Decontamination and Survey Plan for Magill and Rhodes Halls

prepared for

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1.0 INTRODUCTION

The purpose of this document is to describe the protocol for survey, decontamination (if necessary) and disposition of equipment, materials, and building surfaces (e.g., walls and floors) that are potential radiologically contaminated with americium-241 (Am-241).

In August through November of calendar year 2000 (CY00), certain room/corridor building surfaces, equipment and materials within Magill Hall were decontaminated, surveyed, inspected by the Nuclear Regulatory Commission (NRC) and released for unrestricted use (NRC 2001). All of Magill Hall was released for unrestricted use in November 2000. However, during the characterization, decontamination and final status survey of these areas in Magill Hall, 100% of the room/corridor building surfaces, equipment and materials were not accessible for survey (i.e., large shelving cabinets, permanently installed lab benches, etc.). Therefore, this plan describes the protocol for survey and decontamination (if necessary) of these previously inaccessible areas.

In addition, there were some items that were discovered outside of Magill Hall, primarily in Rhodes Hall, that were contaminated above release limits. These were items that were thought to have originated from Magill Hall and were moved to other locations within the University in the normal conduct of University operations. A visual scoping survey was conducted across the University (all buildings except Magill Hall and residence halls) to identify any other items that might have been moved from Magill Hall and required survey. The visual scoping survey was completed in June of 2002. This plan also describes the protocol for survey, decontamination (if necessary) and disposition of items from Magill and Rhodes Halls identified for surplus within the University system.

1.1 SCOPE

The scope of this document is limited to building surfaces, equipment and materials within Magill Hall that were not accessible for survey during the CY00 effort. Survey, decontamination (if necessary), re-survey (if necessary) and release of these previously inaccessible items and surfaces will be investigated when the RSO is informed that they will become accessible due to movement of equipment, renovation of the room, etc. Room 242 is not included because all contents of the room were removed (including all permanently installed cabinetry and flooring) during the CY00 effort. Survey of building infrastructure (i.e., piping systems, electrical systems, HVAC systems, etc.) are also not included in the scope of this plan and are not required for routine maintenance or replacement activities or release of components disassembled from the system during maintenance. However, if building surface surveys indicate that the building infrastructure may have been impacted by any contamination that is found during the implementation of this plan, the portion of infrastructure that has been impacted will be included in the scope of this document.

In addition, the scope of this document also includes any items that the University intends to surplus from Magill or Rhodes Hall that were in place prior to the CY00 effort. Although an extensive visual scoping survey has already been conducted, the RSO can use this plan to evaluate and survey items brought to the RSO's attention from other areas

of the University that may have originated from Magill or Rhodes Hall. However, items intended to be surplused or disposed of from outside of Magill or Rhodes Hall are not required to be surveyed in accordance with this procedure.

1.2 SITE DESCRIPTION AND HISTORY

Southeast Missouri State University (Southeast) is located in the town of Cape Girardeau, Missouri near the Mississippi River. Cape Girardeau is a community of approximately 40,000 people and is considered a hub for retailing, medicine, manufacturing, communications and cultural activities between St. Louis, Missouri and Memphis, Tennessee. There are approximately 8,500 students and 350 full-time faculty members at the university.

1.2.1 HISTORICAL AM-241 CONTAMINATION

In CY00, Am-241 contamination was discovered in Magill Hall. The source of contamination was determined to be from a broken source vial in the source safe, which was being stored in the Magill Hall basement. Science Applications International Corporation (SAIC) was contracted to characterize, decontaminate, survey and release the building. Magill Hall was decontaminated, surveyed, inspected by the NRC and released for unrestricted use in November, 2000.

1.2.2 PREVIOUS SCOPING INVESTIGATIONS

The Magill Hall basement was also used as a temporary storage location for surplus items being held for public auction and radioactive contamination was found in this surplus item storage area. The Magill storage area was radiologically released with the rest of the building as stated above.

As part of the CY00 survey and lab discharge system survey efforts, scoping surveys of ventilation (Magill Hall) and piping systems (Magill and Rhodes Hall) were conducted to determine if these systems had been impacted. Scoping surveys of ventilation systems within Magill Hall ducts left in place after the CY00 survey effort did not identify removable gross alpha contamination in excess of limits. Scoping surveys of laboratory hood exhausts in Rhodes and Magill Halls showed that these systems were not impacted. Survey of piping systems within Magill and Rhodes Halls (sink and floor drains) performed in 2002 did identify one drain system (RH303) which was decontaminated and released for unrestricted use.

In CY00, an investigation was conducted to link members of the public and auctioned surplus items that may have been stored in Magill Hall. No link could be established, however, several corrective actions were recommended. One action included, at a minimum, routine visual inspections of items awaiting auction to ensure that no radioactive or hazardous material is contained within any items to be surplused. If items are located during these inspections that contain (or are suspected to contain) radioactive or hazardous material, they were immediately removed from the items to be auctioned, evaluated, and an investigation was undertaken to determine why the item was not identified earlier in the surplus process.

In CY02, a Visual Scoping and Survey Plan (SAIC 2002a) was developed that described a strategy for the location of items that had a potential to be radiologically contaminated with Am-241 (suspect items) and were moved from Magill Hall to other areas of the Southeast campus including off-campus locations, survey items to determine if they have been impacted, determine the appropriate disposition of those items determined to be contaminated, and evaluate potential radiological exposure to individuals likely to have had contact with those items. This plan was implemented in April through June of 2002 and documented in a report (SAIC 2002b).

1.3 RADIOLOGICAL CONTAMINANT OF CONCERN

Am-241 is the primary radiological contaminant of concern. Since other radionuclides (e.g., cesium-137) have been previously identified in a waste stream (e.g., acid dilution pit sediment) from University laboratories, radiological surveys will be conducted that are capable of detecting both alpha and beta contamination.

If characterization data indicates contamination that is uncharacteristic of Am-241 (i.e., beta contamination greater than Regulatory Guide 1.86 limits), additional characterization will be performed to identify and quantify the detected contamination. Once the contaminant is identified, release criteria will be selected from appropriate sources (e.g., Appendix B-1 of NUREG 1757, volume 1, etc.) or developed following the same methodology presented in this document for deriving the Am-241 release criteria. If different contaminants are found in the same location (room), a sum of the ratios will be applied prior to release."

2.0 RADIOLOGICAL SURVEYS

2.1 RADIOLOGICAL INSTRUMENTATION

Calibration, maintenance, accountability, operation and quality control of radiation detection instruments will be performed in accordance with Southeast's Radiation Protection Program (RPP) procedures RP-11 "Radiological Monitoring", RP-30 "Radiological Instrumentation", and this plan, as appropriate.

2.1.1 Instrument Selection

The radiological instruments Southeast has selected to survey for alpha and beta contamination are able to detect Am-241 and Cs-137 at or below their respective screening levels. Instruments used for contamination monitoring will be calibrated by Southeast or qualified vendors under approved procedures using calibration sources traceable to the National Institute of Standards and Technology (NIST). The instruments will be calibrated with thorium-230 (Th-230) and strontium-90 (Sr-90) sources unless Am-241 and Cs-137 sources are available. Th-230 and Sr-90 sources underestimate instrument efficiency when surveying for Am-241 and Cs-137 since Am-241 gives off a higher energy alpha than Th-230 and Cs-137 gives off a higher energy beta than Sr-90. This ensures a conservative approach to detecting these radionuclides if instrumentation is calibrated with these radionuclide sources.

A Ludlum Model 2360 meter with a 43-93 zinc-sulfide (ZnS) probe or equivalent will be used for scan and fixed point surveys. A Ludlum Model 2929 bench scaler with a 43-10-1 ZnS probe or equivalent will be used to quantify removable contamination.

2.1.2 Quality Controls (QC)

Southeast's RPP procedure RP-30 requires daily QC checks on all in-use instruments. This includes pre-operational, background, and source checks. Results will be documented on the appropriate form.

2.2 UNRESTRICTED USE CRITERIA

2.2.1 Unrestricted Use Criteria for Items and Materials to be Released fromthe University

The NRC has previously approved Regulatory Guide 1.86 (NRC 1974) limits during the initial decontamination and survey of items and materials in Magill Hall and therefore, these limits will be applied as the unrestricted use criteria (Table 2-1) for items and materials to be released from the University.

Table 2-1. Unrestricted Use Criteria for Items and Materials

Contaminant of Concern	Unrestricted Use Criteria[a] (dpm/100cm^2)		
	Fixed [b]	Removable [b]	Maximum [c]
Am-241	100	20	300
Cs-137	5000	1000	15,000

[a] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[b] Measurements of average contaminant should not be averaged over more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[c] The maximum contamination level applies to an area of not more than 100 cm^2.

Appropriate scan rates and fixed point count times (Table 2-2) have been set to ensure the selected instruments are able to detect minimum contaminant concentrations below the unrestricted use criteria.

The investigation levels (Table 2-2) for this plan are set at the count per minute (cpm) level equivalent to the fixed contamination unrestricted use criteria plus background. Investigation levels account for instrument, surface, and surveyor efficiencies, detector surface area, and appropriate background values.

2.2.2 Unrestricted Use Criteria for Building Surfaces

In accordance with 10 Code of Federal Regulations (CFR) Part 20 Subpart E, a site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem/yr and is as-low-as-reasonably-achievable (ALARA). The dose-based release criteria derived in this report is applicable for building surface contamination potentially present in previously inaccessible areas within Magill Hall.

On April 12, 2002, Southeast submitted a letter to NRC, Region III to present the results of a conservative dose assessment for potential exposures resulting from the contaminated table discovered in Johnson Hall Room 222 at Southeast. RESRAD-Build Version 3.1 was used for determining doses to three reasonable maximally exposed receptor scenarios. They include:

- Chemistry department staff who spends an entire work year at the contaminated table using it as a desk;
- Chemical department staff who teach a class or lab using the table during the school year; and
- Facilities Management (FM) personnel who moved the table then continually move boxes in and out of storage everyday for an entire work year.

Appendix A of this report includes the pertinent information related to that letter. Appendix A includes all the necessary information related to three receptor scenarios, source terms, exposure pathways, and results of the assessments. The results of the

assessment showed that the chemistry departmental staff who spends an entire year at the contaminated table receives the maximum dose of 10.2 millirem per year (mrem/yr).

This report utilizes that same receptor scenario for the derivation of release criteria for previously inaccessible building surfaces. Except for the receptor, source lifetime, and source location, the assigned values for all other exposure parameters remain the same. The receptor is assumed to be present at the middle of the room and 1 meter above the contaminated floor. To account for potential mechanical disturbance of the surface areas during renovation, the source lifetime has been reduced to 1 year (365 days). Appendix B includes all the necessary information related to this receptor scenario, source terms, exposure pathways, and results of the assessment. The release criterion derived in Appendix B, for Am-241, of 1,160 dpm/100 cm^2 total alpha activity represents an unrestricted use criteria for building surfaces that, if met, will ensure that the 25 mrem/yr dose criteria is satisfied and is ALARA. The RESRAD Build Version 3.3 output summary report is contained in Attachment B-1 to Appendix B of this document. Although the release criteria established above is based upon 50% of the contamination being removable, any removable contamination detected will be decontaminated to below the Regulatory Guide 1.86 removable contamination limits as an ALARA approach. Additionally, release limit area factors will be applied in accordance with Section 2.2.5 to small areas of elevated activity in rooms where previously inaccessible potentially radioactively contaminated areas are smaller than the area assumed for the receptor scenario.

Table 2-2. Scan Rates, Investigation Levels, and Fixed Point Count Times

Instrument	Surface material	Scan Rate (inches/second)	Items/Material Investigation Level[1] (cpm/126 cm^2)	Building Surfaces Investigation Level[1] (cpm/126 cm^2)	Count Time (minutes)
43-93 w/2360 meter Alpha	Concrete	0.25	8	68	2
	Tile	0.5	12	132	1
	Counter Slate	0.5	16	136	1
	Steel	0.25	4	37	2.5
	Wood	0.5	9	89	1
43-93 w/2360 meter Beta	Concrete	0.25	404	785	2
	Tile	0.5	418	1180	1
	Counter Slate	0.5	552	1314	1
	Steel	0.25	514	1276	2.5
	Wood	0.5	423	994	1
43-10-1 w/2929 meter Alpha	N/A	N/A	7	980[2]	1
43-10-1 w/2929 meter Beta	N/A	N/A	421	N/A	1

(1) The investigation levels are based on an assumed instrument efficiency of 0.16 (α) and 0.27 (β), a surveyor efficiency of 0.7 and the following surface efficiency for concrete of 0.4, tile of 0.8, counter slate of 0.8, steel of 0.2, and wood of 0.5. The background for each surface listed is based on actual measurements and are as follows; concrete 2.1 cpm (α) and 308 cpm (β), tile 1.1 cpm (α) and 228 cpm (β), counter slate 4.8 cpm (α) and 361 cpm (β), steel 1.0 cpm (α) and 323 cpm (β), and wood 1.0 cpm (α) and 280 cpm (β). NOTE: Beta investigation levels for building surfaces are based upon the Regulatory Guide 1.86 beta-gamma emitter average contamination release limit of 5000 dpm/100 cm^2.

(2) The removable fraction of the total release criterion is assumed to be 50 percent.

2.2.3 Action Level Requiring SAIC Involvement

Southeast will involve SAIC in the survey if any item or building surface is found to have removable alpha contamination levels exceeding 10,000 dpm/100 cm^2 averaged over 1 m^2 (not to exceed 30,000 dpm/100 cm^2 in any single location) (SAIC 2002a).

2.2.4 Action Level Requiring NRC Notification

Southeast will notify the NRC in writing within 30 days if concentrations of radioactive material in excess of 10 times the 10 CFR 20 Appendix C value (i.e., 0.001 uCi Am-241) is found in an unrestricted area and when required by 10 CFR 20.2203.

Southeast will notify the NRC within 24 hours if contamination is found in an area where personnel are normally stationed during routine University operations with removable alpha contamination levels exceeding 110,000 dpm/100 cm^2 averaged over 1 m^2 (not to exceed 330,000 dpm/100 cm^2 in any single location) and when required by 10 CFR 20.2202. The 110,000 dpm/100 cm^2 action level was developed using RESRAD-BUILD Version 3.1 and very conservative input parameters listed in NUREG 6697, *Development of Probabilistic RESRAD 6.0 and RESRAD 3.0 Computer Codes* (NRC 2000). This level of contamination is based upon the conservative assumption that if an individual were present for 24 hours, the individual could receive an intake greater than one occupational annual limit on intake (ALI) (SAIC, 2002a).

2.2.5 Release Limit Area Factors

The exposure scenario in Appendix B is very conservative as an ALARA approach and tends to overestimate exposure for contaminated areas significantly smaller than 1 m^2. Therefore, release limit area factors were developed for small areas of elevated activity in rooms where previously inaccessible potentially radioactively contaminated areas are smaller than the area assumed for the receptor scenario. The area factors listed in Table 2-3 were developed using the same receptor scenario documented in Appendix B with the exception of the source area. Although area factor release limits were developed for areas down to 100 cm^2, as an ALARA approach Southeast will apply the 1 m^2 area factor for all elevated areas less than 1 m^2.

Table 2-3. Area Factors for Small Areas of Elevated Activity

Area (m^2)	Area Factor Release Limit (dpm/100 cm^2)
9	1,160
4	2,600
1	10,000
0.1	104,000
0.01 (100 cm^2)	1,045,000

When evaluating small areas of elevated activity, Southeast will ensure that removable contamination is less than the Regulatory Guide 1.86 removable contamination limits; will ensure that the average contamination levels for all previously inaccessible

potentially radioactively contaminated areas in a room are less than the release criteria stated in Section 2.2.2 for total alpha activity; and apply the area factor release limits of Table 2-3.

NOTE: In rooms where the total area of previously inaccessible potentially radioactively contaminated areas is less than the receptor scenario source area of 9 m^2, then the next highest area factor release limit will apply to the entire area (e.g., if the total previously inaccessible potentially radioactively contaminated area in a room is 3 m^2 then the area factor release limit for 4 m^2 will apply to the entire area verses the 9 m^2 release limit.

2.3 SURVEYING

Items/building surfaces that require surveys should receive a 100% radiological scan survey of all accessible surfaces of the item/building surface. If the radiological scan identifies contamination above background, then fixed point survey measurements and a removable contamination survey will be conducted that is sufficient to determine average contamination levels. The term "surveys" as used in this plan indicates both alpha and beta contamination surveys. Scan rates and counting times are provided in Table 2-2.

- Scan survey results above the investigation level will require a fixed-point survey on the suspect area. Investigation levels and fixed-point count times are provided in Table 2-2.

- Smear surveys for loose surface contamination will be performed in conjunction with fixed-point surveys and as necessary to adequately determine average contamination levels.

- Smears will be analyzed at Southeast by the RSO or designee. Appropriate information will be recorded on the smear cover and/or survey form. Count times are provided in Table 2-2.

Note: Survey of building infrastructure (i.e., piping systems, electrical systems, HVAC systems, etc.) are not required for routine maintenance or replacement activities or release of components disassembled from the system during maintenance unless it is determined that they have been impacted by contamination identified during the implementation of this plan.

2.4 PROCESSING OF CONTAMINATED ITEMS AND BUILDING SURFACES

Survey, release, decontamination, transfer, storage, and/or disposition of contaminated items and building surfaces will be performed in accordance with the appropriate Southeast RPP procedures and this plan, as appropriate. The following actions will be taken based upon radiological survey results:

- If survey results are below the established unrestricted use criteria presented in Table 2-1 for items and materials and Table 2-2 for building surfaces, the item or building surface may be left unattended and considered released for unrestricted use.

- If survey results indicate contamination above the established unrestricted use criteria then one or more of the following actions will be taken:

Decontamination (process when removable contamination is between 20 and 10,000 dpm/100 cm^2).

- The RSO will determine whether a decontamination attempt on an item will be performed or if the item will be contained and stored for disposal.

- If an item is small and easy to transport, the item will be wrapped to prevent the spread of contamination and transported to an approved Radioactive Material Storage Area to await decontamination. Decontamination will be performed at the Radiological Laboratory in Building RH212 in accordance with RPP procedure RP-10 and an approved Radiological Work Permit.

- For building surfaces or if the item is large, hard to transport, and/or movement of the contaminated item will likely spread contamination, and the RSO has determined that decontamination of the item is necessary, a "temporary job site" will be set up to perform decontamination. A "temporary job site" is defined as an area not currently listed on Southeast's NRC license, secured and designated by the RSO or designee as an authorized location to perform radiological decontamination. Radiological controls will be maintained at "temporary job sites" in accordance with the Southeast RPP, including but not limited to appropriate radiological postings, contamination controls, use of proper personal protective equipment, and radiological monitoring.

- The item or building surface will be resurveyed after each decontamination attempt and either released for unrestricted use if survey results are below the established unrestricted use criteria or contained and stored as described below if survey results are above the established unrestricted use criteria.

- More than one decontamination attempt may be performed to determine appropriate disposition of the item or building surface.

- After decontamination is complete and/or the contaminated item has been removed from the temporary job site, the general area of the temporary job site will be surveyed to ensure contamination has not spread and de-posted in accordance with the Southeast RPP. The RSO will determine the necessary scope of the survey necessary to release and de-post the temporary job site.

- All decontamination attempts and surveys will be properly documented.

Contain and Store (process when removable contamination is between 20 and 10,000 dpm/100 cm^2 or fixed contamination above 100 dpm/100 cm^2).

- If decontamination of an item is unsuccessful or the RSO has decided not to perform decontamination, the item will be contained such that no radioactive material will be released. The item will then be transported to the Magill Radioactive Materials Storage Bunker or other temporary radioactive material storage area (RMSA), inventoried, and stored for disposal. If moving the item is not immediately practical, then restrictive locks will be placed on doors to limit access until a decontamination attempt can be made by SAIC, or the item can be moved to an approved RMSA.

- It is not anticipated that decontamination of building surfaces will be unsuccessful. If decontamination of a building surface is unsuccessful, surfaces will be painted or covered to prevent the spread of contamination and the area will be posted in accordance with the Southeast RPP.

- All decontamination attempts and surveys will be properly documented.

Restrict Access (process when removable contamination greater than 10,000 dpm/100 cm^2).

- When removable contamination is greater than 10,000 dpm/100 cm^2, restrictive locks will be placed on doors to limit access to the area or item. The RSO will coordinate with SAIC to make a determination on how to safely decontaminate or place the item in storage for disposal.

- A survey of the surrounding area near the contaminated item will be made to ensure contamination has not spread.

- All decontamination attempts and surveys will be properly documented.

NRC Notification (process when removable contamination is greater than 110,000 dpm/100 cm^2).

- If the removable contamination is greater than 110,000 dpm/100 cm^2, the room/area will be evacuated and the doors secured with restrictive locks. Southeast will notify the NRC within 24 hours of discovery of removable contamination at this level.

- Decontamination and/or removal of the item will be conducted by the RSO and/or SAIC under an approved RWP.

2.5 STORAGE AND DISPOSAL

Contaminated materials will be stored in the Magill Hall Radiation Bunker, which currently is an approved radioactive materials storage location on the Southeast NRC license. This room is double locked with restrictive cores and a padlock. Only the RSO

and designee have access. Other temporary RMSAs may be set up if approved by the RSO.

Contaminated materials, not to exceed 1 mCi total Am-241 activity can be stored for up to 1 year. Storage will be conducted in accordance with RPP Procedure RP-25.

Disposition of contaminated materials, including packaging, transport, and disposal, will be performed by the RSO and/or an outside contractor in accordance with applicable RPP procedures.

2.6 SURVEY DOCUMENTATION

All radiological surveys within the scope of this plan will be documented in accordance with the appropriate Southeast RPP procedures and this plan, as appropriate.

3.0 EXPOSURE EVALUATION

3.1 IDENTIFICATION OF POTENTIALLY EXPOSED PERSONNEL

The identification of potentially exposed personnel will be conducted on a case by case basis as determined by the RSO after review of the radiological survey results.

3.2 EVALUATION TO DETERMINE REQUIREMENT TO MONITOR

Southeast will monitor for internal exposure those non-occupational personnel identified in Section 3.1 that are likely to have received a total effective dose equivalent of 100 mrem/yr as determined by the RSO.

4.0 SAFETY AND HEALTH

Personnel involved with the scope of this document will follow all applicable local, state, and federal regulations, and applicable Southeast RPP procedures.

5.0 REFERENCES

Code of Federal Regulations, Title 10 Part 20, "Standards for Protection Against Radiation", Nuclear Regulatory Commission.

NRC 1974, Regulatory Guide 1.86, “Termination of Operating Licenses for Nuclear Reactors”, United States Atomic Energy Commission, Directorate of Regulatory Standards, June.

NRC 2001, NRC Inspection Report 030-33508/2000-002(DNMS) and Notice of Violation, Letter from NRC to Southeast Missouri State University dated January 19, 2001.

SAIC 2002a, “Visual Scoping and Survey Plan”, Southeast Missouri State University, April

SAIC 2002b, Implementation of the Visual Scoping and Survey Plan – Final Report, Southeast Missouri State University, September.

APPENDIX A

EXPOSURE SCENARIO DEVELOPMENT FOR TABLE IN JH222

1.0 INTRODUCTION

The purpose of this document is to develop conservative exposure scenarios for Chemistry department staff, Facilities Management employees, and other credible exposure groups who may have been potentially exposed to the americium-241 (Am-241) contaminated table found at Southeast in Johnson Hall Room 222 (JH222).

2.0 HISTORY

On February 28, 2002, the Southeast Radiation Safety Officer (RSO) discovered a slate top table in JH222. He recognized the table as an item that may have come from the previously Am-241 contaminated laboratory in Magill Hall. The RSO performed an initial radiological survey on the table and found levels of fixed and loose radiological contamination above the release limits established in Southeast's Radiation Protection Program (RPP).

On March 14, 2002, a one hundred percent (100%) radiological survey of the items in JH222 was performed to determine the magnitude and extent of contamination and determine the appropriate disposition of contaminated items. Two boxes were found with levels of contamination above release limits; however the majority of the contamination was located on the table itself. The survey results revealed two "hotspots" (each less than 100 cm^2 in size) on the table. One hotspot had a total alpha contamination level of 280,000 disintegrations per minute per 100 cm^2 (dpm/100 cm^2) and 261 dpm/100 cm^2 removable. The other hotspot had 9000 dpm/100 cm^2 total alpha and 210 dpm/100 cm^2 removable. The rest of the table had levels of fixed and removable contamination higher than background, but well below the lowest hotspot results.

JH222 is primarily used as a storage room for boxes of paperwork and other items from Johnson Hall. It is unlikely that any individual would have spent more than thirty minutes per workday in this room. However, the history of the location of the table prior to being located in JH222 and the date that the table became contaminated is unknown. Therefore, exposure scenarios should consider the table to be available in other more conservative settings (i.e., classroom, office, etc.) as well as the storage room.

3.0 METHODOLOGY

RESRAD-BUILD Version 3.1 was used to determine a conservative dose to the maximally exposed individuals identified in the exposure scenarios below.

4.0 REASONABLE SCENARIOS

Since the history of the table is unknown, there are an unlimited number of scenarios that can be developed. However, it is not likely that the table has been in a location outside of the College of Science and Mathematics buildings. Therefore, the hypothetically maximally exposed individual or group would be persons who frequent the science buildings regularly. These individuals would include science department staff (instructors, graduate students, etc.), students, and facilities management personnel. It is

not likely that other groups or individuals would spend more time in the science buildings than those listed. Students and graduate students would likely spend less time in the science halls than instructors and they would likely spend their time in the same locations as the instructors. Also there is a specific concern about potential dose received by individuals involved in moving the table from one location to another. These individuals will be considered a subset of the facilities management scenario described below since it is likely that they spent less time per year around the table than the individual in the scenario. The concern that the table movers might have higher exposures due to potentially higher contact and indirect ingestion is negated because all scenarios use the conservative default value for indirect ingestion.

Therefore, there are three reasonable exposure scenarios for maximally exposed groups or individuals that have been modeled:

- Chemistry department staff who spend an entire work year at the contaminated table using it as a desk;
- Chemistry department staff who teach a class or lab at the table during a school year; and
- Facilities Management (FM) personnel who moved the table then continually move boxes in and out of storage every day for an entire work year.

Other scenarios (e.g., a student attending classes at the table) were considered, however, the three scenarios listed were determined to be the most limiting.

5.0 EXPOSURE MODELING

For the scenarios described above, the NRC approved RESRAD-BUILD Version 3.1 modeling code was used to conservatively determine exposures. The RESRAD-BUILD code uses conservative default values, but allows the user to change these values, as appropriate, to model a more realistic exposure. All the RESRAD-BUILD default values except indoor fraction, lifetime, and source geometry were used.

All values input into the RESRAD-Build code are listed in Table A-1.

Table A-1. RESRAD-BUILD Input Parameters

Scenario	Desk (Chemistry Staff)	Classroom Table (Chemistry Staff)	FM person	Comments
Time Parameters				
Exposure Duration	365 days	365 days	365 days	Default
Indoor Fraction	0.23	0.082	0.014	See Below
Evaluation Time	1 year	1 year	1 year	Default
Building Parameters				
Number of Rooms	1	1	1	Default
Deposition Velocity	0.01 m/sec	0.01 m/sec	0.01 m/sec	Default
Resuspension Rate	5.0 E-07 sec^{-1}	5.0 E-07 sec^{-1}	5.0 E-07 sec^{-1}	Default
Building Exchange Rate	0.8 hr^{-1}	0.8 hr^{-1}	0.8 hr^{-1}	Default
Room Area	36 m^2	36 m^2	36 m^2	Default
Room Height	2.5 m	2.5 m	2.5 m	Default
Room Exchange Rate	0.8 hr^{-1}	0.8 hr^{-1}	0.8 hr^{-1}	Default
In/Out Flow Rate	72 m^3/hr	72 m^3/hr	72 m^3/hr	Default
Receptor Parameters				
Number of Receptors	1	1	1	Default
Room # Location	1	1	1	Default
Time Fraction	1	1	1	Default
Breathing Rate	18 m^3/day	18 m^3/day	18 m^3/day	Default
Ingestion Rate	1 E-04 m^2/hr	1 E-04 m^2/hr	1 E-04 m^2/hr	Default
Receptor Location	5m, 3m, 1m	5m, 3m, 1m	5m, 3m, 1m	See Below
Shielding Parameters				
Thickness	0	0	0	Default
Density	NA	NA	NA	Default
Material	NA	NA	NA	Default
Source Parameters				
Number of Sources	1	1	1	Default
Room # location	1	1	1	Default
Source Type	Area	Area	Area	See Below
Direction	X	X	X	See Below
Location	6m, 3m, 1m	6m, 3m, 1m	6m, 3m, 1m	See Below
Geometry: Area	2 m^2	2 m^2	2 m^2	See Below
Air Fraction	0.1	0.1	0.1	Default
Direct Ingestion	0 g/hr	0 g/hr	0 g/hr	Default
Removal Fraction	0.5	0.5	0.5	Default
Lifetime	1825 days	1825 days	1825 days	See Below
Radionuclides Concentration	4.7E5 pCi/m^2	4.7E5 pCi/m^2	4.7E5 pCi/m^2	See Below

6.0 EXPLANATION OF NON-DEFAULT PARAMETERS

The RESRAD-BUILD default value for indoor fraction is set at 0.5. The indoor fraction is the fraction of time an individual spends inside the contaminated room during the exposure duration. The default value for exposure duration is 365 days (1 year). Since the contaminated room is located in the university, it is unlikely that any individual would spend 12 hours per day every day of the year in JH222 or any other room. Conservative indoor fractions have been calculated for the scenarios.

- Chemistry department staff using the table as a desk could spend 2000 hours per year (hr/yr) based upon 40 hours per week and 50 weeks per year. Therefore the indoor fraction for this scenario is 0.23 (2000 hr/yr at work / 8760 hr/yr total).

- Chemistry department staff who teach a class or lab at the table could spend 720 hr/yr based upon 9 months of class, 20 days per month, and 4 hours per day (hr/day). Therefore the indoor fraction for this scenario is 0.082 (720 hr/yr in the room / 8760 hr/yr total).

- A FM person moving the table and other material in and out of storage every day for an entire work year could spend 125 hr/yr based upon 50 weeks per year, 5 days per week, and 30 minutes per day in the contaminated room. Therefore the indoor fraction for this scenario is 0.014 (125 hr/yr in the room / 8760 hr/yr total).

The source location was set based upon as found conditions of the table in JH222. The receptor location was set assuming the individual was very close to the source (1 m away). Source type was set as an AREA and direction was set as X.

The RESRAD-BUILD default value for source geometry is set at 36 m^2, which is equivalent to the default value for room area. The actual room area is approximately 36 m^2, however, the extent of contamination was primarily limited to the table top. Although the majority of contamination was located at two hotspots on the table (each less than or equal to 100 cm^2), the entire surface area of the table is modeled to be evenly distributed with levels of contamination at 10,355 dpm/100 cm^2, which is equivalent to the weighted average contamination level shown below. A conservative source geometry for all scenarios of 2 m^2 is assumed for the surface area of the table (1 m by 2 m).

The RESRAD-BUILD default value for source lifetime is set at 365 days (1 year). Source lifetime represents the time over which surface contamination is removed. It is likely that the table was contaminated in the 1970's in Magill Hall room 242 (MH242) when it was used as a radiochemistry laboratory. However, the table may have been contaminated during the Am-241 source spill in the basement of Magill Hall. Since the Am-241 source spill in the basement of Magill Hall is assumed to have occurred in 1997 and MH242 has not been used as a radiochemistry laboratory since 1980, it is unlikely that the surface contamination would have been removed in 1 year. This statement is confirmed by the fact that, at least five years after the contamination event, survey results indicate that the

surface contamination has not been removed completely. Therefore, conservative source lifetime values have been set at 1825 days (5 years) for all scenarios.

A conservative value for source concentration was calculated to be 4.7E05 picocuries per m^2 (pCi/ m^2) based upon an average total alpha contamination level of 10,355 dpm/100 cm^2 evenly distributed over the entire area of the source. The average total contamination level was calculated by conservatively assuming that the entire table (except the most contaminated hotspot) was contaminated at the same level as the least contaminated hotspot and then averaging the two areas as shown below:

Assume:

Area $_{total}$ = 2 m^2
Hotspot A:

- Area $_a$ = 100 cm^2 (0.01 m^2)
- Concentration (C_a) = 280,000 dpm/100 cm^2
- Hotspot B:
- Area $_b$ = Source area – Hotspot A area = 2 m^2 – 0.01 m^2 = 1.99 m^2
- Concentration (C_b)= 9000 dpm/100 cm^2

$$C_{ave} = \frac{((C_a * Area_a) + (C_b * Area_b))}{Area_{total}} = \frac{((280{,}000 * 0.01) + (9000 * 1.99))}{2} = 10{,}355 \text{ dpm/100 cm}^2$$

$$C_{RESRAD} = \frac{10{,}355 dpm}{100 cm^2} * \frac{1 \rho Ci}{2.22 dpm} * \frac{100 (100 cm^2)}{1 m^2} = 4.7\text{E05 pCi/m}^2$$

7.0 EXPOSURE MODELING RESULTS

The conservative parameters were input into the RESRAD-BUILD code resulting in the following modeled exposures listed in Table A-2.

Table A-2. RESRAD-BUILD Exposure Results

Scenario	Desk (Chemistry staff)	Classroom Table (Chemistry staff)	FM Person
Exposure (mrem/yr)	10.2	3.6	0.6

APPENDIX B

EXPOSURE SCENARIO DEVELOPMENT AND DETERMINATION OF UNRESTRICTED RELEASE CRITERIA FOR PREVIOUSLY INACCESSIBLE SURFACES IN MAGILL HALL

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this appendix is to develop dose-based release criteria for potential contamination that may be present on previously inaccessible building surfaces within Magill Hall at Southeast. Americium is the contaminant of concern (COC) for the Southeast Site, specifically the isotope Am-241. The release criterion derived for Am-241 meet the "radiological criteria for unrestricted use" requirements set forth by the NRC. These criteria can be found in the 10 CFR Part 20.1402. In accordance with 10 CFR 20 Subpart E, a site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem/yr.

The 25 mrem/yr value is a primary limit. The release criterion represents cleanup goals that, if met, will ensure that the primary limit is satisfied. Demonstrating compliance with the release criterion presented in this report would allow release of the building surfaces without institutional controls.

1.2 SCOPE

The dose-based release criteria derived and documented in this appendix are applicable for potential surface contamination present on previously inaccessible building surface within Magill Hall.

1.3 BACKGROUND INFORMATION

On April 12, 2002, Southeast submitted a letter to USNRC, Region III to present the results of a conservative dose assessment for potential exposures resulting from the contaminated table discovered in Johnson Hall Room 222 on the Southeast. RESRAD-Build version 3.1 was used for determining doses to three reasonable maximally exposed receptor scenarios. They include:

- Chemistry department staff who spends an entire work year at the contaminated table using it as a desk;
- Chemical department staff who teach a class or lab the table during a school year; and
- Facilities Management (FM) personnel who moved the table then continually move boxes in and out of storage everyday for an entire work year.

Appendix A of this report includes details related to that letter. Appendix A includes all the necessary information related to three receptor scenarios, source terms, exposure pathways, and results of the assessments. The results of the assessment showed that the chemistry departmental staff who spends an entire year at the contaminated table receives the maximum dose (10.2 millirem per year (mrem/yr)).

2.0 DEVELOPMENT OF DOSE-BASED RELEASE CRITERION

2.1 SELECTION OF THE ANNUAL PUBLIC DOSE LIMIT

The annual dose limit for the site corresponds to the radiological criteria for unrestricted use given in 10 CFR Part 20.1402.

2.2 DEFINING THE SOURCE TERM

As a conservative assumption, this assessment assumed 25% of the floor of the hypothetical room in Magill Hall is uniformly contaminated and that 50% of the contamination identified is removable surface contamination. Therefore the source term is based upon surficial contamination. Except for the receptor, source lifetime, and source area and location, the assigned values for all other source related parameters remain the same as that presented in Appendix A. Table B-1 includes the assigned values for the modeled parameters. The source lifetime was reduced from 1,825 days to 365 days to account for the potential of additional mechanical disturbance of surficial contamination during remediation.

2.3 SELECTION OF CRITICAL RECEPTOR SCENARIO

As mentioned previously, among three receptor scenarios, the chemical staff who spends an entire work year at the contaminated table using it as a desk is the critical receptor. This report utilizes that same receptor scenario during the derivation of release criteria for the previously inaccessible building surfaces. Except for the source and receptor location, the assigned values for all other exposure parameters remain the same. Table B-1 presents the assigned value for each RESRAD-Build parameters.

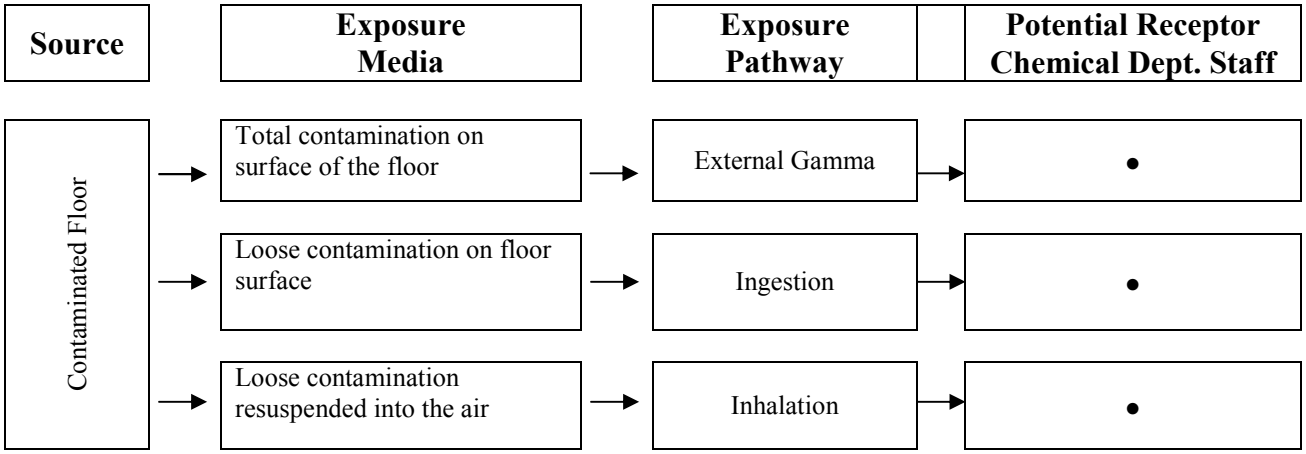
B-1. RESRAD-BUILD INPUT PARAMETERS

Scenario	Desk (Chemistry Staff)	Comments
Time Parameters		
Exposure Duration	365 days	Default
Indoor Fraction	0.23	Based on 2000 hour/yr occupancy rate
Evaluation Time	1 year	Default
Building Parameters		
Number of Rooms	1	Default
Deposition Velocity	0.01 m/sec	Default
Resuspension Rate	5.0 E-07 sec^{-1}	Default
Building Exchange Rate	0.8 hr^{-1}	Default
Room Area	36 m^2	Actual Size of the Room
Room Height	2.5 m	Default
Room Exchange Rate	0.8 hr^{-1}	Default
In/Out Flow Rate	72 m^3/hr	Default
Receptor Parameters		
Number of Receptors	1	Default
Room # Location	1	Default
Time Fraction	1	Default
Breathing Rate	18 m^3/day	Default
Ingestion Rate	1 E-04 m^2/hr	Default
Receptor Location	3m, 3m, 1m	Middle of the room
Shielding Parameters		
Thickness	0	Default
Density	NA	Default
Material	NA	Default
Source Parameters		
Number of Sources	1	Default
Room # location	1	Default
Source Type	Area	Surface Contamination
Direction	Z	25% of the floor is contaminated, and the receptor is located just 1meter above the source.
Location	3m, 3m, 0m	
Geometry: Area	9 m^2	
Air Fraction	0.1	Default
Direct Ingestion	0 g/hr	Default
Removal Fraction	0.5	Default
Lifetime	365 days	Lower than previous assessment to account for renovation.
Radionuclide	Am-241	
Radionuclides Concentration	1 pCi/m^2	

2.4 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) identifies the relationship between the sources of contamination, source areas, transport mechanisms, exposure routes, and the receptor. The CSM provides a description of how contaminants enter into the environment, how they are transported within the environment, and the routes of exposures to humans. The CSM for JH222 structures is illustrated in Figure B-1. Figure B-1 identifies the contaminated medium considered in this report, potential receptor, and the exposure pathways that could lead to a radiological dose (in mrem/year) to potential receptor.

FIGURE B-1: CONCEPTUAL SITE MODEL FOR JH222



Although not shown in Figure B-1, the CSM assumes that receptor is exposed in a single room with a contaminated source. It is also assumed that the ingestion pathway is completed through the re-deposition of suspended dust particles followed by inadvertent hand-to-mouth transfer. This approach represents the RESRAD-BUILD default pathway for ingestion. The direct ingestion pathway (without considering re-deposition) is assumed to be negligible.

The complete exposure pathways for the critical receptor scenario are:

- External gamma exposure,
- Indirect ingestion of re-deposited non-fixed contamination, and
- Inhalation of re-suspended non-fixed contamination.

The external gamma pathway is independent of the contaminant nature (loose or fixed). However, the ingestion and inhalation pathways are subject only to the quantity of loose contamination that may be inadvertently transferred to the mouth or re-suspended into the air.

2.5 DETERMINATION OF STRUCTURE RELEASE CRITERION

RESRAD-Build, Version 3.3 was used to perform the dose assessment for the surface contamination present on the floor of the room. A unit concentration of Am-241 (1 pCi/m^2) along with the assigned values for RESRAD-Build model input parameters

provided in Table B-1 were used during the dose assessment. The dose resulting from a unit concentration for Am-241 is defined as the dose-to-source ratio (DSR). The DSR (in units of mrem/yr per pCi/ m^2) for the evaluation period for Am-241 was then divided into the 25 mrem/yr primary limit to determine the release criterion for Am-241.

3.0 RESULTS OF RELEASE CRITERION FROM RESRAD-BUILD OUTPUT

An assessment using Am-241 as the radionuclide COC was performed to determine the maximum dose. Attachment B-1 to this appendix presents the output RESRAD-Build run. Results of the assessment showed that the maximum dose for Am-241 occurred at year zero (0).

Table B-2 shows that the release criterion for Am-241 on previously inaccessible Magill Hall building surfaces is 1160 dpm/ 100 cm^2. This release criterion will be used to compare with surface measurements to be collected from the previously inaccessible building surfaces in Magill Hall as they become available for survey (i.e., during remodeling or renovation activities).

TABLE B-2. RELEASE CRITERION FOR AM-241 ON MAGILL HALL BUILDING SURFACES

Radionuclide	Dose to Source Ratio	Surface Contamination	Release Criterion
	(mrem/yr)/(pCi/m^2)	(pCi/m^2)	(dpm/100 cm^2)
Am-241	4.78E-04	5.23E+04	1160

4.0 AREA FACTOR RELEASE LIMITS

The exposure scenario in described above is very conservative as an ALARA approach and tends to overestimate exposure. Therefore, release limit area factors were developed for small areas of elevated activity in rooms where previously inaccessible potentially radioactively contaminated areas are smaller than the area assumed for the receptor scenario. The area factors listed in Table B-2 were developed using the same receptor scenario documented above with the exception of the source area. Although area factor release limits were developed for areas down to 100 cm^2, as an ALARA approach Southeast will apply the 1 m^2 area factor for all elevated areas less than 1 m^2.

When evaluating small areas of elevated activity, Southeast will ensure that removable contamination is less than the Regulatory Guide 1.86 removable contamination limits; will ensure that the average contamination levels for all previously inaccessible potentially radioactively contaminated areas in a room are less than the release criteria stated in Section 2.2.2 for total alpha activity; and apply the area factor release limits of Table 2-3.

NOTE: In rooms where the total area of previously inaccessible potentially radioactively contaminated areas is less than the receptor scenario source area of 9 m^2, then the next highest area factor release limit will apply to the entire area (e.g., if the total previously inaccessible potentially radioactively contaminated area in a room is 3 m^2 then the area factor release limit for 4 m^2 will apply to the entire area verses the 9 m^2 release limit.

TABLE B-2. AREA FACTORS FOR SMALL AREAS OF ELEVATED ACTIVITY

Area (m^2)	Dose to Source Ratio	Surface Contamination	Area Factor Release Limit
	(mrem/yr)/(pCi/m^2)	(pCi/m^2)	(dpm/100 cm^2)
9	4.78E-04	5.23E+04	1160
4	2.13E-04	1.17E+05	2,600
1	5.31E-05	4.71E+05	10,000
0.1	5.31E-06	4.71E+06	104,000
0.01 (100 cm^2)	5.31E-07	4.71E+07	1,045,000

ATTACHMENT B-1

RESRAD-BUILD VERSION 3.3 SCENARIO OUTPUT

 Title : Default Case for RESRAD-BUILD
 Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld

RESRAD-BUILD Table of Contents

 Title : Default Case for RESRAD-BUILD
 Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld

RESRAD-BUILD Input Parameters

Number of Sources : 1
Number of Receptors: 1
Total Time   : 3.650000E+02 days
Fraction Inside   : 2.300000E-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

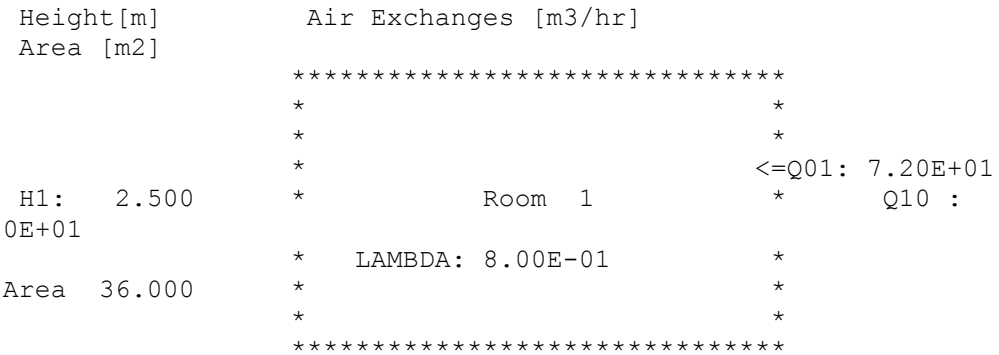
Receptor-Source Shielding Relationship

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

 Title : Default Case for RESRAD-BUILD
 Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld

======== Building Information ========

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



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

 Title : Default Case for RESRAD-BUILD
 Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld

======== Source Information ========

 Source: 1
        Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00[m]
        Geometry:: Type: Area   Area:9.00E+00 [m2] Direction: z
        Pathway ::
             Direct Ingestion Rate: 0.000E+00 [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 13 Morbidity

		Ingestion	Inhalation	Submersion
	[pCi/m2]	[mrem/pCi]	[mrem/pCi]	[mrem/yr/(pCi/m3)]
AM-241	1.000E+00	3.640E-03	4.440E-01	9.554E-05
NP-237	0.000E+00	4.444E-03	5.400E-01	1.212E-03
U-233	0.000E+00	2.890E-04	1.350E-01	1.904E-06
TH-229	0.000E+00	4.027E-03	2.169E+00	1.741E-03

 Title : Default Case for RESRAD-BUILD
 Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld
 Evaluation Time: 0.00000000E+00 years

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

Source Information

Source: 1
Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m]
Geometry:: Type: Area Area:9.00E+00 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 5.000E-01
Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [pCi/m2]
AM-241	1.000E+00
NP-237	0.000E+00
U-233	0.000E+00
TH-229	0.000E+00

 Title : Default Case for RESRAD-BUILD
 Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld
 Evaluation Time: 0.00000000E+00 years

RESRAD-BUILDDose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Total
Receptor 1	4.78E-04	4.78E-04
Total	4.78E-04	4.78E-04

 Title : Default Case for RESRAD-BUILD
 Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld
 Evaluation Time: 0.00000000E+00 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.08E-07	3.68E-09	1.53E-11	4.67E-04	0.00E+00	1.02E-05
Total	1.08E-07	3.68E-09	1.53E-11	4.67E-04	0.00E+00	1.02E-05

 Title : Default Case for RESRAD-BUILD
 Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld
 Evaluation Time: 0.00000000E+00 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
AM-241		
AM-241	4.78E-04	4.78E-04
NP-237	9.23E-11	9.23E-11
U-233	3.23E-17	3.23E-17
TH-229	1.19E-20	1.19E-20

 Title : Default Case for RESRAD-BUILD
 Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld
 Evaluation Time: 1.00000000 years

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

Source Information

Source: 1
Location:: Room : 1 x: 3.00 y: 3.00 z: 0.00 [m]
Geometry:: Type: Area Area:9.00E+00 [m2] Direction: z
Pathway ::
Direct Ingestion Rate: 0.000E+00 [1/hr]
Fraction released to air: 1.000E-01
Removable fraction: 0.000E+00
Time to Remove: 3.650E+02 [day]

Contamination::

Nuclide	Concentration [pCi/m2]
AM-241	4.992E-01
NP-237	1.618E-07
U-233	3.528E-13
TH-229	1.111E-17

 Title : Default Case for RESRAD-BUILD
 Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld
 Evaluation Time: 1.00000000 years

RESRAD-BUILDDose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Total
Receptor 1	7.16E-08	7.16E-08
Total	7.16E-08	7.16E-08

Title : Default Case for RESRAD-BUILD
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld
Evaluation Time: 1.00000000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	7.16E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	7.16E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

 Title : Default Case for RESRAD-BUILD
 Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld
 Evaluation Time: 1.00000000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
AM-241		
AM-241	7.16E-08	7.16E-08
NP-237	2.00E-13	2.00E-13
U-233	4.63E-21	4.63E-21
TH-229	4.87E-23	4.87E-23

 Title : Default Case for RESRAD-BUILD
 Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Decon BO.bld
 Full Summary

RESRAD-BUILD Dose (Time) Tables

Receptor Dose Received for the Exposure Duration

(mrem)

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	4.78E-04	7.16E-08

Receptor Dose/Yr Averaged Over Exposure Duration

(mrem/yr)

	Evaluation Time [yr]	
	0.00E+00	1.00E+00
1	4.78E-04	7.16E-08