Southeast
Missouri State University

ONE UNIVERSITY PLAZA • CAPE GIRARDEAU, MISSOURI 63701-4799 • (573) 651-2000 • http://www.semo.edu

July 2, 2010

Mr. Kevin Null
USNRC Region III
2443 Warrenville Road
Suite 210
Lisle, Illinois 60532-4352

Dear Mr. Null:

Enclosed please find a revised version of our "Decontamination and Survey Plan for Magill and Rhodes Halls. This plan is tied to our current NRC license No. 24-09296-02 parts 6 and 9, section H. This version is intended for your review prior to replacement. If it is sufficient as is, or after revision, we will formally request that it replace the current version of the Plan dated November 2006.

I will be available Tuesday through Friday of next week, and the week of the 12th if you have questions.

Sincerely,

Walt W. Lilly
Radiation Safety Officer
Professor of Biology

Decontamination and Survey Plan for Magill and Rhodes Halls

prepared for

Southeast Missouri State University
CAPE GIRARDEAU

prepared by

SAIC
An Employee-Owned Company

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
St. Louis, Missouri

July 2010

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LIST OF ACRONYMS AND ABBREVIATIONS

μCi	microcurie(s)
%	percent
σ	standard deviation
Δ	shift
Δ/σ	relative shift
A_f	area correction factor
Am	americium
ALARA	as-low-as-reasonably achievable
ALI	annual limit on intake
bgs	below ground surface
CFR	Code of Federal Regulations
cm	centimeter(s)
cm^2	square centimeter(s)
COC	Contaminant of Concern
cpm	counts per minute
Cs	cesium
CY	calendar year
D&D	decontamination and decommissioning
DCGL	Derived Concentration Guideline Level
$DCGL_{EMC}$	Derived Concentration Guideline Level used for elevated measurement comparison
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DOD	Department of Defense
DOE	Department of Energy
DQA	Data Quality Assessment
DQO	data quality objectives
EPA	Environmental Protection Agency
FIDLER	Field Instrument for the Detection of Low-Energy Radiation
FM	Facilities Management
FSS	Final Status Survey
ft	foot/feet
g	gram(s)
GPS	Global Positioning Systems
GWS	Gamma Walkover Survey
H_a	alternative hypothesis
H_0	null hypothesis
hr/yr	hours per year
HVAC	heating, ventilation, and air conditioning
JH222	Johnson Hall Room 222
keV	kiloelectron Volts
LBGR	Lower Bound of the Grey Region
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
m	meter(s)
m^2	square meter(s)

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

mCi	millicuries
MDC	minimum detectable concentration
MDC_{Scan}	scan minimum detectable concentration
MH242	Magill Hall Room 242
mrem/yr	millirmem per year
MS/MSD	matrix spike/matrix spike duplicate
NaI	Sodium Iodine
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
pCi	picocurie(s)
QA	quality assurance
QC	quality control
RESRAD	RESidual RADioactivity computer model
RSMA	radioactive material storage area
RPP	Radiation Protection Program
RRP	Radiation Protection Program procedure
RSO	Radiation Safety Officer
SAIC	Science Applications International Corporation
sec	second(s)
Sr	strontium
TEDE	total effective dose equivalent
Th	thorium
ZnS	zinc-sulfide

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 (FSS) of these areas in Magill Hall, 100 percent (%) 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.

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.

In May 2010, a small area of elevated activity was identified south of Magill Hall near the radiological material storage bunker. A Gamma Walkover Survey (GWS) was performed to locate the source of the elevated activity and a sample was collected. The analytical results from the sample collected during the investigation identified the elevated radioactivity as Am-241. Therefore, a revision to this plan was necessary to address protocol for investigation of surface soil adjacent to Magill and Rhodes Halls.

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. In addition to items mentioned above, surface soils around Magill and Rhodes Halls may require investigation for the presence of licensed materials. Appendix C has been added to this plan to describe how surface soils will be investigated, if necessary.

Survey, decontamination (if necessary), re-survey (if necessary) and release of these previously inaccessible items and surfaces will be investigated when the Radiation Safety Officer (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, heating, ventilation, and air conditioning [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.

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.

1.2 SITE DESCRIPTION AND HISTORY

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 Americium-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).

From CY02 to the present, radiological surveys have been conducted during renovation of classrooms and laboratories in Magill Hall. Surveys were conducted as described in Section 2.0 and survey results were compared to the release criteria in Table 2-1. Contaminated items and building surfaces were processed as described in Section 2.4.

In CY10, an investigation was performed on an area of surface soil which exhibited a small area of elevated activity south of Magill Hall near the radioactive material storage bunker. A GWS was performed using a Ludlum 44-10 Sodium Iodine (NaI) Detector. At the time of the GWS the Contaminant of Concern (COC) was unknown, however analytical results from the samples collected during the investigation have identified the elevated radioactivity as Am-241.

1.3 RADIOLOGICAL CONTAMINANT OF CONCERN

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

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.

A Ludlum Model 2221 meter with a 44-10 2"x2" NaI scintillation detector will be used for GWSs. In addition, a Field instrument for the Detection of Low-Energy Radiation (FIDLER) will also be used to conduct GWSs due to the low energy gamma emitted by Am-241. The FIDLER is a thin-window (1.6 millimeter) NaI scintillation detector that is specifically designed for low energy gamma radiation monitoring and is capable of detecting the 59.5 kiloelectron Volts (keV) gammas associated with Am-241 at lower levels than a standard 2"x2" NaI scintillation detector.

2.2 QUALITY CONTROLS

2.2.1 Field Survey Instrumentation Quality Controls

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

2.2.2 Soil Investigation Quality Controls

To assess whether quality assurance (QA) objectives have been achieved, analyses of specific field and laboratory QC samples will be required. These QC samples include field duplicates, field splits, laboratory method blanks, laboratory control samples, laboratory duplicates, rinsate blanks, and matrix spike/matrix spike duplicate (MS/MSD) samples.

Rinsate blanks will be submitted for analysis along with field QC samples to provide a means to assess the quality of the data resulting from the field sampling program. Rinsate blanks are used to assess the effectiveness of field decontamination processes if resusable equipment is used.

Field duplicate samples are analyzed to determine sample heterogeneity and sampling methodology reproducibility.

Field QA split samples will be collected as co-located or homogenized replicates of field QA samples and distributed to the QA laboratory for analysis. Split samples are implemented for detection of problems with field sampling, documentation, packaging, or shipping. They also provide an independent referee laboratory analysis, allowing the project to check the primary analytical result sensitivity, accuracy, and precision. With the exception of screening samples, QA split samples should be collected and analyzed at a frequency of approximately once every twenty samples (5%), or a minimum of one split sample per matrix sampled.

Laboratory method blanks and laboratory control samples are employed to determine the accuracy and precision of the analytical method implemented by the laboratory. MS's provide information about the effect of the sample matrix on the measurement methodology. Laboratory sample duplicates and MS and MSDs assist in determining the analytical reproducibility and precision of the analysis for the analytes of interest.

The general level of QC effort should be at least one field duplicate for every 20 investigative samples and at least one per matrix if there are less than 20 samples collected for a given matrix.

MS/MSD samples are investigative samples. One MS/MSD sample should be designated in the field and collected for at least every 20 investigative samples per sample matrix (i.e., ground water, soil).

2.3 UNRESTRICTED USE CRITERIA

2.3.1 Unrestricted Use Criteria for Items and Materials to be Released from the 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/100 cm^2)		
	Fixed [b]	Removable [b]	Maximum [c]
Am-241	100	20	300
Cs-137	5,000	1,000	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 cpm 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 square meter (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 square centimeters (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.

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	318	2
	Tile	0.5	12	633	1
	Counter Slate	0.5	16	637	1
	Steel	0.25	4	175	2.5
	Wood	0.5	9	428	1
43-93 w/2360 meter Beta	Concrete	0.25	404	N/A	2
	Tile	0.5	418	N/A	1
	Counter Slate	0.5	552	N/A	1
	Steel	0.25	514	N/A	2.5
	Wood	0.5	423	N/A	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).

2 The removable fraction of the total release criterion is assumed to be 50%.

2.3.2 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 (JH222) at Southeast. RESidual RADioactivity computer model (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 and 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 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 (m) above the contaminated floor. 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 5,600 disintegrations per minute per 100 square centimeters (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.

2.3.3 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 square meter (m^2) (not to exceed 30,000 dpm/100 cm^2 in any single location) (SAIC 2002a).

2.3.4 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 microcurie [μCi] 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 2000a). 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).

2.3.5 Soil Release Criteria

Soil release criteria are provided in Table C-1 in Appendix C of this plan. Initially, the soil release criteria are defined as the NRC Screening Levels from *Consolidated NMSS Decommissioning Guidance – Characterization, Survey, and Determination of Radiological Criteria* (NUREG-1757) (NRC 2006); however, at a later time, Southeast may choose to calculate site specific soil release criteria for NRC review and approval.

2.4 SURVEYING AND SAMPLING

2.4.1 Surveys of Items/Building Surfaces

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.

2.4.2 Surface Soil Sampling

Surface soil samples will be collected from 0 to 15 centimeters (cm) (0 to 0.5 foot [ft]) below ground surface (bgs) to determine if the soil satisfies soil release criteria. Soil sampling locations will be planned in accordance with the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (NRC 2000b) guidance as described in Appendix C of this plan. Soil samples will be collected using hand augers, trowels, or other appropriate collection method in accordance with Southeast or SAIC field technical procedures.

2.5 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.

2.6 CONTROLS FOR SOILS IN EXCESS OF RELEASE CRITERIA

In the event that soils in excess of release criteria are identified, the following controls will be put into place:

1. The NRC will be notified;
2. The area in question will be roped off or otherwise restricted for access;
3. Additional investigation will be conducted to determine the extent of contamination; and
4. The area will be posted as required by the Southeast RPP.

2.7 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.

Contaminated soils will be left in place and access restricted until such time that the NRC provides authorization for remediation of soil under the Southeast radioactive material license.

2.8 SURVEY DOCUMENTATION

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

Soil investigations will be documented in reports following the general guidance in MARSSIM as described in Appendix C to this plan.

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 SAFETEY 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 (CFR), Title 10 Part 20, "Standards for Protection Against Radiation", Nuclear Regulatory Commission.

EPA 2006. U.S. Environmental Protection Agency, Office of Environmental Information. *Data Quality Assessment: A Reviewer's Guide*. EPA QA/G-9R. EPA/240/B-06/002. February 2006.

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

NRC 1998. *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, NUREG-1507, U.S. Nuclear Regulatory Commission, June.

NRC 2000a. *Development of Probabilistic RESRAD 6.0 and RESRAD 3.0 Computer Codes,* Nuclear Regulatory Commission, NUREG 6697.

NRC 2000b. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, 1575, USEPA 402-R-97-016, Revision 1, U.S. Department of Defense, U. S. Department of Energy, U.S. Environmental Protection Agency, and U.S. Nuclear Regulatory Commission, August.

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.

NRC 2006. *Consolidated NMSS Decommissioning Guidance – Characterization, Survey, and Determination of Radiological Criteria*, NUREG 1757, Volume 2. Revision 1. September 2006.

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 JOHNSON HALL ROOM 222

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 Am-241 contaminated table found at Southeast in 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 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 square centimeters [cm^2] in size) on the table. One hotspot had a total alpha contamination level of 280,000 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
- 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

g – gram(s)

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. 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 $(C_b) = 9{,}000\ dpm/100\ cm^2$

$$C_{ave} = \frac{((C_\alpha\ x\ Area_\alpha)+(C_\beta x Area_\beta))}{Area_{total}} = \frac{((280{,}000\ x\ 0.01)+(9{,}000\ x\ 1.99)}{2} = 10{,}355\ dpm/100\ cm^2$$

$$C_{RESRAD} = \frac{10{,}355\ dpm}{100\ cm^2}\ x\ \frac{1\ pCi}{2.22\ dpm}\ x\ \frac{100(100\ cm^2)}{1\ m^2} = 4.7x10^5\ pCi/m^2$$

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 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 JH222 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
- 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 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.

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.

Table 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

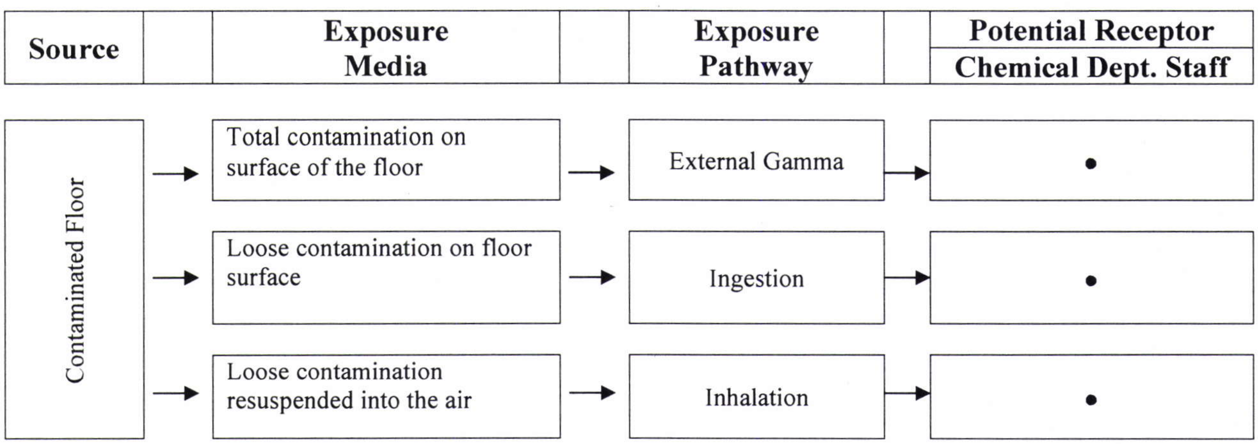
Table B-1. RESRAD-Build Input Parameters

Scenario	Desk (Chemistry Staff)	Comments
	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	1,825 days	Same as Previous Assessment
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/gram [g]) 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 maximum DSR (in units mrem/yr per pCi/g) over the 1000-year 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 (for years 0, 1, 10, 100, and 1000) using Am-241 as the radionuclide COC was performed to determine when the maximum dose would occur during a 1000 year period. Attachment B-1 to this appendix represents 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 5600 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 Americium-241 on Magill Hall Building Surfaces

Radionuclide	Dose to Source Ratio (mrem/yr)/(pCi/m^2)	Surface Contamination (pCi/m^2)	Release Criterion (dpm/100 cm^2)
Am-241	9.78E-05	2.56E+05	5,676

ATTACHMENT B-1

RESRAD-BUILD VERSION 3.3 SCENARIO OUTPUT

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 1 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld

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** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 2 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld

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ÍÍÍ RESRAD-BUILD Input Parameters ÍÍÍ
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Number of Sources : 1
Number of Receptors: 1
Total Time : 3.650000E+02 days
Fraction Inside : 2.300000E-01

ÍÍÍÍÍÍÍÍÍ Receptor Information ÍÍÍÍÍÍÍÍÍ

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

ÍÍÍ Receptor-Source Shielding Relationship ÍÍÍ

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

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** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page:  3 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld


ííííííí Building Information ííííííí


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


          Height[m]      Air Exchanges [m3/hr]
                         Area [m2]
                   ********************************
                   *                      *
                   *                      *
                *                <=Q01: 7.20E+01
H1:  2.500    *      Room  1       *    Q10 :  7.20E+01
                  *  LAMBDA: 8.00E-01        *
          Area  36.000   *                      *
                   *                      *
                   ********************************


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

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 4 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld

ÍÍÍÍÍÍÍÍ Source Information ÍÍÍÍÍÍÍÍ

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: 1.825E+03 [day]

Contamination::

Nuclide	Concentration [pCi/m2]	Dose Conversion Factor (Library: FGR 13 Morbidity) Ingestion [mrem/pCi]	Inhalation [mrem/pCi]	Submersion [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

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 5 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 0.00000000E+00 years

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

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: 1.825E+03 [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

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 6 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 0.00000000E+00 years

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ÍÍÍ RESRAD-BUILDDose Tables ÍÍÍ
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Source Contributions to Receptor Doses
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[mrem]

	Source 1	Total
Receptor 1	9.77E-05	9.77E-05
Total	9.77E-05	9.77E-05

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 7 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 0.00000000E+00 years

Pathway Detail of Doses
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[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.36E-07	7.52E-10	3.13E-12	9.55E-05	0.00E+00	2.09E-06
Total	1.36E-07	7.52E-10	3.13E-12	9.55E-05	0.00E+00	2.09E-06

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 8 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 0.00000000E+00 years

Nuclide Detail of Doses
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[mrem]

Source: 1

Nuclide	Receptor 1 AM-241	Total
AM-241	9.77E-05	9.77E-05
NP-237	1.94E-11	1.94E-11
U-233	6.88E-18	6.88E-18
TH-229	2.61E-21	2.61E-21

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 9 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 1.00000000 years

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ííí Assessment for Time: 2 ííí
ííí Time =1.00E+00 yr ííí
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ííííííí Source Information ííííííí

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: 4.444E-01
Time to Remove: 1.825E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m2]
	AM-241	8.985E-01
	NP-237	2.913E-07
	U-233	6.350E-13
	TH-229	1.999E-17

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 10 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 1.00000000 years

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ííí RESRAD-BUILDDose Tables ííí
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Source Contributions to Receptor Doses
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[mrem]

	Source 1	Total
Receptor 1	9.75E-05	9.75E-05
Total	9.75E-05	9.75E-05

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 11 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 1.00000000 years

Pathway Detail of Doses
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[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.22E-07	7.50E-10	3.13E-12	9.53E-05	0.00E+00	2.08E-06
Total	1.22E-07	7.50E-10	3.13E-12	9.53E-05	0.00E+00	2.08E-06

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 12 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 1.00000000 years

Nuclide Detail of Doses
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Source: 1

Nuclide	Receptor 1 AM-241	Total
AM-241	9.75E-05	9.75E-05
NP-237	5.81E-11	5.81E-11
U-233	4.82E-17	4.82E-17
TH-229	3.92E-20	3.92E-20

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 13 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 10.0000000 years

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ííí Assessment for Time: 3 ííí
ííí Time =1.00E+01 yr ííí
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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: 1.825E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m2]
	AM-241	4.920E-01
	NP-237	1.607E-06
	U-233	3.511E-11
	TH-229	1.106E-14

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 14 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 10.0000000 years

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Source Contributions to Receptor Doses
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[mrem]

	Source 1	Total
Receptor 1	7.05E-08	7.05E-08
Total	7.05E-08	7.05E-08

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 15 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 10.0000000 years

Pathway Detail of Doses
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[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	7.05E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	7.05E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 16 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 10.0000000 years

Nuclide Detail of Doses
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Source: 1

Nuclide	Receptor 1 AM-241	Total
AM-241	7.05E-08	7.05E-08
NP-237	1.39E-12	1.39E-12
U-233	2.18E-19	2.18E-19
TH-229	1.50E-20	1.50E-20

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 17 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 100.000008 years

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ííí Assessment for Time: 4 ííí
ííí Time =1.00E+02 yr ííí
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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: 1.825E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m2]
	AM-241	4.259E-01
	NP-237	1.496E-05
	U-233	3.348E-09
	TH-229	1.065E-11

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 18 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 100.000008 years

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Source Contributions to Receptor Doses
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[mrem]

	Source 1	Total
Receptor 1	6.11E-08	6.11E-08
Total	6.11E-08	6.11E-08

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 19 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 100.000008 years

Pathway Detail of Doses
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[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	6.11E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	6.11E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 20 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 100.000008 years

Nuclide Detail of Doses
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Source: 1

Nuclide	Receptor 1 AM-241	Total
AM-241	6.10E-08	6.10E-08
NP-237	1.24E-11	1.24E-11
U-233	1.90E-17	1.90E-17
TH-229	1.27E-17	1.27E-17

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 21 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 1000.00000 years

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ííí Assessment for Time: 5 ííí
ííí Time =1.00E+03 yr ííí
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ííííííí Source Information ííííííí

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: 1.825E+03 [day]

Contamination::	Nuclide	Concentration [pCi/m2]
	AM-241	1.005E-01
	NP-237	8.063E-05
	U-233	2.205E-07
	TH-229	7.573E-09

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 22 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 1000.00000 years

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Source Contributions to Receptor Doses
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	Source 1	Total
Receptor 1	1.45E-08	1.45E-08
Total	1.45E-08	1.45E-08

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 23 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 1000.00000 years

Pathway Detail of Doses
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[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	1.45E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.45E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 24 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Evaluation Time: 1000.00000 years

Nuclide Detail of Doses
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[mrem]

Source: 1

Nuclide	Receptor 1 AM-241	Total
AM-241	1.44E-08	1.44E-08
NP-237	6.65E-11	6.65E-11
U-233	1.24E-15	1.24E-15
TH-229	8.87E-15	8.87E-15

** RESRAD-BUILD Dose Program Output, Version 3.3 06/23/06 14:47:17 Page: 25 **
Title : Dose Assessment for Am-241 (1 pCi/m2)
Input File : C:\Program Files\RESRAD_Family\BUILD\SEMO Dose Assessment.bld
Full Summary

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Receptor Dose Received for the Exposure Duration
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(mrem)

Evaluation Time [yr]

0.00E+00	1.00E+00	1.00E+01	1.00E+02	1.00E+03
9.77E-05	9.75E-05	7.05E-08	6.11E-08	1.45E-08

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

Evaluation Time [yr]

0.00E+00	1.00E+00	1.00E+01	1.00E+02	1.00E+03
9.78E-05	9.76E-05	7.06E-08	6.11E-08	1.45E-08

APPENDIX C

SOIL SURVEY PLAN FOR SURFACE SOILS OUTSIDE MAGILL AND RHODES HALLS

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this Soil Survey Plan is to provide the basis for conducting surveys and sampling of the soils surrounding Magill and Rhodes Halls.

The ultimate objective of the survey plan is to determine if soil areas adjacent to Magill and Rhodes Hall have been impacted by licensed activities at Southeast.

1.2 SCOPE

This plan provides guidance in the following areas:

- MARSSIM classification of an impacted site or impacted portions of a site;
- Planning and execution of MARSSIM based characterization and/or FSSs (surveys);
- Survey data analysis; and
- Survey reporting.

The survey process for investigation of surface soils as described in this plan consists of the following general steps:

- Identify the Derived Concentration Guideline Levels (DCGLs);
- Classify impacted sites or impacted portions of sites based on contamination potential;
- Design the survey;
- Execute the survey;
- Evaluate the survey data; and
- Prepare a survey report.

The details of the planning and evaluation process are described in subsequent sections.

1.3 APPLICABILITY

This plan is applicable to impacted surface soils adjacent to Magill and Rhodes Halls.

1.4 RADIOLOGICAL CONTAMINANTS OF CONCERN

Am-241 is the primary radiological COC. Since other radionuclides (e.g., Cs-137) have been previously identified in a waste stream (e.g., acid dilution pit sediment) from Southeast laboratories, radiological surveys will be conducted that are capable of detecting the gamma energy associated with Am-241 and Cs-137.

2.0 DATA QUALITY OBJECTIVES

The data quality objectives (DQOs) for soil surveys are provided below to establish a systematic procedure for defining the criteria by which the data collection design is satisfied. The DQO process includes a description of when to collect samples, where to collect samples, the tolerable level of decision errors for the study, and how many samples to collect. The DQO process includes the following seven steps, which are found in the *Guidance for the Data Quality Objectives Process* (EPA 2000):

1. State the Problem;
2. Identify the Decision;
3. Identify Inputs to the Decision;
4. Define the Study Boundaries;
5. Develop the Decision Rule;
6. Specify Tolerable Limits on Decision Error; and
7. Optimize the Design for Obtaining Data.

The DQO process is described below as it applies to this Soil Survey Plan.

2.1 STATE THE PROBLEM

The surface soil adjacent to Magill and Rhodes Halls is potentially impacted as a consequence of licensed activities performed at Southeast.

2.2 IDENTIFY THE DECISION

This plan will be used to demonstrate that residual radionuclide concentrations within the surface soils comply with the DCGLs (Table C-1). Initially, DCGLs are defined as the NRC Screening Levels.

Table C-1. Radiological DCGLs

Radionuclide	Soil Surface
Am-241	2.1 pCi/g
Cs-137	11 pCi/g

At a later time, Southeast may choose to calculate site specific DCGLs for NRC review and approval. Compliance will be satisfied using guidance found in the MARSSIM and *Methods for Evaluating the Attainment of Cleanup Standards* (EPA 1989). Specifically, compliance will be demonstrated by:

- Collecting systematic/random and biased surface soil samples for radiological COCs consistent with MARSSIM;
- Performing GWS to identify gross radiological contamination and small areas of elevated activity;
- Comparing radiological sampling results from the analytical laboratory to DCGLs; and

2.3 IDENTIFY INPUTS TO THE DECISION

Guidance provided in MARSSIM is the basis for this Soil Survey Plan. The MARSSIM process was developed collaboratively by the NRC, Environmental Protection Agency (EPA), Department of Energy (DOE), and Department of Defense (DOD), for use in designing, implementing, and evaluating radiological surveys. This process emphasizes the use of DQO and Data Quality Assessment (DQA) processes, along with a sound program of quality assurance/quality control. The "graded approach" concept is also used to assure that survey efforts are maximized in those areas where there is the highest probability for residual contamination or greatest potential for adverse impacts of residual contamination. Examples of integrating the graded approach into the MARSSIM process include the use of site history, site conditions, equipment capabilities, and the results as the survey progresses to establish or adjust the degree of scanning coverage of a survey area, survey unit size, sampling frequency, and criteria for evaluation of elevated measurements.

Field activities for characterization and FSSs will consist of:

- Surface gamma scans of soil to identify gross contamination and any areas of elevated activity;
- Collecting systematic samples of surface soil;
- Collecting biased surface soil samples to investigate areas of elevated activity;
- Performing statistical tests; and
- Reviewing the data to verify that it is of sufficient quality and quantity.

The data generated by these field activities will be used to compare the radiological conditions to the radiological DCGLs identified in Table C-1. Survey activities will be conducted in accordance with standard operating procedures of Southeast and/or SAIC. Modifications, additions, or other changes to meet project-specific requirements as the survey progresses will be documented according to Southeast direction.

2.3.1 Concerns Related to the Radiological COCs

The weak gamma emission (i.e., 59.5 keV) given off by Am-241 poses several challenges in scanning large areas. Due to the weak gamma emission, a FIDLER will be used to scan for the presence of Am-241 in surface soil. Besides the scanning for Am-241, a NaI 2"x 2" detector will be used to scan surface soils for Cs-137. Any areas found to exhibit count rates greater than 1.5 times background will be rescanned with a FIDLER. A biased sample may be collected.

> The DCGL for Am-241 is such that the scan MDCs cannot be reliably met. However, when area factoring is taken into account, the scan MDCs are anticipated less than the Derived Concentration Guideline Level used for elevated measurement comparison ($DCGL_{EMC}$).

The decision to apply scanning for weak gamma radiation is highly dependent on the DCGLs and an assessment of the available survey instrument's ability to meet the DQOs for the DCGLs. This decision will be made when the DCGLs are available. Screening level DCGLs approved for use by the NRC are listed in Attachment A. If screening level DCGLs are not adequate for the purposes of the individual project, site specific DCGLs may need to be derived and approved by NRC.

As a result of the inability to scan at levels below the DCGL, sampling density will be increased sufficiently to minimize the chance of missing small areas of elevated activity.

2.3.2 Gamma Walkover Survey Procedure

To investigate surface soil areas adjacent to Magill and Rhodes Halls for the potential presence of contamination, GWSs are performed using a FIDLER and a 2" x 2" sodium iodide (NaI) detector tied to Global Positioning Systems (GPS) and a data logger. The surveyor will advance at a speed of approximately 1.6 ft/sec (0.5 m/sec) while passing the detector in a serpentine pattern about 10 cm (4 inches) above the ground surface. Audible response of the instrument will be monitored by the surveyor and locations of elevated audible response investigated. Scanning results will be recorded in cpm. The ambient background for the soil areas will be determined at the start of the survey and a scanning response that is detectable above the background level (e.g., 1,500 to 2,000 cpm above background) will be set as the GWS investigation level. GWS results that are evaluated will be plotted on a map of the area involved with color coding to depict the count rates present.

2.3.3 Gamma Walkover Survey Scan MDCs

GWS MDCs are a function of several variables including gamma emissions of the radionuclides of interest, detector characteristics, and surveyor efficiency. The assumptions used to calculate walkover survey MDCs in the NRC's NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC 1998), are appropriate for this survey. Using a 2 x 2 (NaI) detector, the following assumptions apply:

- NaI 2"x 2" background count-rate of 10,000 cpm.
- NaI 2"x 2" detector count-rate vs. exposure rate values in NUREG-1507, Table 6.4.
- An observation interval of 1 second (based on a scan rate of 1.6 ft/s (0.5 m/s).
- A level of performance to yield a d' of 1.38

Based on these assumptions, the walkover survey scan MDC for the NaI 2"x 2" detector applicable at Southeast is 31.5 pCi/g for Am-241 and 6.4 pCi/g for Cs-137.

2.3.4 GWS Coverage

Prior to conducting sampling, screening gamma scans will be performed for surface soils of Class 1, Class 2, and Class 3 areas (see Section 4.1.1 for information regarding area classification) at the percentage listed in Table C-2.

Table C-2. GWS Coverage Guidelines

Area Classification	Amount of Coverage	Notes
Class 1	100%	----------
Class 2	10% to 100%	Value based on the amount of concern for the presence of small areas of elevated activity.
Class 3	0 to 10%	Scans are biased towards areas that are most likely to have a contamination potential.

Locations exceeding the GWS investigation levels (typically 1,500 to 2,000 cpm above background) will be investigated by collecting representative biased samples (i.e., biased samples which represent an area of elevated activity). Gamma scan data may also be recorded in real time, using position and data recording methods.

Table C-3 lists radiological field survey instruments that are commonly used (functional and performance equivalents may be used, as determined by a Health Physicist). Refinements to these detection sensitivity estimates will be made, as necessary, on the basis of instrument response and background data gathered during site survey activities.

Table C-3. Typical Gamma Scan Instruments

Description	Application	Approximate Detection Sensitivity (pCi/g)
Ludlum Model 44-10; 2-inch × 2-inch sodium iodide (NaI) gamma scintillation detector	Gamma scans of all surfaces	Am-241 (31.5), Cs-137 (6.4)[a]
Ludlum Model 2221; Scaler/ratemeter (with earphones)	Readout instrument for gamma scintillation detector	N/A
G5 FIDLER NaI Gamma scintillation detector	Gamma scans of all surfaces	Able to detect weak gamma emissions given off my Am-241

[a] Value from NUREG 1507, Table 6.4.

Instrumentation will have current calibration (within the past 12 months, or more frequently if recommended by the manufacturer). Daily field performance checks will be conducted in accordance with instrument use procedures. These performance checks will be performed prior to and following daily field activities and at any time the instrument response appears questionable. Only data obtained using instruments that satisfy the performance requirements will be accepted for use in the evaluation.

2.3.5 Surface Soil Samples

Soil samples will be collected from 0 to 15 cm (0 to 0.5 ft) bgs to determine if the soil satisfies the DCGL.

Random measurement patterns are used for soil sampling within MARSSIM Class 3 areas to ensure that the measurements are independent while still supporting the assumptions of the statistical tests. Systematic grids are used for soil sampling within MARSSIM Class 2 and Class 1 areas because there is an increased probability of encountering small areas of elevated activity. See Sections 4.1 and 4.2 for the number of samples required to be collected within each survey area and the grid spacing, respectively.

3.0 DEFINE THE STUDY BOUNDARY

Study boundaries for impacted areas are defined by both horizontal (areal) and vertical parameters. The vertical boundary of any study area is limited to the top 6 inches (in) of surface soil.

Areal boundaries are defined in this plan by the potential for containing contaminated soil (i.e., the class). An area is Class 1 if prior to excavation activities, it is known to contain contamination above DCGL. An area is Class 2 if contamination above DCGL is *not* believed to exist. An area is Class 3 if contamination is not expected or is expected at a small fraction of the DCGLs.

MARSSIM recommends limiting areas of Class 1, Class 2, and Class 3 survey units to 2,000 m^2 (0.5 acres), 10,000 m^2 (2.5 acres), and no limit, respectively.

3.1 DEVELOP THE DECISION RULE

MARSSIM guidance is used to determine whether a survey area is acceptable for unrestricted use or if remediation is required. This determination is made by performing surface scans, collecting soil samples, testing sample results against applicable DCGLs, and performing statistical tests, and performing risk and dose assessments to confirm compliance with the appropriate requirements from all sources (as described in Appendix I, Section 11 of MARSSIM). A detailed discussion of the steps is presented in Section 4.0 of this plan.

If results indicate contamination levels in excess of the DCGLs are encountered in the surrounding areas around Magill and Rhodes Halls, further investigation will be performed which may include additional measurements, reclassification, and/or resurvey, as appropriate to determine if soil remediation is necessary.

3.2 SPECIFY TOLERABLE LIMITS ON DECISION ERROR

As part of the DQO process, the null hypothesis (H_0) for demonstrating compliance of the data with the DCGL is assessed. There are two scenarios that can be used for hypothesis testing. Scenario A can be used at any time. Scenario B can be used when the residual radioactivity consists of radionuclides that have a relatively large variability in the background reference areas. When using Scenario A, a typical H_0 that residual contamination exceeds the DCGLs is tested. By disproving the H_0, the alternative hypothesis (H_a) must be accepted and the finding of the assessment is that the survey unit satisfies the DCGLs. Typically, the Sign Test will be used since potential contaminants are not present in the background. For the second scenario, Scenario B, a different survey design method can be used. Scenario A will be the typical method used at Southeast. A separate planning package should be written if Scenario B is used.

To enable testing of data relative to the DCGL, the following decision errors have been established for the Southeast. The Type I (alpha) decision error to be used in data testing is 0.05; this provides a confidence level of 95% that the statistical tests will not incorrectly determine that a surveyed unit satisfies the DCGL when, in fact, it does not. The Type II (beta) decision error used to determine sample quantity per survey unit will range from 0.25 to 0.05; this provides a confidence level of 75-95% that the statistical tests will not incorrectly determine that a survey unit does not satisfy criteria when, in fact, it does. The Type II error has been set at 0.20. Type II errors do not adversely impact public safety and health and thus are subject to change.

3.3 OPTIMIZE THE DESIGN FOR OBTAINING DATA

Field screening techniques, soil sampling, surface activity measurements and the DQA process will be used, as appropriate, throughout the survey to focus efforts and minimize survey/sampling efforts using a graded approach.

4.0 SURVEY PLANNING AND DESIGN

4.1 DETERMINE THE NUMBER OF DATA POINTS

The number of data points to be collected in a survey area is estimated using the Sign test, a non-parametric statistical test for contaminants that are not present in background. The following steps ensure an adequate number of samples are taken to represent contamination levels for individual survey units at Southeast.

4.1.1 Classify Survey Units

Consistent with MARSSIM, survey areas are classified based on a historical site assessment and the results of scoping and characterization surveys. If an adequate amount of historical information and data exists, then the survey unit may be classified without performing scoping and characterization surveys.

Survey units under MARSSIM are broken into three classes. A survey unit is classified as a Class 1 unit when it has or had prior to remediation, a potential for radioactive contamination or known contamination above the DCGL. Class 1 survey units should not exceed 2,000 m^2.

A survey unit is classified as a Class 2 unit when it has a potential for radioactive contamination or known contamination, but is not expected to exceed the DCGL. Class 2 survey units should not exceed 10,000 m^2.

A survey unit is classified as a Class 3 unit when it is not expected to contain any residual radioactivity, or is expected to contain levels of residual radioactivity at a small fraction of the DCGL, based on site operating history and previous radiation surveys. There is no limitation to the size of Class 3 survey units.

4.1.2 Specify Decision Errors

SAIC has established acceptable decision errors for Southeast in order to enable testing of survey data relative to the acceptance criteria. The Type I (α) decision error to be used is 0.05. This provides a confidence level of 95% that the statistical tests will not incorrectly determine that a survey unit satisfies criteria when, in fact, it does not. The Type II (β) decision error is set at 0.20. Type II errors, which would result in excess uncontaminated materials being removed, do not adversely impact public safety or health and thus are subject to change.

4.1.3 Estimate Sample Standard Deviation

Site specific data should be used, when available, to estimate the survey unit standard deviation (σ). The use of previous survey data to estimate the σ for a survey unit is discussed in MARSSIM. Choosing an appropriate value for σ is very important. If the value is grossly underestimated, the number of samples will be too few to obtain the desired power for the statistical test, and a resurvey may be recommended. If the value is overestimated, the number of samples determined will be unnecessarily large. Historical, characterization, and preliminary design investigation sample data may be used to estimate the σ.

4.1.4 Calculate Relative Shift

The relative shift (Δ/σ) is an expression of the resolution of the measurements in units of measurement uncertainty. The shift (Δ) is set equal to the DCGL minus the Lower Bound of the Grey Region (LBGR). The DCGL has been set as 2.1 for Am-241. MARSSIM recommends initially setting the LBGR to one half of the DCGL. The LBGR may be set at the mean concentration of the survey unit if it is known. When calculating the Δ/σ, MARSSIM recommends a value between 1 and 3. When using one half of the DCGL as the LBGR, the Δ is stated as:

$$\Delta = \text{DCGL} - \text{LBGR} = 2.1 - 1.05 = 1.05$$

Using a LBGR value of 1.05 and an estimated value of 0.6 as the σ, the Δ/σ is:

$$\Delta/\sigma = 1.05/0.6 = 1.8$$

4.1.5 Estimating the Number of Samples

The number of samples for statistical testing can be obtained directly from MARSSIM Table 5.3 or may be calculated by using the equation listed below:

$$N = \frac{(Z_{1-\alpha} - Z_{1-\beta})^2}{4(Sign\ \rho - 0.5)^2}$$

$$N = \frac{(1.645 - 0.842)^2}{4(0.964070 - 0.5)^2} = 7 \text{ Samples*}$$

where:

N = Number of Samples

$Z_{1-\alpha}$ = Percentile represented by selected α decision error (0.05) = 1.645 (MARSSIM Table 5.2)

$Z_{1-\beta}$ = Percentile represented by selected β decision error (0.20) = 0.842 (MARSSIM Table 5.2)

Sign p = Probability that a random measurement from the survey unit will be less than $DCGL_W$ when the survey unit median is equal to LBGR. (MARSSIM Table 5.4). Since $\Delta/\sigma = 1.8$, Sign $p = 0.964070$

* This number is based on a SU area of 2,000 m^2.

Increasing the number of samples by 20%, then rounding up to the next even number as recommended by MARSSIM results in 9 samples.

4.2 DETERMINE SAMPLE SPACING

The grid spacing (L) is estimated in one of two ways, depending on the intended shape of the grid. Using the preferred method of a triangular grid, L is estimated using the following equation.

$$L = \sqrt{\frac{(A)}{(0.866)(n)}}$$

where: A = the surface area in the survey unit

n = the number of data point to be taken

Area units or measurements must be used consistently throughout this equation. Grid spacing should generally be rounded down to the nearest distance that can be measured conveniently in the field

4.3 SMALL AREAS OF ELEVATED ACTIVITY

For conditions where contamination is fairly uniform across a SU, systematic sampling density (i.e., grid spacing) shown above will provide sufficient information to determine whether or not the residual radioactivity at a site exceeds the DCGL. However, the survey also needs to determine if any small areas of elevated activity are present that are significant as compared to the DCGL or $DCGL_{EMC}$. The $DCGL_{EMC}$ takes into account the difference in area between the whole survey unit and the small are of elevated activity and the resulting change in dose..

When the GWS instrument scan MDC (MDC_{Scan}) used for the scanning survey is greater than the DCGL, the systematic sampling noted in previous sections may not be sufficient for detecting small areas of elevated activity. "Instead, systematic sampling and biased sampling, in conjunction with surface scanning (i.e., GWS), are used to obtain adequate assurance that small areas of elevated radioactivity will still satisfy the release criterion or the $DCGL_{EMC}$." (MARSSIM, Section 5.5.2.4). This is applicable for Class 1 SUs since small pockets of activity above DCGLs are only likely in Class 1 units.

The method used for determining values for the $DCGL_{EMC}$ is to modify the existing DCGL using an area correction factor (A_f) that corresponds to the difference in area and the resulting change in dose or risk. The A_f is defined as; the magnitude by which the concentration within the small area of elevated activity can exceed the DCGL while maintaining compliance with the release criteria (MARSSIM, Section 5.5.2.4 and Figure 5.3).

Once the $DCGL_{EMC}$ is determined for the area represented by each systematic sample, it should be compared to the MDC_{Scan} for the detector being used for the GWS. If the $MDC_{Scan}/DCGL_{EMC} < 1.0$, then the systematic sample grid spacing is sufficient. If the $MDC_{Scan}/DCGL_{EMC} > 1.0$, then the grid spacing must be reduced so that the $DCGL_{EMC}$ times the area representing each sample in the grid is greater than or equal to the MDC_{Scan}.

4.3.1 Example Calculation

The NRC Screening Levels (initially adopted as DCGLs) listed in Table C-1 of this plan, represent soil concentrations that are deemed to be compliant with the 25 mrem/year dose standard in 10 CFR 20 Subpart E. These screening levels were derived based on the residential scenario pathways and parameters set forth in NUREG-5512, Volume 3 and the decontamination and decommissioning (D&D) Computer Code. The A_f listed in Table C-4 were developed using RESRAD default parameters and pathways (i.e., residential scenario) with the exception of the following RESRAD non-default parameters that were changed to be consistent with assumptions used during development of screening levels using D&D:

- Am-241 soil concentration was set to 2.1 pCi/g;
- Contaminated zone thickness was set at 0.15 m (0.5 ft); and
- Contaminated area was set at 2,500 m^2.

Table C-4. Outdoor Area Dose Facto'r's

Nuclide	Area Factor				
	0.24 m^2	2.4 m^2	24 m^2	100 m^2	2,500 m^2
Am-241	56	30	15	12	1.0

If the area of the survey area being investigated is 24 m^2 and 10 samples are being collected, then the $DCGL_{EMC}$ for the area represented by each systematic grid sample is 63 pCi/g. Since the $DCGL_{EMC}$ (63 pCi/g) is greater than the MDC_{Scan} using a 2"x2" NaI scintillation detector (31.5 pCi/g) as shown in Table C-5, then the grid spacing is more than sufficient to ensure that a small area of activity is not missed that would result in an exposure greater than the 25 mrem/yr dose criterion.

Table C-5. Southeast Scan MDCs

Nuclide	Scan MDC in pCi/g for 2"X2" NaI Detector
Am-241	31.5

[a] NUREG-1507, Table 6.4

5.0 DATA EVALUATION

Survey data is examined using DQA guidance to ensure two things: (1) that the data met quality requirements (see Section 2.2) and (2) that the data provides the necessary basis for determining whether the survey area can be released for unrestricted use.

The DQA involves scientific and statistical evaluations to determine if data are of the right type, quality, and quantity to support the intended use. The DQA process is based on guidance from Chapter 8 and Appendix E in MARSSIM and follows EPA's *Data Quality Assessment: A Reviewer's Guide* (EPA 2006). The five steps in the DQA process are:

- Review the survey design, including DQOs.
- Conduct a preliminary data review.
- Select a statistical test.
- Verify the assumptions of the statistical test.
- Draw conclusions from the data.

5.1 SCAN SENSITIVITY/SMALL AREAS OF ELEVATED ACTIVITY

The Sign test evaluates whether the residual radioactivity in an area exceeds the DCGL for contamination that is approximately uniform across the survey unit; it may not correctly assess compliance with DCGLs when small areas of contamination are present. GWS are used to obtain assurance that small areas of elevated activity are identified. If the scan sensitivity based on survey unit ratios is inadequate, then the systematic sampling grid (L) may need to be reduced in order to increase the probability of detecting the small areas of elevated activity.

5.2 STATISTICAL TESTING

The Sign Test should be used when the COC is not present in background or present at such a small fraction of the $DCGL_W$ to be considered insignificant. This is the case for Am-241 and Cs-137 at Southeast; therefore, the Sign test will be performed for each survey unit. The Sign Test is applied to the sample data in accordance with the guidance and examples provided in the MARSSIM.

6.0 LABORATORY ANALYSIS

Samples will be transferred to a Southeast approved radio-analytical laboratory for analyses in accordance with documented laboratory-specific standard methods. Specific analyses for each sample will generally include gamma spectrometry. Concentrations of COCs will be determined. In accordance with MARSSIM, analytical techniques will provide a minimum detection level of 50% of the individual radionuclide DCGLs for all primary contaminants, with a preferred target minimum detection level of 10% of these individual radionuclide DCGLs (see Table C-6).

Table C-6. Target Detection Limits

Radionuclide	Minimum Detection Limit	Preferred Detection Limit
Am-241	1.05 pCi/g	0.21 pCi/g
Cs-137	5.5 pCi/g	1.1 pCi/g

Soil samples of approximately 1,000 grams will be obtained; samples will be packaged and uniquely identified in accordance with chain–of–custody and site-specific procedures. Analysis of samples will be performed on dried and homogenized soil. High-resolution gamma spectrometry will be used for quantification of Am-241 and Cs-137. Concentrations will be reported in units of pCi/g.

7.0 REPORT OF SURVEY FINDINGS

Survey procedures and results will be documented in a report following the general guidance in MARSSIM. Data packages and reports will typically contain the following information:

- Survey maps that show GWS data, locations of elevated gamma scan levels and biased sample locations;
- Tables of radionuclide concentrations for soil sample collected during the investigation;
- Summary statistics for soil sample data; and
- Dose estimates, if required.

8.0 REFERENCES

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US POSTAGE

Mr Mike McCann
USNRC Region III
2443 Warrenville Road
Suite 210
Lisle, Il 60532-4352