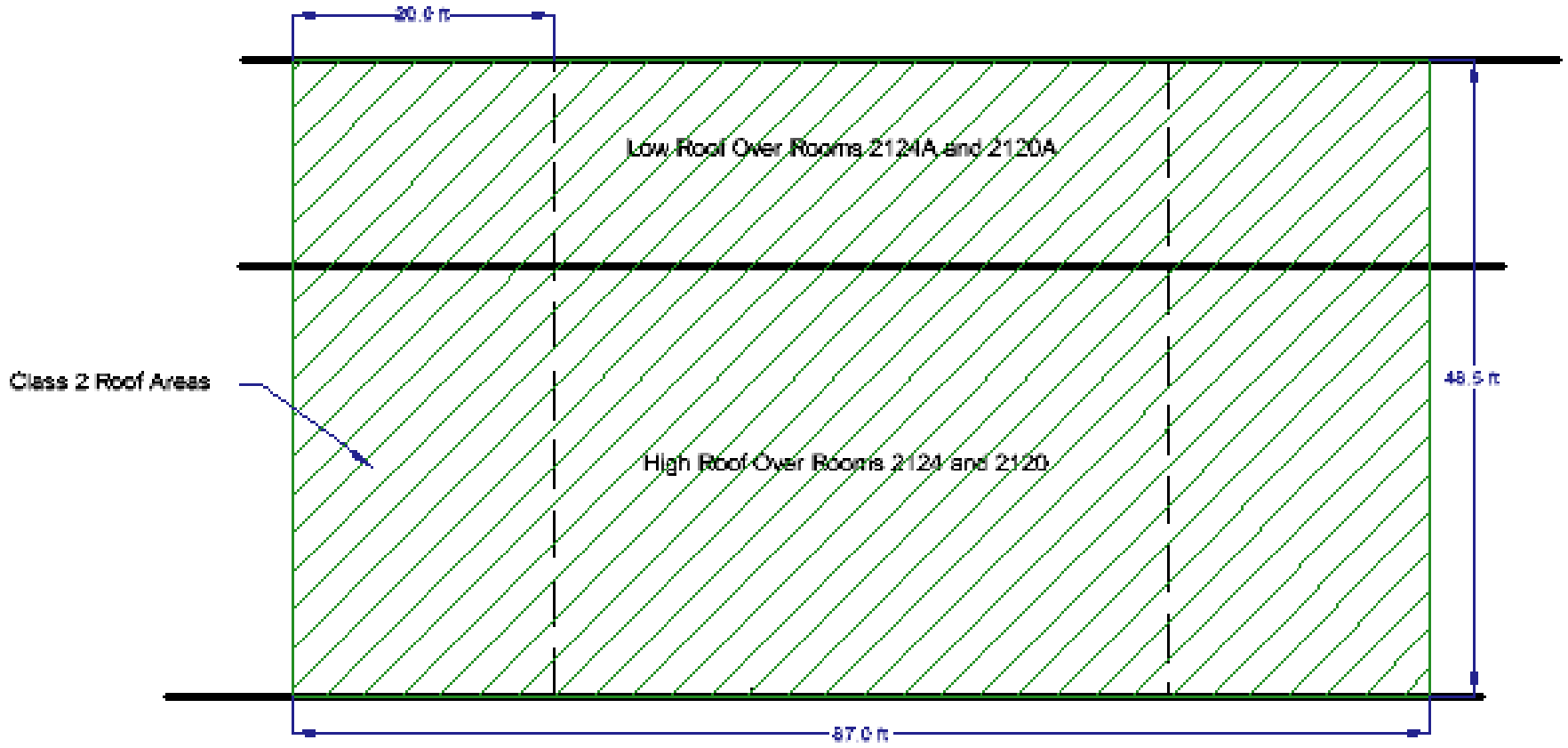


Figure 4-3: Wing 1 Roof Area Classification

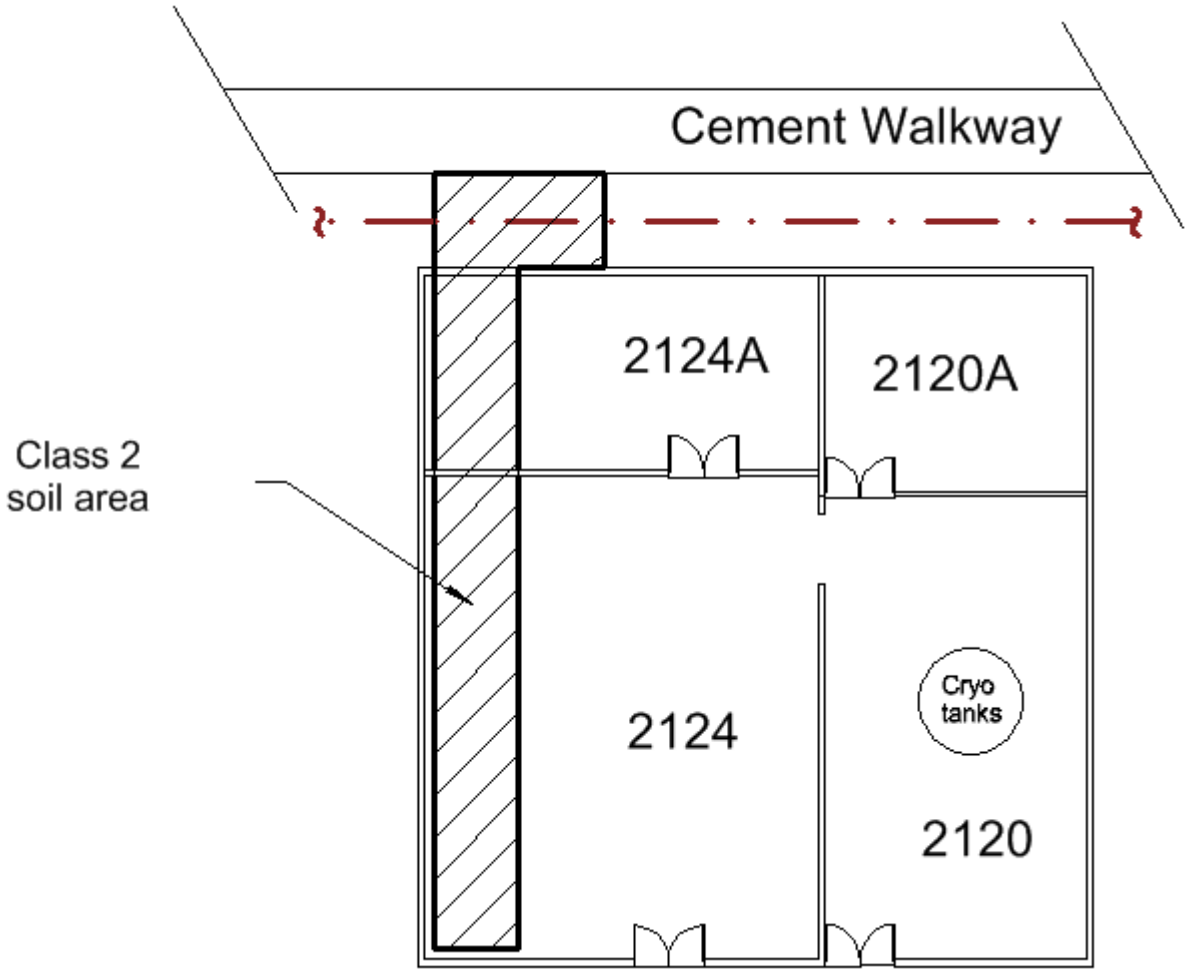


Figure 4-4: Wing 1 Soil Area Classification

4.2.1 Background

No material-specific background corrections for buildings will be performed for total alpha measurements.
A minimum of 10 exposure rate measurements will be performed in a room of the non-impacted Building 1.
Note that there is a high radon activity in Building 1 and elevated readings have been found on smears and fixed surfaces such as rubber. Smear activity has been found to decay up to 20% of the initial activity in two weeks by isolation in closed containers.

4.2.2 Reference Coordinate System

A reference coordinate system will be established for each room to be surveyed. The grid may consist of intersecting lines, referenced to the southwest corner of each room. Survey maps will be generated during survey activities that indicate the location of grids, scan results, fixed alpha surface activity measurements, and soil sampling locations. The grid lines may be marked by indicating the intersection of lines on the floor or wall surface.

4.2.3 Building Measurement and Sampling Locations

The minimum number of measurement and sampling locations that will be collected (smears for removable activity and soil samples) are identified in Table 4-1 below. Smears are not required for MARSSIM surveys; however they are included in this FSS as supplemental information. Measurements and soil sampling will also be performed at locations of elevated radiation as identified during surface scans for all areas. The minimum number of fixed surface activity measurements and soil samples for structures is the same regardless of the survey unit classification. The difference between survey unit classifications is the limit on total surface area and the percent scan coverage for the survey unit.

Table 4-1: Survey Measurements

Measurement Type	Minimum Survey Requirements[1]		
	Building 23		
	Class 1	Class 2	Class 3
Room 2124 Floor (89 m^2) α scan surveys	100%	NA	NA
Room 2124 Floor α fixed point and smear surveys	14	NA	NA
Room 2124 Walls (197 m^2) α scan surveys	100%	NA	NA
Room 2124 Wall α fixed point and smear surveys	15	NA	NA
Room 2124 Ceiling (89 m^2) α scan surveys	100%	NA	NA
Room 2124 Ceiling α fixed point and smear surveys	15	NA	NA
Room 2124A Floor (37 m^2) α scan surveys	100%	NA	NA
Room 2124A Floor α fixed point and smear surveys	15	NA	NA
Room 2124A Walls & Ceiling (115 m^2) α scan surveys	NA	20%	NA
Room 2124A Walls & Ceiling α fixed point and smear surveys	NA	14	NA
Room 2120 Floor (58 m^2) α scan surveys	100%	NA	NA
Room 2120 Floor α fixed point and smear surveys	15	NA	NA
Room 2120 Walls & Ceiling (222 m^2) α scan surveys	100%	NA	NA

Measurement Type	Minimum Survey Requirements[1]		
	Building 23		
	Class 1	Class 2	Class 3
Room 2120 Walls & Ceiling α fixed point and smear surveys	14	NA	NA
Room 2120A Floor (28 m^2) α scan surveys	100%	NA	NA
Room 2120A Floor α fixed point and smear surveys	17	NA	NA
Room 2120A Walls & Ceiling (93 m^2) α scan surveys	NA	20%	NA
Room 2120A Walls & Ceiling α fixed point and smear surveys	NA	14	NA
Room 2007 Floor (18 m^2) α scan surveys	100%	NA	NA
Room 2007 Floor α fixed point and smear surveys	14	NA	NA
Room 2007 Walls & Ceiling (60 m^2) α scan surveys	NA	20%	NA
Room 2007 Walls & Ceiling α fixed point and smear surveys	NA	14	NA
Roof Area (392 m^2) α scan surveys	NA	100%	NA
Roof Area α fixed point and smear surveys	NA	14	NA
Soil Samples from Room 2124 Excavation	NA	14	NA
Soil γ Radiation Scan of Room 2124 Excavation Exposed Soil	NA	100%	NA
Soil Samples from Excavation Outside Room 2124	NA	14	NA
Soil γ Radiation Scan Excavation Outside of Room 2124 Exposed Soil	NA	100%	NA

[1] A minimum number data points was calculated using the COMPASS with Type 1 (α) and II (β) errors set at 0.05.

4.2.4 Sample Identification

All samples will be identified using an alphanumeric code for the purpose of identification and traceability as indicated in procedure CS-FO-PR-003 Section 4.11 (as listed in Attachment 9.1).

4.2.5 Sample Storage

All samples will be stored in a controlled area as provided in procedure CS-FO-PR-003 (Listed in Attachment 9.1). Samples will be inspected prior to being placed in the storage area for identification, damage, packaging, and traceability to records. Packaging and identification shall be consistent with the duration and conditions of storage. An inventory and sample retention time shall be maintained throughout the storage period.

4.2.6 Sample Accountability

All samples will be tracked from the time the sample is obtained through final disposition or authorization for disposal is provided by NIST. This tracking includes the use of a Chain-of-Custody Record or similar form to track samples that are sent offsite for analysis as indicated in procedure CS-FO-PR-003 (Listed in Attachment 9.1).

4.2.7 Survey Notes

There is a drain from a sink in Room 2124 that was contaminated during the broken vial incident. This drain traverses room 2124 from the west side of the room to the east side of the room below grade and continues outside to join the storm water drain system. Portions or all of this drain will be excavated based on survey data obtained during the drain excavation. If the drain has leaked and there is contaminated soil in the drain area it will be removed. After the drain is excavated, soil surveys will be performed as part of the FSS in and around the Room 2124 sink drain excavation.

4.2.8 Sampling

Sampling will be accomplished by marking sample locations as indicated in this plan. NIST will review these locations for potential buried utilities interferences or other anomalies. If there are interferences or anomalies, the sample locations will be offset. A utility survey was performed by NIST to identify the location of nearby utilities.

- Soil sample will be obtained using hand tools (trowel and/or hand auger) to obtain the samples with a planned sampling depth of 1-foot from the bottom of the excavation. Samples will be generated for two areas of interest, surface (0 to 6- in depth) and near surface (6-in to 1-ft depth). The sampling locations will be marked with flags until the excavation is backfilled.

  There is a need to backfill indoor and outdoor excavation as soon as possible because there is a safety concern over open excavations and ground water may enter the excavation. We can either provide split sample for verification analysis by the NRC or allow NRC to obtain samples while the excavation is open.

- Each soil sample analyzed by gamma spec analysis and alpha spec analysis.

- The laboratory analysis MDC's will be less than 50% of the proposed DCGL's.

- In order to survey Rooms 2120 and 2124 interior walls, ceilings and overhead horizontal surfaces, a scissors lift or bucket lift will be utilized. If a designated survey point is located in an area that is not accessible with a lift, then an offset of the survey point will be made and documented.

4.3 Survey Records

Records will be maintained of surveys for each area according to project procedures (as listed in Attachment 9.1). The survey records may include the following information depending upon the survey design and protocols:

- Worksheet providing identification, survey location information, general survey instructions, and any specific survey instructions.
- Comments from the survey technician regarding any unusual situation encountered while surveying.
- Diagram/map of the area surveyed as available.
- Photographs of the survey area, as necessary, to show special or unique conditions.
- Printout of laboratory analysis results (if performed).
- Ludlum Model 2350-1 data files and values for all radiation survey measurements.

Direct measurements will be obtained for total alpha surface activity using the Ludlum Model 2350-1 Data Logger system or equivalent. Upon completion of a survey, the contents of the Data Logger's memory will be downloaded.

Data and document control will include the maintenance of the raw data files, translated data files, and documentation of corrections made to the data. The data files will be backed up on a daily basis.

5.0 INVESTIGATION LEVELS AND RECLASSIFICATION

Investigation levels are radionuclide-specific levels of radioactivity used to indicate when additional investigations may be necessary. When an investigation level is exceeded, the first step is to confirm that the initial measurement/sample actually exceeds the particular investigation level. This may involve taking further measurements to determine that the area and level of the elevated residual radioactivity are such that the resulting dose or risk meets the release criterion. Depending on the results of the investigation actions, the survey unit may require reclassification, remediation, and/or resurvey. Table 5-1 provides the investigation levels for this final status survey.

Table 5-1: Final Status Survey Investigation Levels

Survey Unit Classification	Flag Direct Measurement or Sample Result When:	Flag Scanning Measurement Result When:
Class 1	> $DCGL_W$	> $DCGL_W$
Class 2	> $DCGL_W$	> $DCGL_W$
Class 3	>50% of $DCGL_W$	> 50% of $DCGL_W$

Some survey areas may be reclassified and resurveyed during the radiological assessment based on the following:

Class 2 survey units will be reclassified as Class 1 survey units when the survey results in a given area exceed 100% of the criteria for release for unrestricted use. If reclassification is required, the Class 3 survey area will be subdivided and only a portion of the original survey area reclassified.

Class 3 survey units will be reclassified as Class 1 survey units when the survey results in a given area exceed 75% of the criteria for release for unrestricted use. If reclassification is required, the Class 3 survey area will be subdivided and only a portion of the original survey area reclassified.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

All work will be performed in a quality manner and under the auspice of the project *Quality Assurance Project Plan* (Reference 8.1) along with this survey plan and implementing procedures as listed in Attachment 9.1.

The following Quality Control measures will be utilized as an integral part of the survey process.

6.1 General Provisions

6.1.1 Selection of Personnel

Project management and supervisory personnel are required to be familiar with this plan, the procedures referenced in Attachment 9.1, and the *Quality Assurance Project Plan and the Project Health and Safety Plan*. Personnel for this project will be selected based upon their experience and familiarity with area remediation and decontamination activities. Likewise, health physics technicians who will perform the surveys will be selected based upon their qualifications and experience.

6.1.2 Written Procedures

Procedures referenced in Attachment 9.1 and this FSP shall control all survey tasks performed to ensure survey data quality.

6.1.3 Instrumentation Selection, Calibration, and Operation

Instruments proven to reliably detect Am-241 will be utilized. Energy*Solutions* will calibrate instruments in accordance with procedure CS-FO-PR-002 (Attachment 9.1) or use qualified vendors under approved procedures using calibration sources traceable to the NIST. All detectors are subject to daily response checks, when in use, in accordance with procedure CS-FO-PR-004 (Attachment 9.1).
Instrument selection, calibration, and response checks were also discussed in Sections 3.0, 3.1, and 3.2.

6.1.4 Survey Documentation

Records of surveys will be documented and managed in accordance with procedure CS-FO-PR-001 (as listed in Attachment 9.1). Survey measurements will be identified by the date, technician, instrument type and serial number, detector type and serial number, location code, type of measurement, mode of instrument operation, and QC sample number, as applicable.
The field data collected will be managed using forms and bound field notebooks. Laboratory data will be transcribed onto a computer-based management system. This data will be summarized in a manner that provides efficiency in data reduction, tabulation, and evaluation. All measurements taken during this project will be identified by source, type, and sample location to avoid ambiguity. Field records will include the following minimum information:

- A chronological listing of significant site events and sampling activities
- Site Name, surveyor name, signature, and date on each page
- Site conditions, notes or sketches of sampling locations and sample descriptions
- Sample times
- Record of all measurements (e.g. field screening parameters).
- Photographic Log (if taken)

6.1.5 Chain of Custody

Responsibility for the custody of samples from the time of collection until results are obtained is provided for in procedure CS-FO-PR-001 (as listed in Attachment 9.1). Any samples shipped offsite for analysis will be accompanied by a chain-of-custody record to track each sample.

6.1.6 Records Management

Generation, handling, and storage of survey data packages are controlled by procedure CS-AD-PR-002 (as listed in Attachment 9.1).

6.1.7 Independent Review of Survey Results

The survey package and survey data from each area will receive an independent review to verify all documentation is complete and accurate as provided for in procedure CS-FO-PR-001 (as listed in Attachment 9.1).

6.2 Sample Analyses and Measurements

Energy*Solutions* will ensure that quality control checks are performed on 5% of all sample analyses and measurements. This will consist of the analysis of split samples and duplicate measurements. Split samples will be analyzed if an ample amount of material is collected in a sample with the sample homogenized and split into two separate samples for analysis. If soils samples do not contain sufficient material to prepare two separate samples, then the duplicate analyses will be performed. Duplicate measurements will be performed for direct measurements and duplicate

analyses will be performed for smears. Alpha direct measurements will be duplicated on randomly selected locations at different times with different detectors if possible to check the quality control of the measurement. In addition, as discussed in Section 3.0, 10% of all the smear samples will be sent offsite for confirmatory analyses.
In order to verify that the precision of duplicate analyses are within acceptable limits, the relative percent difference (RPD) of the duplicates is determined for each radionuclide measured. The RPD is equal to the positive difference of the two measurements (nanocuries/gram) for each radionuclide measured multiplied by 100 and divided by the average of the two measured values.
If the RPD is less than or equal to 20% plus the 2-sigma statistical counting error, then the RPD value is accepted. If any of the RPD's is greater than 20% plus the 2-sigma statistical counting error, then the RPD is not accepted and the Project Technical Manager (PTM) or designee must evaluate the potential effect on data quality and record a course of action on the duplicate calculation sheet. The RPD is calculated as shown below:

$$RPD = \frac{|S_1 - S_2|}{\chi} * 100 \qquad \chi = \frac{S_1 + S_2}{2}$$

Where:

S_1 = the value for the primary sample and/or measurement
S_2 = the value for the duplicate sample

6.3 Training

All project personnel will receive site specific training to identify the specific hazards present in the work and survey areas. Training will also include a briefing and review of this plan, applicable procedures (as listed in Attachment 9.1), the *Quality Assurance Project Plan* (Reference 8.1), and the *Project Health and Safety Plan* (Reference 8.3). Copies of all training records will be maintained onsite through the duration of onsite activities.

During site orientation and training, survey personnel will become familiar with site emergency procedures. In the event of emergency, personnel will act in accordance with all applicable site emergency procedures.

7.0 SURVEY REPORT

Energy*Solutions* will begin preparing a Final Status Survey Report (FSSR) in parallel with survey activities while onsite. This report will include all relevant survey and sample analysis data. The report will also contain survey forms, survey and sampling maps, instrument calibration information, and other information necessary to support the validity of the data. The report will also detail any NIST approved deviations from this plan that may become necessary as all surveys are by nature an iterative work process.

8.0 REFERENCES

8.1 Energy*Solutions*, CS-QA-PN-012, Quality Assurance Project Plan for the Plutonium Spill Recovery for NIST Campus Boulder Colorado, Rev. 0

8.2 Energy*Solutions*, CS-RS-PG-001, Radiation Protection Program Commercial Services Projects, Rev. 0

8.3 Energy*Solutions*, CS-SH-PN-020, Health and Safety Plan for the Plutonium Spill Recovery for NIST Campus Boulder, Rev. 0

8.4 U.S. Nuclear Regulatory Commission. NUREG-1757, Consolidated Decommissioning Guidance – Decommissioning Process for Materials Licensees, includes the September 2006 updates

8.5 U.S. Nuclear Regulatory Commission. NUREG 1575, Revision 1, *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM); August 2000, includes the June 2001 updates

8.6 Westinghouse Electric Company LLC, PR-DO-023 Site Work Control, Rev. 0

8.7 NRC screening computer code DandD Version 2.1.0

8.8 U.S. Nuclear Regulatory Commission. NUREG-1720, Re-Evaluation of the Indoor Resuspension Factor for the Screening Analysis of the Building Occupancy Scenario for NRC's License Termination Rule, Draft Report for Comment, June 2002

8.9 COMPASS Code Version 1.1.0 was developed under the sponsorship of the U.S. Nuclear Regulatory Commission for implementation of MARSSIM in support of the decommissioning license termination rule (10 CFR Part 20, Subpart E)

9.0 ATTACHMENTS

9.1 Energy*Solutions* Plans and Procedures

9.2 Room 2120 Information Survey Data

9.3 Building Surface DCGL Development and D&D Code Results

9.4 Soil DCGL Development and D&D Code Results

9.5 Proposed Survey Units

9.6 COMPASS Building Surface Survey Plan for Room 2124

9.7 COMPASS Room 2124 Surface Soil Survey Plan

9.8 COMPASS Site Input Parameter Summary

9.9 COMPASS Building Surface Survey Plan Input Parameter Summary

9.10 COMPASS Surface Soil Survey Plan Input Parameter Summary

Attachment 9.1
Energy*Solutions* Plans and Procedures

Procedure Number	Procedure Title
CS-AD-PR-002	Commercial Services Project Records Procedure
CS-FO-PR-001	General Radiological Survey and Air Sampling Procedure for Field Projects
CS-FO-PR-002	Calibration and Maintenance of Radiological Survey and Sampling Equipment Procedure
CS-FO-PR-003	Soil Surveys; Collection of Water, Sediment, Vegetation and Soil Samples; and Chain-of-Custody Procedure
CS-FO-PR-004	QA/QC of Portable Radiological Survey Instruments
CS-RS-PR-003	Commercial Services Radiation Worker and Authorized User Training Proc.
CP-CSA-203	Ludlum Model 2350-1 Series Data Logger Download
CP-INST-201	Operation of the Ludlum Model 2350-1 Series Data Loggers
ES-AD-PR-009	Control of Measuring and Test Equipment

Attachment 9.2
Room 2120 Information Survey Data

Room 2120 Information Survey

27-Oct-08

Instrument: 2350-1 with 43-68A Alpha Scintillator Probe

Total Instrument Efficiency: 4.7%

Instrument Probe Area: 126 cm^2

Area	Counts	Count Time (sec)	Location	Background (cpm)	Net ($cpm/100cm^2$)	Net ($dpm/100cm^2$)
Wall 01	1	42	1	2	-0.5	-10
Wall 01	0	42	2	2	-1.6	-34
Wall 01	2	42	3	2	0.7	14
Wall 01	1	42	4	2	-0.5	-10
Wall 01	3	42	5	2	1.8	39
Wall 01	2	42	6	2	0.7	14
Wall 01	2	42	7	2	0.7	14
Wall 01	3	42	8	2	1.8	39
Wall 01	1	42	9	2	-0.5	-10
Wall 01	2	42	10	2	0.7	14
Wall 01	0	42	11	2	-1.6	-34
Wall 01	4	42	12	2	2.9	63
Wall 01	2	42	13	2	0.7	14
Wall 01	3	42	14	2	1.8	39
Wall 01	4	42	15	2	2.9	63
Wall 02	10	42	1	2	9.8	207
Wall 02	9	42	2	2	8.6	183
Wall 02	4	42	3	2	2.9	63
Wall 02	6	42	4	2	5.2	111
Wall 02	6	42	5	2	5.2	111
Wall 02	0	42	6	2	-1.6	-34
Wall 02	3	42	7	2	1.8	39
Wall 02	7	42	8	2	6.3	135
Wall 02	2	42	9	2	0.7	14
Wall 02	5	42	10	2	4.1	87
Wall 03	3	42	1	2	1.8	39
Wall 03	2	42	2	2	0.7	14
Wall 03	5	42	3	2	4.1	87
F01	1	6	1	2	6.3	135
F01	0	6	2	2	-1.6	-34
F01	1	6	3	2	6.3	135
F01	0	6	4	2	-1.6	-34
F01	2	6	5	2	14.3	304
F01	0	6	6	2	-1.6	-34
F01	1	6	7	2	6.3	135
F01	2	6	8	2	14.3	304
F01	2	6	9	2	14.3	304
F01	4	6	10	2	30.2	642
F01	1	6	11	2	6.3	135
F01	0	6	12	2	-1.6	-34

Area	Counts	Count Time (sec)	Location	Background (cpm)	Net (cpm/100cm^2)	Net (dpm/100cm^2)
F01	2	6	13	2	14.3	304
F01	1	6	14	2	6.3	135
F01	3	6	15	2	22.2	473
W03	4	60	4	2	1.6	34
W03	5	60	5	2	2.4	51
W03	2	60	6	2	0.0	0
W04	5	60	1	2	2.4	51
W04	2	60	2	2	0.0	0
W04	4	60	3	2	1.6	34
W04	0	60	4	2	-1.6	-34
W04	3	60	5	2	0.8	17
W04	1	60	6	2	-0.8	-17
F01	1	60	16	2	-0.8	-17
F01	0	60	17	2	-1.6	-34
F01	0	60	18	2	-1.6	-34
F01	1	60	19	2	-0.8	-17
F01	0	6	20	2	-1.6	-34

	(cpm/100 cm^2)	(dpm/100 cm^2)
Number:	**57**	**57**
Mean:	**3.4**	**73**
STDEV:	**6.2**	**132**

Attachment 9.3
Building Surface DCGL Development and D&D Code Results

$DCGL_W$ Values for NIST Boulder Building Surfaces

(Resuspension factor changed to a constant 1 x 10^{-6} m^{-1})

Radionuclide	DandD Code TEDE* for 100 dpm/100 cm^2 (mrem/year)	$DCGL_W$ for 25mrem/year TEDE (dpm/100 cm^2)	Activity (%)	Decay Mode
Pu-238	6.14	407	0.81%	Alpha
Pu-239	6.74	370	31.32%	Alpha
Pu-240	6.74	370	9.95%	Alpha
Pu-241	0.13	18,939	47.76%	Beta
Pu-242	6.45	387	0.00%	Alpha
U-234	1.99	1,256	0.00%	Alpha
U-235	1.87	1,336	0.00%	Alpha
U-236	1.88	1,329	0.00%	Alpha
Am-241	6.97	358	10.15%	Alpha
Np-237	8.52	293	0.00%	Alpha
U-238	1.78	1,404	0.00%	Alpha

* 90% of the 100 calculated TEDE values are less than the reported value

Justification for modification: Based on NUREG-1720 which states…"staff recommends using an RF value of 10^{-6} m^{-1} in the screening analysis of the inhalation dose calculation for the building occupancy scenario."

The DandD Code Results to support the table above are provided on the pages that follow.

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 1:13:11 PM
Site Name: NIST Boulder Campus
Description: Affected Labs Building 1
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST Pu-238.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
238Pu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Evaluation Concentration		Value 1.00E+02

Site Specific Parameters:

General Parameters:

Parameter Name	Description	Distribution
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	CONSTANT(1/m)
Justification for modification: Based on NUREG-1720 which states... staff recommends using an RF value of 10-6 m-1 in the screening analysis of the inhalation dose calculation for the building occupancy scenario.		Value 1.00E-06
		Default DERIVED(1/m)

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are** < 6.14E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 6.14E+00 **to** 6.14E+00 **mrem/year**

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 1:17:10 PM
Site Name: NIST Boulder Campus
Description: Affected Labs Building 1
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST Pu-239.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
239Pu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Evaluation Concentration		Value 1.00E+02

Site Specific Parameters:

General Parameters:

Parameter Name	Description	Distribution
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	CONSTANT(1/m)
Justification for modification: Based on NUREG-1720 which states... staff recommends using an RF value of 10-6 m-1 in the screening analysis of the inhalation dose calculation for the building occupancy scenario.		Value 1.00E-06
		Default DERIVED(1/m)

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are** < 6.74E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 6.74E+00 **to** 6.74E+00 **mrem/year**

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 1:21:13 PM
Site Name: NIST Boulder Campus
Description: Affected Labs Building 1
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST Pu-240.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
240Pu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Evaluation Concentration		Value 1.00E+02

Site Specific Parameters:

General Parameters:

Parameter Name	Description	Distribution
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	CONSTANT(1/m)
Justification for modification: Based on NUREG-1720 which states... staff recommends using an RF value of 10-6 m-1 in the screening analysis of the inhalation dose calculation for the building occupancy scenario.		Value 1.00E-06
		Default DERIVED(1/m)

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are** < 6.74E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 6.74E+00 **to** 6.74E+00 **mrem/year**

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 2:51:27 PM
Site Name: NIST Boulder Campus
Description: Affected Labs Building 1
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST Pu-241.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
241Pu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Evaluation Concentration		Value 1.00E+02

Site Specific Parameters:

General Parameters:

Parameter Name	Description	Distribution
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	CONSTANT(1/m)
Justification for modification: Based on NUREG-1720 which states... staff recommends using an RF value of 10-6 m-1 in the screening analysis of the inhalation dose calculation for the building occupancy scenario.		Value 1.00E-06
		Default DERIVED(1/m)

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are** < 1.32E-01 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.32E-01 **to** 1.32E-01 **mrem/year**

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 2:56:39 PM
Site Name: NIST Boulder Campus
Description: Affected Labs Building 1
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST Pu-242.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
242Pu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Evaluation Concentration		Value 1.00E+02

Site Specific Parameters:

General Parameters:

Parameter Name	Description	Distribution
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	CONSTANT(1/m)
Justification for modification: Based on NUREG-1720 which states... staff recommends using an RF value of 10-6 m-1 in the screening analysis of the inhalation dose calculation for the building occupancy scenario.		Value 1.00E-06
		Default DERIVED(1/m)

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are** < 6.45E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 6.45E+00 **to** 6.45E+00 **mrem/year**

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 3:05:29 PM
Site Name: NIST Boulder Campus
Description: Affected Labs Building 1
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST U-234.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
234U	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Evaluation Concentration		Value 1.00E+02

Site Specific Parameters:

General Parameters:

Parameter Name	Description	Distribution
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	CONSTANT(1/m)
Justification for modification: Based on NUREG-1720 which states... staff recommends using an RF value of 10-6 m-1 in the screening analysis of the inhalation dose calculation for the building occupancy scenario.		Value 1.00E-06
		Default DERIVED(1/m)

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are** < 1.99E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.99E+00 **to** 1.99E+00 **mrem/year**

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 3:11:25 PM
Site Name: NIST Boulder Campus
Description: Affected Labs Building 1
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST U-235.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
235U	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Evaluation Concentration		Value 1.00E+02

Site Specific Parameters:

General Parameters:

Parameter Name	Description	Distribution
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	CONSTANT(1/m)
Justification for modification: Based on NUREG-1720 which states... staff recommends using an RF value of 10-6 m-1 in the screening analysis of the inhalation dose calculation for the building occupancy scenario.		Value 1.00E-06
		Default DERIVED(1/m)

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are** < 1.87E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.87E+00 **to** 1.87E+00 **mrem/year**

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 3:14:04 PM
Site Name: NIST Boulder Campus
Description: Affected Labs Building 1
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST U-236.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
236U	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Evaluation Concentration		Value 1.00E+02

Site Specific Parameters:

General Parameters:

Parameter Name	Description	Distribution
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	CONSTANT(1/m)
Justification for modification: Based on NUREG-1720 which states... staff recommends using an RF value of 10-6 m-1 in the screening analysis of the inhalation dose calculation for the building occupancy scenario.		Value 1.00E-06
		Default DERIVED(1/m)

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are** < 1.88E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.88E+00 **to** 1.88E+00 **mrem/year**

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 3:00:17 PM
Site Name: NIST Boulder Campus
Description: Affected Labs Building 1
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST Am-241.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
241Am	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Evaluation Concentration		Value 1.00E+02

Site Specific Parameters:

General Parameters:

Parameter Name	Description	Distribution
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	CONSTANT(1/m)
Justification for modification: Based on NUREG-1720 which states... staff recommends using an RF value of 10-6 m-1 in the screening analysis of the inhalation dose calculation for the building occupancy scenario.		Value 1.00E-06
		Default DERIVED(1/m)

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are** < 6.97E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 6.97E+00 **to** 6.97E+00 **mrem/year**

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 3:02:36 PM
Site Name: NIST Boulder Campus
Description: Affected Labs Building 1
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST Np-237.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
237Np	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Evaluation Concentration		Value 1.00E+02

Site Specific Parameters:

General Parameters:

Parameter Name	Description	Distribution
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	CONSTANT(1/m)
Justification for modification: Based on NUREG-1720 which states... staff recommends using an RF value of 10-6 m-1 in the screening analysis of the inhalation dose calculation for the building occupancy scenario.		Value 1.00E-06
		Default DERIVED(1/m)

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are** < 8.52E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 8.52E+00 **to** 8.52E+00 **mrem/year**

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 3:16:39 PM
Site Name: NIST Boulder Campus
Description: Affected Labs Building 1
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST U-238.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
238U	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: Evaluation Concentration		Value 1.00E+02

Site Specific Parameters:

General Parameters:

Parameter Name	Description	Distribution
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	CONSTANT(1/m)
Justification for modification: Based on NUREG-1720 which states... staff recommends using an RF value of 10-6 m-1 in the screening analysis of the inhalation dose calculation for the building occupancy scenario.		Value 1.00E-06
		Default DERIVED(1/m)

Correlation Coefficients:

None

Summary Results:

90.00% **of the** 100 **calculated TEDE values are** < 1.78E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.78E+00 **to** 1.78E+00 **mrem/year**

Attachment 9.4
Surface Soil DCGL Development and D&D Code Results

Radionuclide	DandD Code TEDE[a] for 1 pCi/g (mrem/year)	$DCGL_W$[b] for 25mrem/year TEDE (pCi/g)
Uranium-234	2.75	9.0
Uranium-235	3.17	7.8
Uranium-236	1.83	13.6
Uranium-238	2.49	10.0
Plutonium-238	9.7	2.5
Plutonium-239	11.1	2.2
Plutonium-240	10.8	2.3
Plutonium-241	0.34	73
Plutonium-242	10.3	2.4
Americium-241	11.8	2.1
Neptunium-237	260	0.10

[a] 90% of the 100 calculated TEDE values are less than the reported value

[b] These values represent surficial surface soil concentrations of individual radionuclides that would be deemed in compliance with the 25 mrem/y (0.25 mSv/y) unrestricted release dose limit in 10 CFR 20.1402. For radionuclides in a mixture, the "sum of fractions" rule applies.

The DandD Code Results to support the table above are provided on the pages that follow.

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 4:52:52 PM
Site Name: NIST Boulder Campus
Description: Soil
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST\NIST Am-241 in Soil.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 122
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
241Am	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Evaluation Concentration		Value 1.00E+00

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

file://D:\Documents and Settings\pely\My Documents\DandD Docs\NIST\NIST Am-241 in Soil ... 11/4/2008

90.00% **of the** 122 **calculated TEDE values are** < 1.18E+01 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.10E+01 **to** 1.39E+01 **mrem/year**

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 11/4/2008 5:05:46 PM
Site Name: NIST Boulder Campus
Description: Soil
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST\NIST Np-237 in Soil.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 122
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
237Np	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Evaluation Concentration		Value 1.00E+00

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

file://D:\Documents and Settings\pely\My Documents\DandD Docs\NIST\NIST Np-237 in Soil r... 11/4/2008

90.00% **of the** 122 **calculated TEDE values are** < 2.60E+02 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 2.01E+02 **to** 4.61E+02 **mrem/year**

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 11/5/2008 9:16:16 AM
Site Name: NIST Boulder Campus
Description: Soil
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST\NIST Pu-238 in Soil.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 122
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
238Pu	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Evaluation Concentration		Value 1.00E+00

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

file://D:\Documents and Settings\pely\My Documents\DandD Docs\NIST\NIST Pu-238 in Soil r... 11/5/2008

90.00% **of the** 122 **calculated TEDE values are** < 9.74E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 9.43E+00 **to** 1.09E+01 **mrem/year**

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 11/5/2008 9:26:14 AM
Site Name: NIST Boulder Campus
Description: Soil
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST\NIST Pu-239 in Soil.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 122
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
239Pu	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Evaluation Concentration		Value 1.00E+00

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

file://D:\Documents and Settings\pely\My Documents\DandD Docs\NIST\NIST Pu-239 in Soil r... 11/5/2008

90.00% **of the** 122 **calculated TEDE values are** < 1.11E+01 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.05E+01 **to** 1.20E+01 **mrem/year**

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 11/5/2008 9:32:50 AM
Site Name: NIST Boulder Campus
Description: Soil
FileName:D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST\NIST Pu-240 in Soil.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 122
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
240Pu	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Evaluation Concentration		Value 1.00E+00

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

file://D:\Documents and Settings\pely\My Documents\DandD Docs\NIST\NIST Pu-240 in Soil r... 11/5/2008

90.00% **of the** 122 **calculated TEDE values are** < 1.08E+01 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.04E+01 **to** 1.15E+01 **mrem/year**

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 11/5/2008 9:37:00 AM
Site Name: NIST Boulder Campus
Description: Soil
FileName:D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST\NIST Pu-241 in Soil.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 129
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
241Pu	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Evaluation Concentration		Value 1.00E+00

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

file://D:\Documents and Settings\pely\My Documents\DandD Docs\NIST\NIST Pu-241 in Soil r... 11/5/2008

90.00% **of the** 129 **calculated TEDE values are** < 3.41E-01 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 3.11E-01 **to** 7.23E-01 **mrem/year**

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 11/5/2008 9:41:08 AM
Site Name: NIST Boulder Campus
Description: Soil
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST\NIST Pu-242 in Soil.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 129
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
242Pu	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Evaluation Concentration		Value 1.00E+00

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

file://D:\Documents and Settings\pely\My Documents\DandD Docs\NIST\NIST Pu-242 in Soil r... 11/5/2008

90.00% **of the** 129 **calculated TEDE values are** < 1.03E+01 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 9.87E+00 **to** 1.12E+01 **mrem/year**

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 11/5/2008 9:49:24 AM
Site Name: NIST Boulder Campus
Description: Soil
FileName:D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST\NIST U-234 in Soil.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 129
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
234U	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Evaluation Concentration		Value 1.00E+00

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

file://D:\Documents and Settings\pely\My Documents\DandD Docs\NIST\NIST U-234 in Soil re... 11/5/2008

90.00% **of the** 129 **calculated TEDE values are** < 2.75E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.38E+00 **to** 6.09E+00 **mrem/year**

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 11/5/2008 9:54:16 AM
Site Name: NIST Boulder Campus
Description: Soil
FileName:D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST\NIST U-235 in Soil.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 129
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
235U	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Evaluation Concentration		Value 1.00E+00

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

file://D:\Documents and Settings\pely\My Documents\DandD Docs\NIST\NIST U-235 in Soil re... 11/5/2008

90.00% **of the** 129 **calculated TEDE values are** < 3.17E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 2.58E+00 **to** 6.25E+00 **mrem/year**

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 11/5/2008 9:58:18 AM
Site Name: NIST Boulder Campus
Description: Soil
FileName: D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST\NIST U-236 in Soil.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 129
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
236U	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Evaluation Concentration		Value 1.00E+00

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

file://D:\Documents and Settings\pely\My Documents\DandD Docs\NIST\NIST U-236 in Soil re... 11/5/2008

90.00% **of the** 129 **calculated TEDE values are** < 1.83E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.19E+00 **to** 3.43E+00 **mrem/year**

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 11/5/2008 10:07:04 AM
Site Name: NIST Boulder Campus
Description: Soil
FileName:D:\Documents and Settings\pely\My Documents\DandD_Docs\NIST\NIST U-238 in Soil.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 129
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
238U	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: Evaluation Concentration		Value 1.00E+00

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

file://D:\Documents and Settings\pely\My Documents\DandD Docs\NIST\NIST U-238 in Soil re... 11/5/2008

90.00% **of the** 129 **calculated TEDE values are** < 2.49E+00 **mrem/year .**
The 95 % Confidence Interval for the 0.9 **quantile value of TEDE is** 1.26E+00 **to** 8.27E+00 **mrem/year**

Attachment 9.5
Proposed Survey Units

				Characterization Elevated Activity Summary	
Survey Package/Survey Unit Classification	**Room/Area Description**	**Surface**	**Area m^2**	**Direct Alpha Activity (dpm/100 cm2)**	**Removable Activity (dpm/100 cm2)**
SU001 Class 1	2124	Floor	89	Max > 500,000 cpm	Max 573,549
SU002 Class 1	2124	Walls	197	Max 3,453	No Information
SU003 Class 1	2124	Ceiling	89	No Information	No Information
SU004 Class 1	2124A	Floor	37	No Information	Max 5
SU005 Class 1	2120	Floor	58	Max 152	Max 32
SU006 Class 1	2120A	Floor	28	Max 140	Max 145
SU007 Class 1	2007	Floor	18	No Information	Max 15
SU008 Class 2	2124A	Walls & Ceiling	115	No Information	No Information

				Characterization Elevated Activity Summary	
Survey Package/Survey Unit Classification	**Room/Area Description**	**Surface**	**Area m^2**	**Direct Alpha Activity (dpm/100 cm2)**	**Removable Activity (dpm/100 cm2)**
SU009 Class 1	2120	Walls & Ceiling	122	Max 2,000	Max 200
SU010 Class 2	2120A	Walls & Ceiling	93	Max 484	Max 11
SU011 Class 2	2007	Walls & Ceiling	60	No Information	No Information
SU012 Class 2	Roof Area	Roof Surface	392	No Information	Max 5
SU013 Class 2	Soil from indoor pipe excavation	Surface Soil	15	No Information	No Information
SU014 Class 2	Soil from outdoor pipe excavation	Surface Soil	7	No Information	No Information

Attachment 9.6
COMPASS Building Surface Survey Plan for Room 2124

BUILDING SURFACE SURVEY PLAN

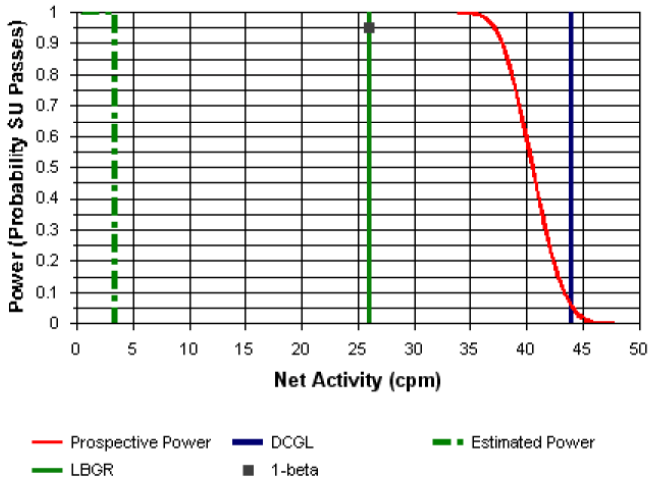
Survey Plan Summary

Site Name:	NIST Boulder Campus
Planner(s):	p ely
Survey Unit Name:	Room 2124 Floor
Comments:	N/A

Statistical Design Details

Area (m²):	89	Classification:	1
Selected Test:	Sign	Estimated Sigma (cpm/100 cm²):	6.2
DCGL (cpm/100 cm²):	44	Sample Size (N):	**14**
LBGR (cpm/100 cm²):	26	Estimated Conc. (cpm/100 cm²):	3.4
Alpha:	0.050	Estimated Power:	1.0
Beta:	0.050	Post-EMC Sample Size (N):	**14**

Prospective Power Curve



Gross Activity Efficiency Data

Instrument Description:	Ludlum 43-68 Gas Flow Proportional
Physical Detector Area (cm²):	126
DCGLw (dpm/100 cm²):	696
Total Efficiency:	0.05
DCGLw (cpm/100 cm²):	44

Contaminant	HTDC[a]	Energy[b]	Fract[c]	Inst. Eff.	Surf. Eff.	Total Eff.
Am-241	No	N/A	0.10	0.36	0.25	0.01
Pu-238	No	N/A	0.01	0.36	0.25	0.00
Pu-239	No	N/A	0.31	0.36	0.25	0.03
Pu-240	No	N/A	0.10	0.36	0.25	0.01
Pu-241	Yes	5.23	0.48	0.00	0.00	0.00

[a]Hard-to-detect contaminant [b]Average beta energy (keV) [N/A indicates alpha emission] [c]Activity fraction

Gross Activity Mean and Sigma Data

Count Time (min):	1
Sign Test Sigma (cpm/100 cm²):	6.2

Data/Material	Mean (cpm/100 cm²)	Std. Dev. (cpm/100 cm²)	MDC (dpm/100 cm²)
SU	3.4	6.2	184

Elevated Measurement Comparison (EMC) for Gross Activity

Scanning Instrumentation Description:	Ludlum 43-68 Gas Flow Proportional
Background (cpm/100 cm²):	2.0
Total Scanning Efficiency:	0.04
True Positive Proportion:	0.85
False Positive Proportion:	0.35
Index of Sensitivity (d'):	1.42
Observation Interval (sec):	1.0
Surveyor Efficiency:	0.50
Area Factor Table Interpolation Method:	Linear

Statistical Design		Hot Spot Design	
N:	14	Actual Scan MDC*:	550
Bounded Area (m²):	6.4	Area Factor:	N/A
Area Factor:	4.5	Bounded Area (m²):	N/A
DCGLw*:	358	Post-EMC N:	14
Scan MDC Required*:	1,597		

Contaminant	Energy[a]	Fract[b]	Inst. Eff.	Surf. Eff.	Total Eff.
Am-241	N/A	0.10	0.20	0.25	0.01
Pu-238	N/A	0.01	0.20	0.25	0.00
Pu-239	N/A	0.31	0.20	0.25	0.02
Pu-240	N/A	0.10	0.20	0.25	0.01

[a]Average beta energy (keV) [N/A indicates alpha emission] [b]Activity fraction

Contaminant	DCGLw*	Area Factor	Scan MDC Req'd*
Am-241	358	4.5	1,597
Pu-238	407	4.5	1,815
Pu-239	370	4.5	1,650
Pu-240	370	4.5	1,650

* dpm/100 cm²

Report Created 12/03/2008 1638 (*COMPASS v1.1.0*)

Attachment 9.7
COMPASS Room 2124 Surface Soil Survey Plan

SURFACE SOIL SURVEY PLAN

Survey Plan Summary

Site Name:	NIST Boulder Campus
Planner(s):	p ely
Survey Unit Name:	Room 2124 Soil
Comments:	N/A

Statistical Design Details

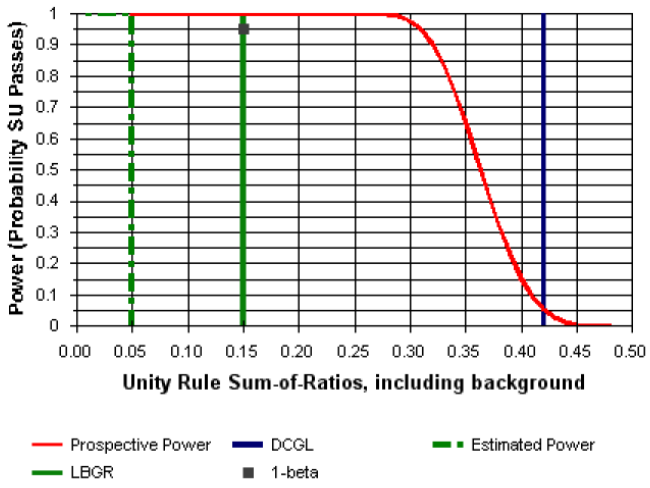
Area (m²):	28	Classification:	1
Selected Test:	Sign	Estimated Sigma (SOR):	0.10
DCGL (SOR):	0.42	Sample Size (N):	14
LBGR (SOR):	0.15	Average Area Bounded by Samples (m²):	2.0
Alpha:	0.050	Estimated Conc. (SOR):	0.05
Beta:	0.050	Estimated Power:	1.0

NOTE: SOR = Sum-of-Ratios

Elevated Measurement Comparison Summary

Scanning Instrumentation:	2"x2" NaI
Post-EMC Sample Size N:	15

Prospective Power Curve



Measured Contaminant Details

Contaminant	DCGLw (pCi/g)	Modified DCGLw (pCi/g)	Survey Unit Estimate (Mean ± 1-Sigma) (pCi/g)	Reference Area Estimate (Mean ± 1-Sigma) (pCi/g)
Am-241	2.1	0.42	0.05 ± 0.10	0.01 ± 0.05

Inferred Contaminant Details (DCGL Modification)

Contaminant	DCGLw (pCi/g)	Surrogate Contaminant (pCi/g)	Ratio (Inferred/Surrogate)
Pu-238	2.5	Am-241	0.08
Pu-239	2.2	Am-241	3.1
Pu-240	2.3	Am-241	0.98
Pu-241	73	Am-241	4.7

Elevated Measurement Comparison Details

Contaminant	DCGL (pCi/g)	Actual Scan MDC	Area Factor	Required Scan MDC	New Area Factor	Area (m^2)	Post-EMC N	Comment
Am-241	0.42	32	75	31	76.19	2.0	15	<< Most Restrictive Contaminant >>

Selected Area Factor Table Interpolation Method: Linear

Report Created 12/03/2008 1658 (*COMPASS v1.1.0*)

Attachment 9.8
COMPASS Site Input Parameter Summary

Parameter	Source of Information	Units	Default Value	Remarks
Contaminant	Radionuclides of concern from Table 1	N/A	N/A	Data saved as NIST Boulder Campus Site
Building Surface $DCGL_W$	Value generated by DandD Code (see Table 2)	dpm/100 cm^2	NUREG-1757 Screening Value	Default DandD code values used **except a modified resuspension factor** used to generate Building Surface DCGLs
Surface Soil $DCGL_W$	Value generated by DandD Code (see Table 4)	dpm/100 cm^2	NUREG-1757 Screening Value	All default values DandD code used for soil DCGLs
Building Surface Area Factors	RESRAD-BUILD	N/A	Values are included in COMPASS but site specific values should be developed	Building surface area factors were developed using RESRAD-BUILD
Surface Soil Area Factors	COMPASS	N/A	COMPASS (from NUREG-1505 Table 8.1	Site-specific building surface area factors were not developed as scanning for Am-241 is not practical

Attachment 9.9 **COMPASS Building Surface Survey Plan Input Parameter Summary**				
Parameter	**Source of Information**	**Units**	**Value**	**Remarks**
Contaminant	Imported from COMPASS Site Report	N/A	N/A	NIST Boulder Campus Site
Building Surface $DCGL_W$	Imported from COMPASS Site Report	dpm/100 cm^2	N/A	NIST Boulder Campus Site
Building Surface Area Factors	Imported from COMPASS Site Report	N/A	N/A	NIST Boulder Campus Site
Survey Area	NIST	N/A	Room 2124 Floor	Largest room to be surveyed
Statistical Test	N/A	N/A	Sign	User Selection
Material Specific Background Correction	N/A	N/A	Gross activity measurements with no correction	User Selection
Ambient Gamma Correction	N/A	N/A	Gross activity measurements with no correction	User Selection
Size of Survey Area	NIST	m^2	89.3	From room measurements
Survey Class	NIST	N/A	1	Contamination initially present in area
Measurement Method	N/A	N/A	Gross Activity DCGL one measurement	Beta measurement not made
Gross Activity Fractions	Radionuclides of concern from Table 2-1	fraction	From Table 2-1	See Table 2-1
Hard to Detect Radionuclides	Rad Health Handbook	N/A	Pu-241	Beta energy too low to detect with portable instruments
$DCGL_W$	Calculated by COMPASS	dpm/100 cm^2	696	
Instrument Type	Energy*Solutions*	N/A	Ludlum 43-68 Gas Flow Proportional	Used with Ludlum 2350 meter
Physical Detector Area	Ludlum	cm^2	126	

Attachment 9.9 **COMPASS Building Surface Survey Plan Input Parameter Summary**				
Parameter	**Source of Information**	**Units**	**Value**	**Remarks**
Instrument Efficiency by nuclide	Calibration Certificate	fraction	0.36	Calibration based on Th-230, all alpha radionuclides of interest have the same efficiency
Surface Efficiency by nuclide	ISO 7503-1	fraction	0.25	Recommended value from ISO 7503-1, all alpha radionuclides of interest have the same efficiency
Total efficiency	Calculated by COMPASS	fraction	0.05	
Gross Activity $DCGL_W$	Calculated by COMPASS	cpm/100 cm^2	44	
Count Time	Energy*Solutions*	min	1	Typical alpha count time
Gross Activity Mean in Survey Unit	Estimated based on existing surveys	dpm/100 cm^2	3.4	
Standard Deviation of Gross Activity Mean in Survey Unit	Estimated based on existing surveys	dpm/100 cm^2	6.2	
Survey MDC	Calculated by COMPASS	dpm/100 cm^2	184	
Estimated Sigma	Calculated by COMPASS	cpm/100 cm^2	6.2	
Alpha type error	Energy*Solutions*	Fraction	0.05	Typical value acceptable to NRC
Beta type error	Energy*Solutions*	Fraction	0.05	Typical value acceptable to client
LBGR	Energy*Solutions*	cpm/100 cm^2	26	Value selected to generate a □/□ value between 1 and 3 as recommended by MARSSIM
Sample Size, N	Calculated by COMPASS	N/A	14	
Estimated Concentration	Calculated by COMPASS	cpm/100 cm^2	3.4	
Estimated Power	Calculated by COMPASS	N/A	1.0	

Attachment 9.9 **COMPASS Building Surface Survey Plan Input Parameter Summary**				
Parameter	**Source of Information**	**Units**	**Value**	**Remarks**
Scanning Instrument	Energy*Solutions*	N/A	Ludlum 43-68 Gas Flow Proportional	
Instrument Background	Energy*Solutions*	cpm/100 cm^2	2.0	Site data for Ludlum 43-68
Scanning Instrument Alpha Instrument Efficiency	Based on Calibration Certificate	fraction	0.31	Efficiency reduced from 36% to 31% based on slight increased distance to surface during scanning
Total scanning instrument efficiency	Calculated by COMPASS	fraction	0.04	
Scan MDC true positive proportion	Energy*Solutions*	N/A	0.85	Alternative value is 0.95
Scan MDC false positive proportion	Energy*Solutions*	N/A	0.35	Alternative value is 0.6
Index of Sensitivity, d'	Calculated by COMPASS	N/A	1.42	
Observation Interval	Energy*Solutions*	sec	1.0	Probe width divided by scan speed
Surveyor Efficiency	Default COMPASS Value	Fraction	0.5	
Statistical Design: N	Calculated by COMPASS	N/A	14	
Statistical Design: Area Factor	Calculated by COMPASS	N/A	4.5	
Statistical Design: $DCGL_W$	Calculated by COMPASS	dpm/100 cm^2	358	
Statistical Design: Scan MDC Required	Calculated by COMPASS	dpm/100 cm^2	1,597	
Hot Spot Design: Actual scan MDC	Calculated by COMPASS	dpm/100 cm^2	550	
Hot Spot Design: Area Factor	Calculated by COMPASS	N/A	N/A	
Hot Spot Design: Bounded Area	Calculated by COMPASS	m^2	N/A	

Attachment 9.9 COMPASS Building Surface Survey Plan Input Parameter Summary				
Parameter	**Source of Information**	**Units**	**Value**	**Remarks**
Hot Spot Design: Post-EMC N	Calculated by COMPASS	N/A	14	

Attachment 9.10 **COMPASS Surface Soil Survey Plan Input Parameter Summary**				
Parameter	**Source of Information**	**Units**	**Value**	**Remarks**
Contaminant	Imported from COMPASS Site Report	N/A	N/A	NIST Boulder Campus Site
Surface Soil $DCGL_W$	Imported from COMPASS Site Report	pCi/g	N/A	NIST Boulder Campus Site
Surface Soil Area Factors	Imported from COMPASS Site Report	N/A	N/A	Default values from NUREG-1505 Table 8.1
Survey Unit Description	NIST	N/A	Room 2124 Soil	Trench area
Size of Survey Area	NIST	m^2	28	From room measurements
Survey Class	NIST	N/A	1	Contamination not expected but potentially present, Class 1 to be conservative
Contaminants to be Measured	Rad Health Handbook	N/A	Am-241	All other radionuclides of interest can not be detected by gamma spectroscopy at the required detection limits
Pu-238 Contaminant Ratio	Table 5	fraction	0.08	
Pu-239 Contaminant Ratio	Table 5	fraction	3.09	
Pu-240 Contaminant Ratio	Table 5	fraction	0.98	
Pu-241 Contaminant Ratio	Table 5	fraction	4.7	
Modified $DCGL_W$	Calculated by COMPASS	dpm/100 cm^2	0.42	
Survey Unit Mean	Estimated	pCi/g	0.05	Am not found in background samples
Standard Deviation of Survey Unit Mean	Estimated	pCi/g	0.1	Am not found in background samples
Reference Area Mean	Estimated	pCi/g	0.01	Am not found in background samples

Attachment 9.10
COMPASS Surface Soil Survey Plan Input Parameter Summary

Parameter	Source of Information	Units	Value	Remarks
Standard Deviation of Reference Area Mean	Estimated	pCi/g	0.05	Am not found in background samples
Alpha type error	Energy*Solutions*	Fraction	0.05	Typical value acceptable to NRC
Beta type error	Energy*Solutions*	Fraction	0.05	Typical value acceptable to client
LBGR	Energy*Solutions*	pCi/g	0.15	Value selected to generate a □/□ value between 1 and 3 as recommended by MARSSIM
Sample Size, N	Calculated by COMPASS	N/A	14	
Estimated Concentration	Calculated by COMPASS	SOR	0.05	Sum of Ratios
Estimated Power	Calculated by COMPASS	N/A	1.0	
Statistical Design Test	Energy*Solutions*	N/A	Sign	
Scanning Instrument	Energy*Solutions*	N/A	NaI 2x2	Typical gamma scanning probe
Scan MDC	NUREG-1507	pCi/g	31.5	
Area Factor	Calculated by COMPASS	N/A	75	
Required Scan MDC	Calculated by COMPASS	N/A	31	
New Area Factor	Calculated by COMPASS	N/A	76.19	
Hot Spot Design: Bounded Area	Calculated by COMPASS	m^2	2	
Hot Spot Design: Post-EMC N	Calculated by COMPASS	N/A	15	

APPENDIX A
Determination of Area Factors for Building Surfaces

The DCGLW is the average concentration across the site that is calculated to result in the average member of the critical group receiving a dose at the appropriate dose limit [e.g., 0.25 mSv/y (25 mrem/y) for unrestricted release]. The general assumption is that the concentration of the radionuclides in the source are fairly homogenous. The degree to which any single localized area can be elevated above the average, assuming the average is at the $DCGL_W$, and not invalidate the homogenous assumption is characterized by the $DCGL_{EMC}$. One method for determining values for the $DCGL_{EMC}$ is to modify the $DCGL_W$ using a correction factor that accounts for the difference in area and the resulting change in dose. The area factor is then the magnitude by which the concentration within the small area of elevated activity can exceed $DCGL_W$ while maintaining compliance with the release criterion.

The area factor works by taking into consideration how a smaller area would affect the dose to the average member of the critical group. For example, a smaller area could mean that external dose is more limited because it is not reasonable to expect the individual to be exposed the same amount of time as the individual would be to a larger area.

However, such factors cannot be calculated by using the DandD computer code. Therefore, as indicated in Appendix O of NUREG-1757, "*when screening DCGL values are used, which were derived from DandD, an alternative approach must be used to calculate area factors for residual radioactivity on building surfaces*." The approach used here is to develop the area factors by using the RESRAD-BUILD computer code. With this approach, the screening DCGL values are converted into the appropriate concentration unit for RESRAD-BUILD (i.e., from dpm/100 cm^2 to dpm/m^2).

The first step was to establish the parameters to be used for RESRAD-Build. The parameters used are provided in Table A-1. The largest room to be surveyed, 2124, was used as the default room size, 89.3 square meters and the maximum room height is 17 feet (5.2 meters). The receptor and source were located in the center of the room with the floor surface used as the source. The room and source information is provided in Table A-2. The ingestion factors are provided in Table A-3. Other parameters used default values.

Table A-1
NIST Boulder Campus
RESRAD-Build Dose Assessment
Input Parameter Summary

Parameter	Description	Units	Default Value	Exposure Scenario (Building Occupant)	Remarks
RESRAD-Build Filename				NIST (Am241, Pu238, Pu239, Pu240 & Pu241).bld	
Exposure Duration	Total length of time considered by the dose assessment, including intervals during which the receptor may be absent from the building or at the contaminated indoor location.	days	365	365	
Indoor Fraction	Fraction of the exposure duration that was spent by one or more receptors inside the building.	NA	0.5	0.5	
Evaluation time	Number of user-defined discrete exposure periods for which the dose calculations are performed	Years	1	1	
Number of Rooms	Number of rooms is the number of distinct air flow regions in the part of the building being modeled.	NA	1	1	A 1-room model was used to represent the affected rooms in Building 1.
Deposition Velocity	Deposition velocity of particles injected into the air from the contaminated sources. The deposition velocity characterizes the rate at which the particles in the indoor air deposit on the surface.	m/s	1.00E-02	1.00E-02	
Resuspension Rate	Rate at which the deposited material is resuspended in the air per unit time.	1/s	5.00E-07	5.00E-07	

Parameter	Description	Units	Default Value	Exposure Scenario (Building Occupant)	Remarks
Building Exchange Rate	Total volume of air in a building or room replaced by outside air per unit time.	1/h	0.8	0.8	
Room Area	Footprint area of the room.	m^2	36	**89.3**	See Table A-2
Room Height	Height of the room.	m	2.5	**5.2**	The height of the building is 17 feet (5.2 meters).
Radiological Units of Activity	Units of radiological activity	dpm/m^2	NA	dpm/m^2	disintegrations per minute
Radiological Units of Dose	Units of radiation dose	mrem	NA	mrem	Units coincide with NRC guideline of 25 mrem/yr
Number of Receptors	Number of receptors who are the subjects of the dose assessment.	NA	1	1	Dose calculated for one receptor.
Receptor Room	Room in which the receptor is located.	NA	1	1	A one-room model is used.
Receptor Location	Spatial coordinates of the point (x,y,z Cartesian coordinate system) occupied by the receptor	m	1,1,1	**varies with hot spot size**	The dose assessment was calculated at 1 meter above the center of the floor or hot spot.
ReceptorTime Fraction	Fraction of time spent by one or more receptors at a given location while inside the building.	NA	1	1	100 % of the time spent inside the building is spent at this location.
Receptor Breathing Rate	Rate at which the exposed individual inhales air while at the specific receptor location.	m^3/day	18	18	
Receptor Indirect Ingestion Rate	Ingestion rate of deposited material for a receptor at a specified location inside a building. This rate represents the transfer of deposited contamination from building surfaces to the mouth via contact with hands, food, or other objects.	m^2/hr	1.00E-04	1.00E-04	

Parameter	Description	Units	Default Value	Exposure Scenario (Building Occupant)	Remarks
Shielding Thickness all receptor/sources	Thickness of shielding material adjusted for orientation with respect to source	cm	0.00E+00	0.00E+00	No shielding is assumed between the source and the receptor.
Shielding Density all receptor/sources	Bulk density of shielding material	g/cc	2.40E+00	2.40E+00	No shielding is assumed between the source and the receptor.
Shielding Material all receptor/sources	Material between source and receptor	NA	concrete	concrete	No shielding is assumed between the source and the receptor.
Number of Sources	Number of radioactive source locations to be considered in the dose assessment.	NA	NA	**1**	Floor only (used to develop Area Factors only)
Source Descriptions	Description of residual activity.	NA	NA	**See Table A-2**	
Source Room Number	Room in which the source is situated.	NA	1	**2124**	Room 2124, the biggest room, was used for the evaluation
Source Type	Geometrical representation of the physical distribution of radiolactive material within a source (i.e. volume, area, line or point).	NA	volume	**area**	The floor surface was used for the source
Source Direction	Direction of the source relative to the three Cartesion coordiate axes. For a line source, the source direction is defined as the axis parallel to the line. For area and volume sources, the source direction is defined as the axis normal to the surface of the source.	NA	x	**perpendicular to floor (z)**	The floor surface was used for the source
Source Location	Spacial position of the source centerpoint in three dimensional space relative to the origin.	m	0, 0, 0	**4.25, 5.25,0**	The center of the floor surface was used for the center of the source, or the center of a smaller hot spot.

Parameter	Description	Units	Default Value	Exposure Scenario (Building Occupant)	Remarks
Source Area	Extent of the contamination. It is the exposed area for a volume or area source, or it is the length for a line source.	m^2	36	**89.3**	The floor area of the largest room, 2124
Air release fraction for all sources	Amount of the contaminated sources material removed from the source that is released into the air in the respirable particulate range.	NA	0.1	0.1	
Direct ingestion rate for all sources	Incidental ingestion rate of contaminated material directly from the source.	1/h	0.0	**1.00E-04**	Calculated from the default ingestion rate of 1.0E-04 m^2/hr and converted to 1/h based on the area of the source. See Table A-3 for supporting calculations.
Removable fraction for all sources	Fraction of a point, line or area source that can be removed. The balance of the source is assumed to remain fixed.	NA	0.5	0.5	
Source lifetime for all sources	Time over which the removable part of the source is (linearly) eroded. If the source is fixed and nothing will be eroded, enter 0 for the removable fraction and a nonzero value for this time.	days	365	365	
Radionuclide activity for all sources	Activity (for a point source) or activity concentration (for volume, area, and line sources) of radionuclides distributed in a source.	dpm/m^2	2.22 of Co-60	**See Table A-2**	The activity for all sources was entered at its single radionuclide $DCGL_W$ value in order to calculate Area Factors. Only those radionuclides activity greater than 1% of the activity in the source were utilized (Am-241, Pu-238, Pu-239, Pu-240 & Pu-241).

Parameter	Description	Units	Default Value	Exposure Scenario (Building Occupant)	Remarks
Radon release fraction for all sources	Fraction of the total amount of radon produced by radium decay that escapes the surface of a contaminated material and is released to the air. This parameter applies to point line and area sources.	NA	0.1	**0**	The radon inhalation pathway is not considered relevant. Therefore, the radon release fraction was set a zero to suppress this pathway (NUREG/CR-6755, Section 4.2)

Table A-2
NIST Boulder Campus
Room Geometry
Largest Affected Room (2124)

Approximate Room Dimensions			
	Cartesion	Dimension	Dimension
	Dimension	(ft)	(m)
Length	x	34.3	10.5
Width	y	28	8.5
Height	z	17	5.2

Area Calculations						
Source Number	Source Description	Room Number	Source Type	Room Length (m)	Room Width (m)	Room Area (m^2)
1	Floor	2124	Area	10.5	8.5	89.3

Conversion of DCGLW values for use with RESRAD-Build

Contaminant	**$DCGL_W$ dpm/100 cm^2**	**$DCGL_W$ dpm/m^2**
Am-241	358	35,800
Np-237	293	29,300
Pu-238	407	40,700
Pu-239	370	37,000
Pu-240	370	37,000
Pu-241	18,939	1,893,900
Pu-242	387	38,700
U-234	1,256	125,600
U-235	1,336	133,600
U-236	1,329	132,900
U-238	1,404	140,400

Source Location (m)			**Source Direction**
X	Y	Z	
4.3	5.2	0	Z

Table A-3
NIST Boulder Campus
RESRAD-Build Dose Assessment
Direct Ingestion Rates

Direct Ingestion Rate for Area Factor Calculations			
Room	Ingestion Rate (Default) (m^2/hr)	Total Source Area (m^2)	Effective Transfer Rate for Ingestion (1/hr)
AF89	1.00E-04	89.25	1.12E-06
AF36	1.00E-04	36	2.78E-06
AF25	1.00E-04	25	4.00E-06
AF16	1.00E-04	16	6.25E-06
AF9	1.00E-04	9	1.11E-05
AF4	1.00E-04	4	2.50E-05
AF1	1.00E-04	1	1.00E-04

Discussion: The direct ingestion rate is included in the RESRAD-BUILD code to cover the unlikely event that a receptor directly ingests source material. Such a receptor could be conducting a maintenance or renovation activity that involves physical contact with the source. The direct ingestion rate is normally set to 0 for most calculations. The direct ingestion rate for NIST is calculated from the default indirect ingestion rate of 1.0E-4 m^2/h in NUREG/CR-5512 building occupancy scenario.

Table A-4
NIST Boulder Campus
RESRAD-Build Dose Assessment
Area Factor Calculations Building Occupancy Scenario

		89.3 m^2	**Source Area (m^2)**						
Radio nuclide	**Filename**	**Base Case**	**100**	**36**	**25**	**16**	**9**	**4**	**1**
		Dose Rate (mrem/year)							
Am-241	NIST Am241.BLD	38.60	NA	19.40	15.50	12.20	9.67	7.87	6.79
Pu-238	NIST Pu238.BLD	38.50	NA	19.40	15.40	12.20	9.64	7.85	6.77
Pu-239	NIST Pu239.BLD	38.70	NA	19.50	15.50	12.20	9.70	7.91	6.82
Pu-240	NIST Pu240.BLD	38.70	NA	19.50	15.50	12.20	9.70	7.90	6.82
Pu-241	NIST Pu241.BLD	37.90	NA	19.10	15.30	12.10	9.62	7.86	6.81
		Area Factors							
Am-241	NIST Am241.BLD		NA	1.99	2.49	3.16	3.99	4.90	5.68
Pu-238	NIST Pu238.BLD		NA	1.98	2.50	3.16	3.99	4.90	5.69
Pu-239	NIST Pu239.BLD		NA	1.98	2.50	3.17	3.99	4.89	5.67
Pu-240	NIST Pu240.BLD		NA	1.98	2.50	3.17	3.99	4.90	5.67
Pu-241	NIST Pu241.BLD		NA	1.98	2.48	3.13	3.94	4.82	5.57

The RESRAD-Build Case Reports to support the table above are provided on the pages that follow.

RESRAD-Build Am-241 Base Case Report

Title: Am-241 89.3 m2

Input File: C:\RESRAD_Family\BUILD\NIST Am241\NIST Am241 89m2.bld

RESRAD-BUILD Input Parameters

Number of Sources: 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	4.250	5.250	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10: 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00[m] Geometry:: Type: Area Length[m]:8.50E+00 Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/(dpm/m3)]
AM-241	3.580E+04	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00 [m] Geometry:: Type: Area Length[m]:8.50E+00 Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
3.580E+04 NP-237 0.000E+00 U-233
0.000E+00 TH-229 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

13.86E+01 3.86E+013.86E+01 3.86E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	9.11E-03	3.26E-04	1.03E-06	3.15E+01	0.00E+00	7.11E+00
Total	9.11E-03	3.26E-04	1.03E-06	3.15E+01	0.00E+00	7.11E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide	Receptor	Total					
1	AM-241	3.86E+01	3.86E+01	NP-237	7.07E-06	7.07E-06	U-233 2.23E-12 2.23E-12 TH-229 8.21E-16 8.21E-16

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00 [m] Geometry:: Type: Area Length[m]:8.50E+00 Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
1.787E+04 NP-237 5.793E-03 U-233
1.263E-08 TH-229 3.976E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

16.06E-03 6.06E-036.06E-03 6.06E-03

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	6.06E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	6.06E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
AM-241	6.06E-03	6.06E-03
NP-237	1.72E-08	1.72E-08
U-233	3.47E-16	3.47E-16
TH-229	4.22E-18	4.22E-18

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	3.86E+01	6.06E-03

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

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	3.87E+01	6.07E-03

RESRAD-Build Am-241 36 m^2 Report

Title : Am-241 36 m2
Input File : C:\RESRAD_Family\BUILD\NIST Am241\NIST Am241 36m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	3.000	3.000	3.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00[m] Geometry:: Type: Area Length[m]:6.00E+00
Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
AM-241	3.580E+04	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:6.00E+00
Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
3.580E+04 NP-237 0.000E+00 U-233
0.000E+00 TH-229 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.94E+01 1.94E+011.94E+01 1.94E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.19E-03	2.47E-04	4.17E-07	1.27E+01	0.00E+00	6.71E+00
Total	2.19E-03	2.47E-04	4.17E-07	1.27E+01	0.00E+00	6.71E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide	Receptor	Total
1 AM-241	1.94E+01	1.94E+01
NP-237	3.36E-06	3.36E-06
U-233	9.37E-13	9.37E-13
TH-229	3.40E-16	3.40E-16

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:6.00E+00 Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
1.787E+04 NP-237 5.793E-03 U-233
1.263E-08 TH-229 3.976E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.46E-03 1.46E-031.46E-03 1.46E-03

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.46E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.46E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
AM-241	1.46E-03	1.46E-03
NP-237	4.18E-09	4.18E-09
U-233	7.57E-17	7.57E-17
TH-229	1.02E-18	1.02E-18

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.94E+01	1.46E-03

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.94E+01	1.46E-03

RESRAD-Build Am-241 25 m^2 Report

Title : Am-241 25 m2

Input File : C:\RESRAD_Family\BUILD\NIST Am241\NIST Am241 25m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days

Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	2.500	2.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00[m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
AM-241	3.580E+04	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
3.580E+04 NP-237 0.000E+00 U-233
0.000E+00 TH-229 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.55E+01 1.55E+011.55E+01 1.55E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	6.01E-03	2.15E-04	2.90E-07	8.83E+00	0.00E+00	6.62E+00
Total	6.01E-03	2.15E-04	2.90E-07	8.83E+00	0.00E+00	6.62E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide	Receptor	Total
1 AM-241	1.55E+01	1.55E+01
NP-237	2.59E-06	2.59E-06
U-233	6.69E-13	6.69E-13
TH-229	2.41E-16	2.41E-16

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
1.787E+04 NP-237 5.793E-03 U-233
1.263E-08 TH-229 3.976E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

14.00E-03 4.00E-034.00E-03 4.00E-03

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	4.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	4.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
AM-241	4.00E-03	4.00E-03
NP-237	1.12E-08	1.12E-08
U-233	2.48E-16	2.48E-16
TH-229	2.74E-18	2.74E-18

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]
	0.00E+00 1.00E+00
1	1.55E+01 4.00E-03

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

	Evaluation Time [yr]
	0.00E+00 1.00E+00
1	1.55E+01 4.00E-03

RESRAD-Build Am-241 16 m^2 Report

Title : Am-241 16 m2

Input File : C:\RESRAD_Family\BUILD\NIST Am241\NIST Am241 16m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	2.000	2.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00[m] Geometry:: Type: Area Length[m]:4.00E+00 Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
AM-241	3.580E+04	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:4.00E+00 Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
3.580E+04 NP-237 0.000E+00 U-233
0.000E+00 TH-229 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.22E+01 1.22E+011.22E+01 1.22E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	4.97E-03	1.78E-04	1.85E-07	5.65E+00	0.00E+00	6.55E+00
Total	4.97E-03	1.78E-04	1.85E-07	5.65E+00	0.00E+00	6.55E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide	Receptor	Total
1 AM-241	1.22E+01	1.22E+01
NP-237	1.96E-06	1.96E-06
U-233	4.50E-13	4.50E-13
TH-229	1.60E-16	1.60E-16

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:4.00E+00 Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
1.787E+04 NP-237 5.793E-03 U-233
1.263E-08 TH-229 3.976E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

13.31E-03 3.31E-033.31E-03 3.31E-03

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.31E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	3.31E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
AM-241	3.31E-03	3.31E-03
NP-237	9.27E-09	9.27E-09
U-233	2.09E-16	2.09E-16
TH-229	2.26E-18	2.26E-18

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.22E+01	3.31E-03

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.22E+01	3.31E-03

RESRAD-Build Am-241 9 m^2 Report

Title : Am-241 9 m2
Input File : C:\RESRAD_Family\BUILD\NIST Am241\NIST Am241 9m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	1.500	1.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00[m] Geometry:: Type: Area Length[m]:3.00E+00
Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
AM-241	3.580E+04	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:3.00E+00
Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
3.580E+04 NP-237 0.000E+00 U-233
0.000E+00 TH-229 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

19.67E+00 9.67E+009.67E+00 9.67E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.74E-03	1.34E-04	1.04E-07	3.18E+00	0.00E+00	6.49E+00
Total	3.74E-03	1.34E-04	1.04E-07	3.18E+00	0.00E+00	6.49E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide	Receptor	Total							
1	AM-241	9.67E+00	9.67E+00	NP-237	1.48E-06	1.48E-06	U-233	2.79E-13	2.79E-13
TH-229	9.70E-17	9.70E-17							

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:3.00E+00 Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
1.787E+04 NP-237 5.793E-03 U-233
1.263E-08 TH-229 3.976E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

12.49E-03 2.49E-032.49E-03 2.49E-03

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.49E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	2.49E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
AM-241	2.49E-03	2.49E-03
NP-237	6.95E-09	6.95E-09
U-233	1.61E-16	1.61E-16
TH-229	1.69E-18	1.69E-18

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]
	0.00E+00 1.00E+00
1	9.67E+00 2.49E-03

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

	Evaluation Time [yr]
	0.00E+00 1.00E+00
1	9.68E+00 2.49E-03

RESRAD-Build Am-241 4 m^2 Report

Title : Am-241 4 m2
Input File : C:\RESRAD_Family\BUILD\NIST Am241\NIST Am241 4m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	1.000	1.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00[m] Geometry:: Type: Area Length[m]:2.00E+00
Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
AM-241	3.580E+04	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:2.00E+00
Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
3.580E+04 NP-237 0.000E+00 U-233
0.000E+00 TH-229 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

17.87E+00 7.87E+007.87E+00 7.87E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.28E-03	8.16E-05	4.63E-08	1.41E+00	0.00E+00	6.46E+00
Total	2.28E-03	8.16E-05	4.63E-08	1.41E+00	0.00E+00	6.46E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 AM-241 7.87E+00 7.87E+00 NP-237 1.13E-06 1.13E-06 U-233 1.57E-13 1.57E-13 TH-229 5.19E-17 5.19E-17

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:2.00E+00 Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
1.787E+04 NP-237 5.793E-03 U-233
1.263E-08 TH-229 3.976E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.52E-03 1.52E-031.52E-03 1.52E-03

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.52E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.52E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
AM-241	1.52E-03	1.52E-03
NP-237	4.23E-09	4.23E-09
U-233	1.00E-16	1.00E-16
TH-229	1.03E-18	1.03E-18

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	7.87E+00	1.52E-03

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	7.88E+00	1.52E-03

RESRAD-Build Am-241 1 m^2 Report

Title : Am-241 1 m2
Input File : C:\RESRAD_Family\BUILD\NIST Am241\NIST Am241 1m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	0.500	0.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************

Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s] Source Information
Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00[m] Geometry:: Type: Area Length[m]:1.00E+00
Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
AM-241	3.580E+04	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:1.00E+00
Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
3.580E+04 NP-237 0.000E+00 U-233
0.000E+00 TH-229 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

16.79E+00 6.79E+006.79E+00 6.79E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	7.74E-04	2.77E-05	1.16E-08	3.53E-01	0.00E+00	6.43E+00
Total	7.74E-04	2.77E-05	1.16E-08	3.53E-01	0.00E+00	6.43E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 AM-241 6.79E+00 6.79E+00 NP-237 9.17E-07 9.17E-07 U-233 8.43E-14 8.43E-14 TH-229 2.48E-17 2.48E-17

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:1.00E+00 Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] AM-241
1.787E+04 NP-237 5.793E-03 U-233
1.263E-08 TH-229 3.976E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

15.15E-04 5.15E-045.15E-04 5.15E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	5.15E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	5.15E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
AM-241	5.15E-04	5.15E-04
NP-237	1.43E-09	1.43E-09
U-233	3.46E-17	3.46E-17
TH-229	3.47E-19	3.47E-19

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	6.79E+00	5.15E-04

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	6.79E+00	5.15E-04

RESRAD-Build Pu-240 Default Case Report

Title : Pu-240 89.3 m2

Input File : C:\RESRAD_Family\BUILD\NIST Pu240\NIST Pu240 89m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days

Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	4.250	5.250	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 * Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00[m] Geometry:: Type: Area Length[m]:8.50E+00 Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-240	3.700E+04	1.595E-03	1.932E-01	2.499E-07
U-236	0.000E+00	1.212E-04	5.631E-02	2.636E-07
TH-232	0.000E+00	1.230E-03	7.387E-01	4.588E-07
TH-228	0.000E+00	3.642E-04	1.556E-01	4.224E-03
RA-228	0.000E+00	6.496E-04	2.287E-03	2.515E-03

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00 [m] Geometry:: Type: Area Length[m]:8.50E+00 Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
3.700E+04 U-236 0.000E+00 TH-232
0.000E+00 TH-228 0.000E+00 RA-228
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

13.87E+01 3.87E+013.87E+01 3.87E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	4.92E-04	1.76E-05	6.21E-09	3.15E+01	1.93E-22	7.15E+00
Total	4.92E-04	1.76E-05	6.21E-09	3.15E+01	1.93E-22	7.15E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-240 3.87E+01 3.87E+01 U-236 1.39E-07 1.39E-07 TH-232 2.87E-17 2.87E-17

RA-228 TH-228 1.02E-20 1.02E-20

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00 [m] Geometry:: Type: Area Length[m]:8.50E+00 Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
1.850E+04 U-236 5.480E-04 TH-232
1.347E-14 TH-228 4.465E-17 RA-228
5.253E-16

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

13.28E-04 3.28E-043.28E-04 3.28E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.28E-04	0.00E+00	0.00E+00	0.00E+00	4.73E-21	0.00E+00
Total	3.28E-04	0.00E+00	0.00E+00	0.00E+00	4.73E-21	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-240	3.28E-04	3.28E-04
U-236	1.14E-11	1.14E-11
TH-232	3.10E-22	3.10E-22
RA-228		
TH-228	7.71E-21	7.71E-21

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	3.87E+01	3.28E-04

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	3.87E+01	3.28E-04

RESRAD-Build Pu-240 36 m^2 Report

Title : Pu-240 36 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu240\NIST Pu240 36m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	3.000	3.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *
* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************
Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s] Source Information
Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00[m] Geometry:: Type: Area Length[m]:6.00E+00
Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-240	3.700E+04	1.595E-03	1.932E-01	2.499E-07
U-236	0.000E+00	1.212E-04	5.631E-02	2.636E-07
TH-232	0.000E+00	1.230E-03	7.387E-01	4.588E-07
TH-228	0.000E+00	3.642E-04	1.556E-01	4.224E-03
RA-228	0.000E+00	6.496E-04	2.287E-03	2.515E-03

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:6.00E+00 Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
3.700E+04 U-236 0.000E+00 TH-232
0.000E+00 TH-228 0.000E+00 RA-228
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.95E+01 1.95E+011.95E+01 1.95E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	4.02E-04	1.44E-05	2.51E-09	1.27E+01	7.77E-23	6.75E+00
Total	4.02E-04	1.44E-05	2.51E-09	1.27E+01	7.77E-23	6.75E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-240 1.95E+01 1.95E+01 U-236 5.89E-08 5.89E-08 TH-232 1.19E-17 1.19E-17

RA-228 TH-228 4.28E-21 4.28E-21

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:6.00E+00 Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
1.850E+04 U-236 5.480E-04 TH-232
1.347E-14 TH-228 4.465E-17 RA-228
5.253E-16

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

12.68E-04 2.68E-042.68E-04 2.68E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.68E-04	0.00E+00	0.00E+00	0.00E+00	1.91E-21	0.00E+00
Total	2.68E-04	0.00E+00	0.00E+00	0.00E+00	1.91E-21	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-240	2.68E-04	2.68E-04
U-236	9.34E-12	9.34E-12
TH-232	2.55E-22	2.55E-22
RA-228		
TH-228	4.15E-21	4.15E-21

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.95E+01	2.68E-04

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.95E+01	2.68E-04

RESRAD-Build Pu-240 25 m^2 Report

Title : Pu-240 25 m2

Input File : C:\RESRAD_Family\BUILD\NIST Pu240\NIST Pu240 25m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days

Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	2.500	2.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00[m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-240	3.700E+04	1.595E-03	1.932E-01	2.499E-07
U-236	0.000E+00	1.212E-04	5.631E-02	2.636E-07
TH-232	0.000E+00	1.230E-03	7.387E-01	4.588E-07
TH-228	0.000E+00	3.642E-04	1.556E-01	4.224E-03
RA-228	0.000E+00	6.496E-04	2.287E-03	2.515E-03

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
3.700E+04 U-236 0.000E+00 TH-232
0.000E+00 TH-228 0.000E+00 RA-228
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.55E+01 1.55E+011.55E+01 1.55E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.59E-04	1.28E-05	1.74E-09	8.83E+00	5.40E-23	6.65E+00
Total	3.59E-04	1.28E-05	1.74E-09	8.83E+00	5.40E-23	6.65E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-240 1.55E+01 1.55E+01 U-236 4.24E-08 4.24E-08 TH-232 8.48E-18 8.48E-18
RA-228 TH-228 3.07E-21 3.07E-21

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
1.850E+04 U-236 5.480E-04 TH-232
1.347E-14 TH-228 4.465E-17 RA-228
5.253E-16

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

12.39E-04 2.39E-042.39E-04 2.39E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.39E-04	0.00E+00	0.00E+00	0.00E+00	1.32E-21	0.00E+00
Total	2.39E-04	0.00E+00	0.00E+00	0.00E+00	1.32E-21	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-240	2.39E-04	2.39E-04
U-236	8.35E-12	8.35E-12
TH-232	2.29E-22	2.29E-22
RA-228		
TH-228	3.27E-21	3.27E-21

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.55E+01	2.39E-04

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.55E+01	2.39E-04

RESRAD-Build Pu-240 16 m^2 Report

Title : Pu-240 16 m2

Input File : C:\RESRAD_Family\BUILD\NIST Pu240\NIST Pu240 16m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days

Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	2.000	2.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00[m] Geometry:: Type: Area Length[m]:4.00E+00 Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-240	3.700E+04	1.595E-03	1.932E-01	2.499E-07
U-236	0.000E+00	1.212E-04	5.631E-02	2.636E-07
TH-232	0.000E+00	1.230E-03	7.387E-01	4.588E-07
TH-228	0.000E+00	3.642E-04	1.556E-01	4.224E-03
RA-228	0.000E+00	6.496E-04	2.287E-03	2.515E-03

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:4.00E+00 Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
3.700E+04 U-236 0.000E+00 TH-232
0.000E+00 TH-228 0.000E+00 RA-228
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.22E+01 1.22E+011.22E+01 1.22E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.04E-04	1.09E-05	1.11E-09	5.65E+00	3.45E-23	6.58E+00
Total	3.04E-04	1.09E-05	1.11E-09	5.65E+00	3.45E-23	6.58E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-240 1.22E+01 1.22E+01 U-236 2.89E-08 2.89E-08 TH-232 5.64E-18 5.64E-18
RA-228 TH-228 2.06E-21 2.06E-21

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:4.00E+00 Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
1.850E+04 U-236 5.480E-04 TH-232
1.347E-14 TH-228 4.465E-17 RA-228
5.253E-16

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

12.03E-04 2.03E-042.03E-04 2.03E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.03E-04	0.00E+00	0.00E+00	0.00E+00	8.48E-22	0.00E+00
Total	2.03E-04	0.00E+00	0.00E+00	0.00E+00	8.48E-22	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-240	2.03E-04	2.03E-04
U-236	7.11E-12	7.11E-12
TH-232	1.96E-22	1.96E-22
RA-228		
TH-228	2.45E-21	2.45E-21

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.22E+01	2.03E-04

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.22E+01	2.03E-04

RESRAD-Build Pu-240 9 m^2 Report

Title : Pu-240 9 m2

Input File : C:\RESRAD_Family\BUILD\NIST Pu240\NIST Pu240 9m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	1.500	1.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00[m] Geometry:: Type: Area Length[m]:3.00E+00 Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-240	3.700E+04	1.595E-03	1.932E-01	2.499E-07
U-236	0.000E+00	1.212E-04	5.631E-02	2.636E-07
TH-232	0.000E+00	1.230E-03	7.387E-01	4.588E-07
TH-228	0.000E+00	3.642E-04	1.556E-01	4.224E-03
RA-228	0.000E+00	6.496E-04	2.287E-03	2.515E-03

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:3.00E+00 Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
3.700E+04 U-236 0.000E+00 TH-232
0.000E+00 TH-228 0.000E+00 RA-228
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

19.70E+00 9.70E+009.70E+00 9.70E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.34E-04	8.40E-06	6.27E-10	3.18E+00	1.94E-23	6.52E+00
Total	2.34E-04	8.40E-06	6.27E-10	3.18E+00	1.94E-23	6.52E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-240 9.70E+00 9.70E+00 U-236 1.83E-08 1.83E-08 TH-232 3.44E-18 3.44E-18

RA-228 TH-228 1.28E-21 1.28E-21

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:3.00E+00 Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
1.850E+04 U-236 5.480E-04 TH-232
1.347E-14 TH-228 4.465E-17 RA-228
5.253E-16

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.56E-04 1.56E-041.56E-04 1.56E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.56E-04	0.00E+00	0.00E+00	0.00E+00	4.77E-22	0.00E+00
Total	1.56E-04	0.00E+00	0.00E+00	0.00E+00	4.77E-22	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-240	1.56E-04	1.56E-04
U-236	5.50E-12	5.50E-12
TH-232	1.52E-22	1.52E-22
RA-228		
TH-228	1.67E-21	1.67E-21

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	9.70E+00	1.56E-04

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	9.71E+00	1.56E-04

RESRAD-Build Pu-240 4 m^2 Report

Title : Pu-240 4 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu240\NIST Pu240 4m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	1.000	1.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *
* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************

Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s] Source Information
Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00[m] Geometry:: Type: Area Length[m]:2.00E+00 Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-240	3.700E+04	1.595E-03	1.932E-01	2.499E-07
U-236	0.000E+00	1.212E-04	5.631E-02	2.636E-07
TH-232	0.000E+00	1.230E-03	7.387E-01	4.588E-07
TH-228	0.000E+00	3.642E-04	1.556E-01	4.224E-03
RA-228	0.000E+00	6.496E-04	2.287E-03	2.515E-03

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:2.00E+00 Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
3.700E+04 U-236 0.000E+00 TH-232
0.000E+00 TH-228 0.000E+00 RA-228
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

17.90E+00 7.90E+007.90E+00 7.90E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.47E-04	5.26E-06	2.79E-10	1.41E+00	8.64E-24	6.49E+00
Total	1.47E-04	5.26E-06	2.79E-10	1.41E+00	8.64E-24	6.49E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-240 7.90E+00 7.90E+00 U-236 1.08E-08 1.08E-08 TH-232 1.86E-18 1.86E-18
RA-228 TH-228 7.12E-22 7.12E-22

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:2.00E+00 Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
1.850E+04 U-236 5.480E-04 TH-232
1.347E-14 TH-228 4.465E-17 RA-228
5.253E-16

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

19.78E-05 9.78E-059.78E-05 9.78E-05

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	9.78E-05	0.00E+00	0.00E+00	0.00E+00	2.12E-22	0.00E+00
Total	9.78E-05	0.00E+00	0.00E+00	0.00E+00	2.12E-22	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-240	9.78E-05	9.78E-05
U-236	3.45E-12	3.45E-12
TH-232	9.59E-23	9.59E-23
RA-228		
TH-228	9.39E-22	9.39E-22

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	7.90E+00	9.78E-05

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	7.91E+00	9.79E-05

RESRAD-Build Pu-240 1 m^2 Report

Title : Pu-240 1 m2

Input File : C:\RESRAD_Family\BUILD\NIST Pu240\NIST Pu240 1m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	0.500	0.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00[m] Geometry:: Type: Area Length[m]:1.00E+00 Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-240	3.700E+04	1.595E-03	1.932E-01	2.499E-07
U-236	0.000E+00	1.212E-04	5.631E-02	2.636E-07
TH-232	0.000E+00	1.230E-03	7.387E-01	4.588E-07
TH-228	0.000E+00	3.642E-04	1.556E-01	4.224E-03
RA-228	0.000E+00	6.496E-04	2.287E-03	2.515E-03

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:1.00E+00 Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
3.700E+04 U-236 0.000E+00 TH-232
0.000E+00 TH-228 0.000E+00 RA-228
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

16.82E+00 6.82E+006.82E+00 6.82E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	5.08E-05	1.82E-06	6.96E-11	3.53E-01	2.16E-24	6.47E+00
Total	5.08E-05	1.82E-06	6.96E-11	3.53E-01	2.16E-24	6.47E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-240 6.82E+00 6.82E+00 U-236 6.34E-09 6.34E-09 TH-232 9.19E-19 9.19E-19 RA-228 TH-228 3.63E-22 3.63E-22

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:1.00E+00 Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-240
1.850E+04 U-236 5.480E-04 TH-232
1.347E-14 TH-228 4.465E-17 RA-228
5.253E-16

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

13.39E-05 3.39E-053.39E-05 3.39E-05

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.39E-05	0.00E+00	0.00E+00	0.00E+00	5.30E-23	0.00E+00
Total	3.39E-05	0.00E+00	0.00E+00	0.00E+00	5.30E-23	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-240	3.39E-05	3.39E-05
U-236	1.20E-12	1.20E-12
TH-232	3.35E-23	3.35E-23
RA-228		
TH-228	2.99E-22	2.99E-22

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	6.82E+00	3.39E-05

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	6.83E+00	3.39E-05

RESRAD-Build Pu-241 Default Case Report

Title : Pu-241 89.3 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu241\NIST Pu241 89m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	4.250	5.250	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *
* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************
Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s] Source Information
Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00[m] Geometry:: Type: Area Length[m]:8.50E+00
Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-241	1.890E+06	3.081E-05	3.716E-03	1.151E-08
AM-241	0.000E+00	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00 [m] Geometry:: Type: Area Length[m]:8.50E+00
Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
1.890E+06 AM-241 0.000E+00 NP-237
0.000E+00 U-233 0.000E+00 TH-229
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

13.79E+01 3.79E+013.79E+01 3.79E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	4.07E-04	1.57E-05	5.61E-08	3.08E+01	0.00E+00	7.13E+00
Total	4.07E-04	1.57E-05	5.61E-08	3.08E+01	0.00E+00	7.13E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-241 3.64E+01 3.64E+01 AM-241 1.49E+00 1.49E+00 NP-237 1.88E-07 1.88E-07 U-233 4.56E-14 4.56E-14 TH-229 1.34E-17 1.34E-17

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00 [m] Geometry:: Type: Area Length[m]:8.50E+00 Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
9.006E+05 AM-241 1.479E+03 NP-237
2.415E-04 U-233 3.524E-10 TH-229
8.341E-15

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

17.87E-04 7.87E-047.87E-04 7.87E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	7.87E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	7.87E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-241	4.38E-05	4.38E-05
AM-241	7.43E-04	7.43E-04
NP-237	1.11E-09	1.11E-09
U-233	1.54E-17	1.54E-17
TH-229	1.45E-19	1.45E-19

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]
	0.00E+00 1.00E+00
1	3.79E+01 7.87E-04

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

	Evaluation Time [yr]
	0.00E+00 1.00E+00
1	3.79E+01 7.87E-04

RESRAD-Build Pu-241 36 m^2 Report

Title : Pu-241 36 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu241\NIST Pu241 36m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	3.000	3.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00[m] Geometry:: Type: Area Length[m]:6.00E+00
Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-241	1.890E+06	3.081E-05	3.716E-03	1.151E-08
AM-241	0.000E+00	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:6.00E+00
Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
1.890E+06 AM-241 0.000E+00 NP-237
0.000E+00 U-233 0.000E+00 TH-229
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.91E+01 1.91E+011.91E+01 1.91E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.08E-04	1.19E-05	2.26E-08	1.24E+01	0.00E+00	6.73E+00
Total	3.08E-04	1.19E-05	2.26E-08	1.24E+01	0.00E+00	6.73E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-241 1.84E+01 1.84E+01 AM-241 7.10E-01 7.10E-01 NP-237 8.63E-08 8.63E-08 U-233 1.90E-14 1.90E-14 TH-229 5.56E-18 5.56E-18

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:6.00E+00 Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
9.006E+05 AM-241 1.479E+03 NP-237
2.415E-04 U-233 3.524E-10 TH-229
8.341E-15

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

15.96E-04 5.96E-045.96E-04 5.96E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	5.96E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	5.96E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-241	3.32E-05	3.32E-05
AM-241	5.63E-04	5.63E-04
NP-237	8.32E-10	8.32E-10
U-233	1.24E-17	1.24E-17
TH-229	1.09E-19	1.09E-19

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	1.91E+01	5.96E-04

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

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	1.92E+01	5.96E-04

RESRAD-Build Pu-241 25 m^2 Report

Title : Pu-241 25 m2

Input File : C:\RESRAD_Family\BUILD\NIST Pu241\NIST Pu241 25m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days

Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	2.500	2.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00[m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-241	1.890E+06	3.081E-05	3.716E-03	1.151E-08
AM-241	0.000E+00	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
1.890E+06 AM-241 0.000E+00 NP-237
0.000E+00 U-233 0.000E+00 TH-229
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.53E+01 1.53E+011.53E+01 1.53E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.68E-04	1.04E-05	1.57E-08	8.62E+00	0.00E+00	6.64E+00
Total	2.68E-04	1.04E-05	1.57E-08	8.62E+00	0.00E+00	6.64E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-241 1.47E+01 1.47E+01 AM-241 5.48E-01 5.48E-01 NP-237 6.54E-08 6.54E-08 U-233 1.35E-14 1.35E-14 TH-229 3.93E-18 3.93E-18

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
9.006E+05 AM-241 1.479E+03 NP-237
2.415E-04 U-233 3.524E-10 TH-229
8.341E-15

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

15.19E-04 5.19E-045.19E-04 5.19E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	5.19E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	5.19E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-241	2.89E-05	2.89E-05
AM-241	4.90E-04	4.90E-04
NP-237	7.22E-10	7.22E-10
U-233	1.10E-17	1.10E-17
TH-229	9.45E-20	9.45E-20

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]
0.00E+00	1.00E+00
1 1.53E+01	5.19E-04

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

	Evaluation Time [yr]
0.00E+00	1.00E+00
1 1.53E+01	5.19E-04

RESRAD-Build Pu-241 16 m^2 Report

Title : Pu-241 16 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu241\NIST Pu241 16m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	2.000	2.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *
* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************
Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s] Source Information
Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00[m] Geometry:: Type: Area Length[m]:4.00E+00
Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-241	1.890E+06	3.081E-05	3.716E-03	1.151E-08
AM-241	0.000E+00	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:4.00E+00
Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
1.890E+06 AM-241 0.000E+00 NP-237
0.000E+00 U-233 0.000E+00 TH-229
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.21E+01 1.21E+011.21E+01 1.21E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.22E-04	8.57E-06	1.01E-08	5.52E+00	0.00E+00	6.58E+00
Total	2.22E-04	8.57E-06	1.01E-08	5.52E+00	0.00E+00	6.58E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-241 1.17E+01 1.17E+01 AM-241 4.15E-01 4.15E-01 NP-237 4.83E-08 4.83E-08 U-233 9.00E-15 9.00E-15 TH-229 2.59E-18 2.59E-18

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:4.00E+00 Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
9.006E+05 AM-241 1.479E+03 NP-237
2.415E-04 U-233 3.524E-10 TH-229
8.341E-15

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

14.29E-04 4.29E-044.29E-04 4.29E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	4.29E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	4.29E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-241	2.39E-05	2.39E-05
AM-241	4.05E-04	4.05E-04
NP-237	5.96E-10	5.96E-10
U-233	9.32E-18	9.32E-18
TH-229	7.78E-20	7.78E-20

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	1.21E+01	4.29E-04

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

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	1.21E+01	4.29E-04

RESRAD-Build Pu-241 9 m^2 Report

Title : Pu-241 9 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu241\NIST Pu241 9m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	1.500	1.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *
* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************
Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s] Source Information
Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00[m] Geometry:: Type: Area Length[m]:3.00E+00
Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-241	1.890E+06	3.081E-05	3.716E-03	1.151E-08
AM-241	0.000E+00	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:3.00E+00
Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
1.890E+06 AM-241 0.000E+00 NP-237
0.000E+00 U-233 0.000E+00 TH-229
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

19.62E+00 9.62E+009.62E+00 9.62E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.67E-04	6.44E-06	5.66E-09	3.10E+00	0.00E+00	6.52E+00
Total	1.67E-04	6.44E-06	5.66E-09	3.10E+00	0.00E+00	6.52E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-241 9.31E+00 9.31E+00 AM-241 3.12E-01 3.12E-01 NP-237 3.49E-08 3.49E-08 U-233 5.50E-15 5.50E-15 TH-229 1.56E-18 1.56E-18

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:3.00E+00 Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
9.006E+05 AM-241 1.479E+03 NP-237
2.415E-04 U-233 3.524E-10 TH-229
8.341E-15

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

13.23E-04 3.23E-043.23E-04 3.23E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.23E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	3.23E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-241	1.79E-05	1.79E-05
AM-241	3.05E-04	3.05E-04
NP-237	4.46E-10	4.46E-10
U-233	7.15E-18	7.15E-18
TH-229	5.83E-20	5.83E-20

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	9.62E+00	3.23E-04

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

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	9.63E+00	3.23E-04

RESRAD-Build Pu-241 4 m^2 Report

Title : Pu-241 4 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu241\NIST Pu241 4m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	1.000	1.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00[m] Geometry:: Type: Area Length[m]:2.00E+00
Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-241	1.890E+06	3.081E-05	3.716E-03	1.151E-08
AM-241	0.000E+00	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:2.00E+00
Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
1.890E+06 AM-241 0.000E+00 NP-237
0.000E+00 U-233 0.000E+00 TH-229
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

17.86E+00 7.86E+007.86E+00 7.86E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.02E-04	3.93E-06	2.51E-09	1.38E+00	0.00E+00	6.48E+00
Total	1.02E-04	3.93E-06	2.51E-09	1.38E+00	0.00E+00	6.48E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-241 7.63E+00 7.63E+00 AM-241 2.38E-01 2.38E-01 NP-237 2.54E-08 2.54E-08 U-233 3.00E-15 3.00E-15 TH-229 8.15E-19 8.15E-19

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:2.00E+00 Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
9.006E+05 AM-241 1.479E+03 NP-237
2.415E-04 U-233 3.524E-10 TH-229
8.341E-15

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.97E-04 1.97E-041.97E-04 1.97E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.97E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.97E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-241	1.10E-05	1.10E-05
AM-241	1.86E-04	1.86E-04
NP-237	2.72E-10	2.72E-10
U-233	4.46E-18	4.46E-18
TH-229	3.54E-20	3.54E-20

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]
	0.00E+00 1.00E+00
1	7.86E+00 1.97E-04

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

	Evaluation Time [yr]
	0.00E+00 1.00E+00
1	7.87E+00 1.97E-04

RESRAD-Build Pu-241 1 m^2 Report

Title : Pu-241 1 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu241\NIST Pu241 1m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	0.500	0.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *
* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************
Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s] Source Information
Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00[m] Geometry:: Type: Area Length[m]:1.00E+00
Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-241	1.890E+06	3.081E-05	3.716E-03	1.151E-08
AM-241	0.000E+00	1.640E-03	2.000E-01	4.304E-05
NP-237	0.000E+00	2.002E-03	2.432E-01	5.461E-04
U-233	0.000E+00	1.302E-04	6.081E-02	8.576E-07
TH-229	0.000E+00	1.814E-03	9.768E-01	7.842E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:1.00E+00
Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
1.890E+06 AM-241 0.000E+00 NP-237
0.000E+00 U-233 0.000E+00 TH-229
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

16.81E+00 6.81E+006.81E+00 6.81E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.45E-05	1.33E-06	6.29E-10	3.45E-01	0.00E+00	6.46E+00
Total	3.45E-05	1.33E-06	6.29E-10	3.45E-01	0.00E+00	6.46E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide	Receptor	Total					
	1	PU-241	6.61E+00	6.61E+00	AM-241	1.94E-01	1.94E-01
NP-237	1.97E-08	1.97E-08	U-233	1.51E-15	1.51E-15	TH-229	3.69E-19	3.69E-19

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:1.00E+00 Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-241
9.006E+05 AM-241 1.479E+03 NP-237
2.415E-04 U-233 3.524E-10 TH-229
8.341E-15

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

16.68E-05 6.68E-056.68E-05 6.68E-05

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	6.68E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	6.68E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-241	3.72E-06	3.72E-06
AM-241	6.31E-05	6.31E-05
NP-237	9.18E-11	9.18E-11
U-233	1.54E-18	1.54E-18
TH-229	1.20E-20	1.20E-20

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	6.81E+00	6.68E-05

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

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	6.81E+00	6.68E-05

RESRAD-Build Pu-238 Base Case Report

Title : Pu-238 89.3 m2

Input File : C:\RESRAD_Family\BUILD\NIST Pu238\NIST Pu238 89m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	4.250	5.250	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00[m] Geometry:: Type: Area Length[m]:8.50E+00 Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-238	4.070E+04	1.441E-03	1.766E-01	2.567E-07
U-234	0.000E+00	1.275E-04	5.946E-02	4.014E-07
TH-230	0.000E+00	2.468E-04	1.468E-01	9.155E-07
RA-226	0.000E+00	5.950E-04	3.871E-03	4.663E-03
PB-210	0.000E+00	2.422E-03	6.214E-03	4.698E-06

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00 [m] Geometry:: Type: Area Length[m]:8.50E+00 Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
4.070E+04 U-234 0.000E+00 TH-230
0.000E+00 RA-226 0.000E+00 PB-210
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

13.85E+01 3.85E+013.85E+01 3.85E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	5.57E-04	1.98E-05	6.97E-09	3.14E+01	1.22E-17	7.09E+00
Total	5.57E-04	1.98E-05	6.97E-09	3.14E+01	1.22E-17	7.09E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-238 3.85E+01 3.85E+01 U-234 1.54E-05 1.54E-05 TH-230 1.10E-10 1.10E-10 RA-226 1.08E-15 1.08E-15 PB-210 1.60E-17 1.60E-17

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00 [m] Geometry:: Type: Area Length[m]:8.50E+00 Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
2.019E+04 U-234 5.735E-02 TH-230
2.585E-07 RA-226 3.734E-11 PB-210
2.885E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

13.68E-04 3.68E-043.68E-04 3.68E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.68E-04	0.00E+00	0.00E+00	0.00E+00	1.52E-16	0.00E+00
Total	3.68E-04	0.00E+00	0.00E+00	0.00E+00	1.52E-16	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-238	3.68E-04	3.68E-04
U-234	1.29E-09	1.29E-09
TH-230	6.87E-15	6.87E-15
RA-226	2.08E-15	2.08E-15
PB-210	9.01E-20	9.01E-20

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	3.85E+01	3.68E-04

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	3.86E+01	3.68E-04

RESRAD-Build Pu-238 36 m^2 Report

Title : Pu-238 36 m2

Input File : C:\RESRAD_Family\BUILD\NIST Pu238\NIST Pu238 36m2.bld

RESRAD-BUILD Input Parameters

Number of Sources: 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	3.000	3.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00[m] Geometry:: Type: Area Length[m]:6.00E+00 Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-238	4.070E+04	1.441E-03	1.766E-01	2.567E-07
U-234	0.000E+00	1.275E-04	5.946E-02	4.014E-07
TH-230	0.000E+00	2.468E-04	1.468E-01	9.155E-07
RA-226	0.000E+00	5.950E-04	3.871E-03	4.663E-03
PB-210	0.000E+00	2.422E-03	6.214E-03	4.698E-06

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:6.00E+00 Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
4.070E+04 U-234 0.000E+00 TH-230
0.000E+00 RA-226 0.000E+00 PB-210
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.94E+01 1.94E+011.94E+01 1.94E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	4.55E-04	1.62E-05	2.81E-09	1.27E+01	4.92E-18	6.69E+00
Total	4.55E-04	1.62E-05	2.81E-09	1.27E+01	4.92E-18	6.69E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-238 1.94E+01 1.94E+01 U-234 6.51E-06 6.51E-06 TH-230 4.56E-11 4.56E-11 RA-226 7.81E-16 7.81E-16 PB-210 1.25E-17 1.25E-17

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:6.00E+00 Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
2.019E+04 U-234 5.735E-02 TH-230
2.585E-07 RA-226 3.734E-11 PB-210
2.885E-13

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

13.01E-04 3.01E-043.01E-04 3.01E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.01E-04	0.00E+00	0.00E+00	0.00E+00	6.15E-17	0.00E+00
Total	3.01E-04	0.00E+00	0.00E+00	0.00E+00	6.15E-17	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-238	3.01E-04	3.01E-04
U-234	1.05E-09	1.05E-09
TH-230	5.56E-15	5.56E-15
RA-226	1.51E-15	1.51E-15
PB-210	7.07E-20	7.07E-20

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	1.94E+01	3.01E-04

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

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	1.94E+01	3.01E-04

RESRAD-Build Pu-238 25 m^2 Report

: Pu-238 25 m2
Title : Pu-238 25 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu238\NIST Pu238 25m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	2.500	2.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00[m] Geometry:: Type: Area Length[m]:5.00E+00
Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide	Concentration [dpm/m2]	Dose Conversion Factor (Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Library: FGR 11) Submersion [mrem/yr/ (dpm/m3)]
PU-238	4.070E+04	1.441E-03	1.766E-01	2.567E-07
U-234	0.000E+00	1.275E-04	5.946E-02	4.014E-07
TH-230	0.000E+00	2.468E-04	1.468E-01	9.155E-07
RA-226	0.000E+00	5.950E-04	3.871E-03	4.663E-03
PB-210	0.000E+00	2.422E-03	6.214E-03	4.698E-06

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
4.070E+04 U-234 0.000E+00 TH-230
0.000E+00 RA-226 0.000E+00 PB-210
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.54E+01 1.54E+011.54E+01 1.54E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	4.06E-04	1.45E-05	1.95E-09	8.81E+00	3.42E-18	6.60E+00
Total	4.06E-04	1.45E-05	1.95E-09	8.81E+00	3.42E-18	6.60E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-238 1.54E+01 1.54E+01 U-234 4.69E-06 4.69E-06 TH-230 3.24E-11 3.24E-11 RA-226 7.12E-16 7.12E-16 PB-210 1.18E-17 1.18E-17

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
2.019E+04 U-234 5.735E-02 TH-230
2.585E-07 RA-226 3.734E-11 PB-210
2.885E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

12.68E-04 2.68E-042.68E-04 2.68E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.68E-04	0.00E+00	0.00E+00	0.00E+00	4.27E-17	0.00E+00
Total	2.68E-04	0.00E+00	0.00E+00	0.00E+00	4.27E-17	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-238	2.68E-04	2.68E-04
U-234	9.41E-10	9.41E-10
TH-230	4.96E-15	4.96E-15
RA-226	1.30E-15	1.30E-15
PB-210	6.26E-20	6.26E-20

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

0.00E+00 1.00E+00

1 1.54E+01 2.68E-04

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

Evaluation Time [yr]

0.00E+00 1.00E+00

1 1.54E+01 2.69E-04

RESRAD-Build Pu-238 16 m^2 Report

Title : Pu-238 16 m2

Input File : C:\RESRAD_Family\BUILD\NIST Pu238\NIST Pu238 16m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days

Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	2.000	2.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00[m] Geometry:: Type: Area Length[m]:4.00E+00 Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide Concentration Dose Conversion Factor (Library: FGR 11)

Nuclide	Concentration [dpm/m2]	Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Submersion [mrem/yr/ (dpm/m3)]
PU-238	4.070E+04	1.441E-03	1.766E-01	2.567E-07
U-234	0.000E+00	1.275E-04	5.946E-02	4.014E-07
TH-230	0.000E+00	2.468E-04	1.468E-01	9.155E-07
RA-226	0.000E+00	5.950E-04	3.871E-03	4.663E-03
PB-210	0.000E+00	2.422E-03	6.214E-03	4.698E-06

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:4.00E+00 Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
4.070E+04 U-234 0.000E+00 TH-230
0.000E+00 RA-226 0.000E+00 PB-210
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.22E+01 1.22E+011.22E+01 1.22E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.44E-04	1.23E-05	1.25E-09	5.64E+00	2.19E-18	6.53E+00
Total	3.44E-04	1.23E-05	1.25E-09	5.64E+00	2.19E-18	6.53E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-238 1.22E+01 1.22E+01 U-234 3.19E-06 3.19E-06 TH-230 2.16E-11 2.16E-11 RA-226 6.50E-16 6.50E-16 PB-210 1.12E-17 1.12E-17

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:4.00E+00 Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
2.019E+04 U-234 5.735E-02 TH-230
2.585E-07 RA-226 3.734E-11 PB-210
2.885E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

12.28E-04 2.28E-042.28E-04 2.28E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.28E-04	0.00E+00	0.00E+00	0.00E+00	2.73E-17	0.00E+00
Total	2.28E-04	0.00E+00	0.00E+00	0.00E+00	2.73E-17	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-238	2.28E-04	2.28E-04
U-234	8.00E-10	8.00E-10
TH-230	4.21E-15	4.21E-15
RA-226	1.06E-15	1.06E-15
PB-210	5.28E-20	5.28E-20

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

0.00E+00 1.00E+00

1 1.22E+01 2.28E-04

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

Evaluation Time [yr]

0.00E+00 1.00E+00

1 1.22E+01 2.28E-04

RESRAD-Build Pu-238 9 m^2 Report

Title : Pu-238 9 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu238\NIST Pu238 9m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	1.500	1.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00[m] Geometry:: Type: Area Length[m]:3.00E+00 Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide Concentration Dose Conversion Factor (Library: FGR 11)

Nuclide	Concentration [dpm/m2]	Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Submersion [mrem/yr/ (dpm/m3)]
PU-238	4.070E+04	1.441E-03	1.766E-01	2.567E-07
U-234	0.000E+00	1.275E-04	5.946E-02	4.014E-07
TH-230	0.000E+00	2.468E-04	1.468E-01	9.155E-07
RA-226	0.000E+00	5.950E-04	3.871E-03	4.663E-03
PB-210	0.000E+00	2.422E-03	6.214E-03	4.698E-06

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:3.00E+00 Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
4.070E+04 U-234 0.000E+00 TH-230
0.000E+00 RA-226 0.000E+00 PB-210
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

19.64E+00 9.64E+009.64E+00 9.64E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.66E-04	9.46E-06	7.02E-10	3.17E+00	1.23E-18	6.47E+00
Total	2.66E-04	9.46E-06	7.02E-10	3.17E+00	1.23E-18	6.47E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-238 9.64E+00 9.64E+00 U-234 2.03E-06 2.03E-06 TH-230 1.31E-11 1.31E-11 RA-226 5.94E-16 5.94E-16 PB-210 1.08E-17 1.08E-17

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:3.00E+00 Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
2.019E+04 U-234 5.735E-02 TH-230
2.585E-07 RA-226 3.734E-11 PB-210
2.885E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.76E-04 1.76E-041.76E-04 1.76E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.76E-04	0.00E+00	0.00E+00	0.00E+00	1.54E-17	0.00E+00
Total	1.76E-04	0.00E+00	0.00E+00	0.00E+00	1.54E-17	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-238	1.76E-04	1.76E-04
U-234	6.18E-10	6.18E-10
TH-230	3.26E-15	3.26E-15
RA-226	7.88E-16	7.88E-16
PB-210	4.06E-20	4.06E-20

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

0.00E+00 1.00E+00

1 9.64E+00 1.76E-04

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

Evaluation Time [yr]

0.00E+00 1.00E+00

1 9.65E+00 1.76E-04

RESRAD-Build Pu-238 4 m^2 Report

Title : Pu-238 4 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu238\NIST Pu238 4m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	1.000	1.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************

Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s] Source Information
Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00[m] Geometry:: Type: Area Length[m]:2.00E+00
Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide Concentration Dose Conversion Factor (Library: FGR 11)

Nuclide	Concentration [dpm/m2]	Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Submersion [mrem/yr/ (dpm/m3)]
PU-238	4.070E+04	1.441E-03	1.766E-01	2.567E-07
U-234	0.000E+00	1.275E-04	5.946E-02	4.014E-07
TH-230	0.000E+00	2.468E-04	1.468E-01	9.155E-07
RA-226	0.000E+00	5.950E-04	3.871E-03	4.663E-03
PB-210	0.000E+00	2.422E-03	6.214E-03	4.698E-06

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:2.00E+00 Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
4.070E+04 U-234 0.000E+00 TH-230
0.000E+00 RA-226 0.000E+00 PB-210
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

17.85E+00 7.85E+007.85E+00 7.85E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.66E-04	5.92E-06	3.12E-10	1.41E+00	5.47E-19	6.44E+00
Total	1.66E-04	5.92E-06	3.12E-10	1.41E+00	5.47E-19	6.44E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-238 7.85E+00 7.85E+00 U-234 1.20E-06 1.20E-06 TH-230 7.14E-12 7.14E-12 RA-226 5.44E-16 5.44E-16 PB-210 1.05E-17 1.05E-17

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:2.00E+00 Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
2.019E+04 U-234 5.735E-02 TH-230
2.585E-07 RA-226 3.734E-11 PB-210
2.885E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.10E-04 1.10E-041.10E-04 1.10E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.10E-04	0.00E+00	0.00E+00	0.00E+00	6.83E-18	0.00E+00
Total	1.10E-04	0.00E+00	0.00E+00	0.00E+00	6.83E-18	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-238	1.10E-04	1.10E-04
U-234	3.88E-10	3.88E-10
TH-230	2.04E-15	2.04E-15
RA-226	4.76E-16	4.76E-16
PB-210	2.54E-20	2.54E-20

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

0.00E+00 1.00E+00

1 7.85E+00 1.10E-04

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

Evaluation Time [yr]

0.00E+00 1.00E+00

1 7.85E+00 1.10E-04

RESRAD-Build Pu-238 1 m^2 Report

Title : Pu-238 1 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu238\NIST Pu238 1m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	0.500	0.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00[m] Geometry:: Type: Area Length[m]:1.00E+00
Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Radon Release Fraction: 1.000E-01

Contamination::

Nuclide Concentration Dose Conversion Factor (Library: FGR 11)

		Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Submersion [mrem/yr/ (dpm/m3)]
	[dpm/m2]			
PU-238	4.070E+04	1.441E-03	1.766E-01	2.567E-07
U-234	0.000E+00	1.275E-04	5.946E-02	4.014E-07
TH-230	0.000E+00	2.468E-04	1.468E-01	9.155E-07
RA-226	0.000E+00	5.950E-04	3.871E-03	4.663E-03
PB-210	0.000E+00	2.422E-03	6.214E-03	4.698E-06

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:1.00E+00 Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
4.070E+04 U-234 0.000E+00 TH-230
0.000E+00 RA-226 0.000E+00 PB-210
0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

16.77E+00 6.77E+006.77E+00 6.77E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	5.76E-05	2.05E-06	7.81E-11	3.52E-01	1.37E-19	6.41E+00
Total	5.76E-05	2.05E-06	7.81E-11	3.52E-01	1.37E-19	6.41E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-238 6.77E+00 6.77E+00 U-234 7.00E-07 7.00E-07 TH-230 3.53E-12 3.53E-12 RA-226 5.04E-16 5.04E-16 PB-210 1.03E-17 1.03E-17

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:1.00E+00 Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-238
2.019E+04 U-234 5.735E-02 TH-230
2.585E-07 RA-226 3.734E-11 PB-210
2.885E-13

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

13.81E-05 3.81E-053.81E-05 3.81E-05

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.81E-05	0.00E+00	0.00E+00	0.00E+00	1.71E-18	0.00E+00
Total	3.81E-05	0.00E+00	0.00E+00	0.00E+00	1.71E-18	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-238	3.81E-05	3.81E-05
U-234	1.35E-10	1.35E-10
TH-230	7.11E-16	7.11E-16
RA-226	1.60E-16	1.60E-16
PB-210	8.84E-21	8.84E-21

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

0.00E+00 1.00E+00

1 6.77E+00 3.81E-05

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

Evaluation Time [yr]

0.00E+00 1.00E+00

1 6.77E+00 3.81E-05

RESRAD-Build Pu-239 Base Case Report

Title : Pu-239 89.3 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu239\NIST Pu239 89m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	4.250	5.250	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *
* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************
Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s] Source Information
Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00[m] Geometry:: Type: Area Length[m]:8.50E+00
Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide Concentration Dose Conversion Factor (Library: FGR 11)

Nuclide	Concentration [dpm/m2]	Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Submersion [mrem/yr/ (dpm/m3)]
PU-239	3.700E+04	1.595E-03	1.932E-01	2.231E-07
U-235	0.000E+00	1.204E-04	5.541E-02	4.063E-04
PA-231	0.000E+00	4.775E-03	5.766E-01	9.049E-05
AC-227	0.000E+00	6.665E-03	3.029E+00	9.734E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00 [m] Geometry:: Type: Area Length[m]:8.50E+00
Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
3.700E+04 U-235 0.000E+00 PA-231
0.000E+00 AC-227 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

13.87E+01 3.87E+013.87E+01 3.87E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.50E-04	8.94E-06	5.55E-09	3.15E+01	0.00E+00	7.15E+00
Total	2.50E-04	8.94E-06	5.55E-09	3.15E+01	0.00E+00	7.15E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-239 3.87E+01 3.87E+01 U-235 4.56E-09 4.56E-09 PA-231 3.53E-13 3.53E-13 AC-227 1.28E-14 1.28E-14

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 4.25 y: 5.25 z: 0.00 [m] Geometry:: Type: Area Length[m]:8.50E+00 Width[m]:1.05E+01 Direction: z Pathway ::

Direct Ingestion Rate: 1.120E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
1.850E+04 U-235 1.821E-05 PA-231
1.925E-10 AC-227 2.024E-12

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.66E-04 1.66E-041.66E-04 1.66E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.66E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.66E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-239	1.66E-04	1.66E-04
U-235	3.99E-11	3.99E-11
PA-231	1.79E-16	1.79E-16
AC-227	2.47E-17	2.47E-17

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	3.87E+01	1.66E-04

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	3.87E+01	1.67E-04

RESRAD-Build Pu-239 36 m^2 Report

Title : Pu-239 36 m2

Input File : C:\RESRAD_Family\BUILD\NIST Pu239\NIST Pu239 36m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days

Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	3.000	3.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00[m] Geometry:: Type: Area Length[m]:6.00E+00 Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide Concentration Dose Conversion Factor (Library: FGR 11)

Nuclide	Concentration [dpm/m2]	Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Submersion [mrem/yr/ (dpm/m3)]
PU-239	3.700E+04	1.595E-03	1.932E-01	2.231E-07
U-235	0.000E+00	1.204E-04	5.541E-02	4.063E-04
PA-231	0.000E+00	4.775E-03	5.766E-01	9.049E-05
AC-227	0.000E+00	6.665E-03	3.029E+00	9.734E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:6.00E+00 Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
3.700E+04 U-235 0.000E+00 PA-231
0.000E+00 AC-227 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.95E+01 1.95E+011.95E+01 1.95E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.27E-04	8.12E-06	2.24E-09	1.27E+01	0.00E+00	6.75E+00
Total	2.27E-04	8.12E-06	2.24E-09	1.27E+01	0.00E+00	6.75E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-239 1.95E+01 1.95E+01 U-235 1.94E-09 1.94E-09 PA-231 1.62E-13 1.62E-13 AC-227 5.35E-15 5.35E-15

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:6.00E+00 Width[m]:6.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.780E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
1.850E+04 U-235 1.821E-05 PA-231
1.925E-10 AC-227 2.024E-12

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.51E-04 1.51E-041.51E-04 1.51E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.51E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.51E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-239	1.51E-04	1.51E-04
U-235	3.00E-11	3.00E-11
PA-231	1.37E-16	1.37E-16
AC-227	1.85E-17	1.85E-17

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.95E+01	1.51E-04

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.95E+01	1.51E-04

RESRAD-Build Pu-239 25 m^2 Report

Title : Pu-239 25 m2

Input File : C:\RESRAD_Family\BUILD\NIST Pu239\NIST Pu239 25m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days

Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	2.500	2.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00[m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide Concentration Dose Conversion Factor (Library: FGR 11)

Nuclide	Concentration [dpm/m2]	Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Submersion [mrem/yr/ (dpm/m3)]
PU-239	3.700E+04	1.595E-03	1.932E-01	2.231E-07
U-235	0.000E+00	1.204E-04	5.541E-02	4.063E-04
PA-231	0.000E+00	4.775E-03	5.766E-01	9.049E-05
AC-227	0.000E+00	6.665E-03	3.029E+00	9.734E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
3.700E+04 U-235 0.000E+00 PA-231
0.000E+00 AC-227 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.55E+01 1.55E+011.55E+01 1.55E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.12E-04	7.59E-06	1.55E-09	8.83E+00	0.00E+00	6.65E+00
Total	2.12E-04	7.59E-06	1.55E-09	8.83E+00	0.00E+00	6.65E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-239 1.55E+01 1.55E+01 U-235 1.40E-09 1.40E-09 PA-231 1.23E-13 1.23E-13 AC-227 3.80E-15 3.80E-15

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.50 y: 2.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:5.00E+00 Width[m]:5.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 4.000E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
1.850E+04 U-235 1.821E-05 PA-231
1.925E-10 AC-227 2.024E-12

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.41E-04 1.41E-041.41E-04 1.41E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.41E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.41E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-239	1.41E-04	1.41E-04
U-235	2.61E-11	2.61E-11
PA-231	1.20E-16	1.20E-16
AC-227	1.61E-17	1.61E-17

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.55E+01	1.41E-04

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.55E+01	1.41E-04

RESRAD-Build Pu-239 16 m^2 Report

Title : Pu-239 16 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu239\NIST Pu239 16m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	2.000	2.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *
* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************
Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s] Source Information
Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00[m] Geometry:: Type: Area Length[m]:4.00E+00
Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide Concentration Dose Conversion Factor (Library: FGR 11)

Nuclide	Concentration [dpm/m2]	Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Submersion [mrem/yr/ (dpm/m3)]
PU-239	3.700E+04	1.595E-03	1.932E-01	2.231E-07
U-235	0.000E+00	1.204E-04	5.541E-02	4.063E-04
PA-231	0.000E+00	4.775E-03	5.766E-01	9.049E-05
AC-227	0.000E+00	6.665E-03	3.029E+00	9.734E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:4.00E+00
Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
3.700E+04 U-235 0.000E+00 PA-231
0.000E+00 AC-227 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.22E+01 1.22E+011.22E+01 1.22E+01

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.90E-04	6.80E-06	9.95E-10	5.65E+00	0.00E+00	6.58E+00
Total	1.90E-04	6.80E-06	9.95E-10	5.65E+00	0.00E+00	6.58E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-239 1.22E+01 1.22E+01 U-235 9.55E-10 9.55E-10 PA-231 9.07E-14 9.07E-14 AC-227 2.54E-15 2.54E-15

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 2.00 y: 2.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:4.00E+00 Width[m]:4.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 6.250E-06 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
1.850E+04 U-235 1.821E-05 PA-231
1.925E-10 AC-227 2.024E-12

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.27E-04 1.27E-041.27E-04 1.27E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.27E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.27E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-239	1.27E-04	1.27E-04
U-235	2.15E-11	2.15E-11
PA-231	9.93E-17	9.93E-17
AC-227	1.32E-17	1.32E-17

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]
	0.00E+00 1.00E+00
1	1.22E+01 1.27E-04

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

	Evaluation Time [yr]
	0.00E+00 1.00E+00
1	1.22E+01 1.27E-04

RESRAD-Build Pu-239 9 m^2 Report

Title : Pu-239 9 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu239\NIST Pu239 9m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	1.500	1.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *
* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************
Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s] Source Information
Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00[m] Geometry:: Type: Area Length[m]:3.00E+00
Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide Concentration Dose Conversion Factor (Library: FGR 11)

Nuclide	Concentration [dpm/m2]	Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Submersion [mrem/yr/ (dpm/m3)]
PU-239	3.700E+04	1.595E-03	1.932E-01	2.231E-07
U-235	0.000E+00	1.204E-04	5.541E-02	4.063E-04
PA-231	0.000E+00	4.775E-03	5.766E-01	9.049E-05
AC-227	0.000E+00	6.665E-03	3.029E+00	9.734E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:3.00E+00
Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
3.700E+04 U-235 0.000E+00 PA-231
0.000E+00 AC-227 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

19.70E+00 9.70E+009.70E+00 9.70E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.56E-04	5.59E-06	5.59E-10	3.18E+00	0.00E+00	6.52E+00
Total	1.56E-04	5.59E-06	5.59E-10	3.18E+00	0.00E+00	6.52E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-239 9.70E+00 9.70E+00 U-235 6.09E-10 6.09E-10 PA-231 6.56E-14 6.56E-14 AC-227 1.56E-15 1.56E-15

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.50 y: 1.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:3.00E+00 Width[m]:3.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.110E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
1.850E+04 U-235 1.821E-05 PA-231
1.925E-10 AC-227 2.024E-12

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

11.04E-04 1.04E-041.04E-04 1.04E-04

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.04E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.04E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-239	1.04E-04	1.04E-04
U-235	1.61E-11	1.61E-11
PA-231	7.49E-17	7.49E-17
AC-227	9.89E-18	9.89E-18

Receptor Dose Received for the Exposure Duration (mrem)

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	9.70E+00	1.04E-04

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

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	9.71E+00	1.04E-04

RESRAD-Build Pu-239 4 m^2 Report

Title : Pu-239 4 m2
Input File : C:\RESRAD_Family\BUILD\NIST Pu239\NIST Pu239 4m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	1.000	1.000	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete
Building Information
Building Air Exchange Rate: 8.00E-01 1/hr
Height[m] Air Exchanges [m3/hr]
Area [m2] ****************************** * * * *
* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *
Area 89.300 * * * * ******************************
Deposition velocity: 1.00E-02 [m/s] Resuspension Rate: 5.00E-07 [1/s] Source Information
Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00[m] Geometry:: Type: Area Length[m]:2.00E+00
Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide Concentration Dose Conversion Factor (Library: FGR 11)

Nuclide	Concentration [dpm/m2]	Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Submersion [mrem/yr/ (dpm/m3)]
PU-239	3.700E+04	1.595E-03	1.932E-01	2.231E-07
U-235	0.000E+00	1.204E-04	5.541E-02	4.063E-04
PA-231	0.000E+00	4.775E-03	5.766E-01	9.049E-05
AC-227	0.000E+00	6.665E-03	3.029E+00	9.734E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:2.00E+00
Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
3.700E+04 U-235 0.000E+00 PA-231
0.000E+00 AC-227 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

17.91E+00 7.91E+007.91E+00 7.91E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.05E-04	3.76E-06	2.49E-10	1.41E+00	0.00E+00	6.49E+00
Total	1.05E-04	3.76E-06	2.49E-10	1.41E+00	0.00E+00	6.49E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-239 7.91E+00 7.91E+00 U-235 3.61E-10 3.61E-10 PA-231 4.78E-14 4.78E-14 AC-227 8.57E-16 8.57E-16

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 1.00 y: 1.00 z: 0.00 [m] Geometry:: Type: Area Length[m]:2.00E+00 Width[m]:2.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 2.500E-05 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
1.850E+04 U-235 1.821E-05 PA-231
1.925E-10 AC-227 2.024E-12

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

16.99E-05 6.99E-056.99E-05 6.99E-05

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	6.99E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	6.99E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-239	6.99E-05	6.99E-05
U-235	9.82E-12	9.82E-12
PA-231	4.59E-17	4.59E-17
AC-227	6.01E-18	6.01E-18

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	7.91E+00	6.99E-05

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	7.91E+00	7.00E-05

RESRAD-Build Pu-239 1 m^2 Report

Title : Pu-239 1 m2

Input File : C:\RESRAD_Family\BUILD\NIST Pu239\NIST Pu239 1m2.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1 Number of Receptors: 1 Total Time : 3.650000E+02 days
Fraction Inside : 5.000000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	0.500	0.500	1.000	1.000	1.80E+01	1.00E-04

Receptor-Source Shielding Relationship

Receptor Source Density Thickness Material [g/cm3] [cm] 1 1 2.40E+00 0.00E+00 Concrete

Building Information

Building Air Exchange Rate: 8.00E-01 1/hr

Height[m] Air Exchanges [m3/hr]

Area [m2] ****************************** * * * *

* <=Q01: 3.71E+02 H1: 5.200 * Room 1 * Q10 : 3.71E+02 * LAMBDA: 8.00E-01 *

Area 89.300 * * * * ******************************

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

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00[m] Geometry:: Type: Area Length[m]:1.00E+00 Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide Concentration Dose Conversion Factor (Library: FGR 11)

Nuclide	Concentration [dpm/m2]	Ingestion [mrem/dpm]	Inhalation [mrem/dpm]	Submersion [mrem/yr/ (dpm/m3)]
PU-239	3.700E+04	1.595E-03	1.932E-01	2.231E-07
U-235	0.000E+00	1.204E-04	5.541E-02	4.063E-04
PA-231	0.000E+00	4.775E-03	5.766E-01	9.049E-05
AC-227	0.000E+00	6.665E-03	3.029E+00	9.734E-04

Á Á Assessment for Time: 1 Á Time =0.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:1.00E+00 Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 5.000E-01 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
3.700E+04 U-235 0.000E+00 PA-231
0.000E+00 AC-227 0.000E+00

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

16.82E+00 6.82E+006.82E+00 6.82E+00

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	3.88E-05	1.39E-06	6.22E-11	3.53E-01	0.00E+00	6.47E+00
Total	3.88E-05	1.39E-06	6.22E-11	3.53E-01	0.00E+00	6.47E+00

Nuclide Detail of Doses [mrem]

Source: 1

Nuclide Receptor Total

1 PU-239 6.82E+00 6.82E+00 U-235 2.11E-10 2.11E-10 PA-231 3.71E-14 3.71E-14 AC-227 4.36E-16 4.36E-16

Á Á Assessment for Time: 2 Á Time =1.00E+00 yr Á Á Á

Source Information

Source: 1 Location:: Room : 1 x: 0.50 y: 0.50 z: 0.00 [m] Geometry:: Type: Area Length[m]:1.00E+00 Width[m]:1.00E+00 Direction: z Pathway ::

Direct Ingestion Rate: 1.000E-04 [1/hr] Fraction released to air: 1.000E-01 Removable fraction: 0.000E+00 Time to Remove: 3.650E+02 [day]

Contamination:: Nuclide Concentration

[dpm/m2] PU-239
1.850E+04 U-235 1.821E-05 PA-231
1.925E-10 AC-227 2.024E-12

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses [mrem]

Receptor 1 Total Source Total

12.59E-05 2.59E-052.59E-05 2.59E-05

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	2.59E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	2.59E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide Detail of Doses [mrem]

Source: 1 RESRAD-BUILD Dose (Time) Tables

Nuclide	Receptor	Total
	1	
PU-239	2.59E-05	2.59E-05
U-235	3.32E-12	3.32E-12
PA-231	1.56E-17	1.56E-17
AC-227	2.03E-18	2.03E-18

Receptor Dose Received for the Exposure Duration (mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	6.82E+00	2.59E-05

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

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	6.83E+00	2.59E-05