FINAL

FINAL STATUS SURVEY REPORT

5^{TH} FLOOR

Environmental Measurements Laboratory – U.S. Department of Homeland Security,
New York, NY

JMC Project 2006-001

Submitted by:

CABRERA SERVICES
RADIOLOGICAL • ENVIRONMENTAL • REMEDIATION

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ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
BNL	Brookhaven National Laboratory
CABRERA	Cabrera Services, Inc.
CFR	Code of Federal Regulations
COC	chain of custody
cpm	counts per minute
DCGL	Derived Concentration Guideline Level
DHS	Department of Homeland Security
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EMC	elevated measurement comparison
EML	Environmental Measurements Laboratory
FR	Federal Register
FSS	Final Status Survey
FSSP	Final Status Survey Plan
ft^2	square feet
GSA	General Services Administration
HP	Health Physicist
HRA	Historical Radiological Assessment
JMC	Joint Munitions Command
LBGR	Lower Bound Gray Region
LTR	License Termination Rule
m	meter
m^2	square meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mrem/yr	millirem per year
NaI	sodium iodide
NRC	Nuclear Regulatory Commission
PM	Project Manager
QA	Quality assurance
QC	Quality control
ROCs	radionuclides of concern
SOPs	Standard Operating Procedures
SU	Survey unit
TEDE	Total Effective Dose Equivalent
U.S.	United States
WRS	Wilcoxon Rank Sum

EXECUTIVE SUMMARY

The Department of Homeland Security (DHS) Environmental Measurements Laboratory (EML) leases space from the United States General Services Administration (GSA) building located in lower Manhattan at 201 Varick Street. EML occupies the entire fifth floor of the building, and small areas in the first floor, basement, and roof. EML was formerly operated as an environmental radiochemistry laboratory by the Department of Energy (DOE), but is now organized under DHS. Currently no handling of unsealed radioactive sources occurs within the facility. DHS wishes to achieve unrestricted release of the EML and return the fifth floor to GSA. To this end, Cabrera Services, Inc. (CABRERA) has been contracted via US Army joint Munitions Command (JMC) to provide radiological remediation and characterization to facilitate release of the facility. This Final Status Survey (FSS) report details the remediation action taken during the course of the project and presents survey data relating to the post-remediation radiological condition of the areas covered.

The original scope of the project relating to the 5th floor covered 6 former radiochemistry laboratories. As a result of additional information obtained via interview with site personnel, and contamination surveys performed during the field efforts of the site, the project scope was extended to incorporate all areas of the 5th floor occupied by EML. The 5th floor was divided into 28 distinct survey units (SU) with each of those survey units being surveyed for radiological contamination, remediated to acceptable levels as described in the Final Status Survey Plan (FSSP) and finally characterized via Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) protocols. Analytic samples were collected and analyzed by a certified laboratory for suspect contamination in each SU as appropriate to catalog isotopes of concern. Included in the surveys were exposure rate measurements, beta scans, alpha scans, and fixed point survey measurements at systematic statistical survey locations. The fixed point survey measurements consisted of both fixed beta and alpha integrated measurements, and removable alpha and beta measurements.

The results of the MARSSIM survey following completion of remediation for each survey unit revealed no contamination above criteria set forth in the FSSP. Survey data collected in this effort and contained in this report meet the criteria derived in the Final Status Survey Plan for supporting the unrestricted radiological release of the 5th floor of the building.

1.0 INTRODUCTION

This *Final Status Survey Report* presents results of the final status survey (FSS) conducted by Cabrera Services, Inc. (CABRERA) to support the radiological decommissioning of the 5th floor space occupied by the Department of Homeland Security (DHS) Environmental Measurements Laboratory (EML) leased from General Services Administration (GSA) at 201 Varick Street in lower Manhattan, New York. Activities described in this report were conducted in accordance with the *Final Status Survey Plan (FSSP)* and *Site-Specific Health and Safety Plan (HASP) – Environmental Measurements Laboratory – Department of Homeland Security* (CABRERA, 2007), presented in Appendices A and B, respectively. This report has been prepared by CABRERA for the United States (U.S.) Army Joint Munitions Command (JMC), under JMC Project Number *DHS 2006-001, contract W52P1J-06-D-0019.*

1.1 Site Description and Background

EML occupies the entire fifth floor of the GSA Building at 201 Varick Street, and small areas in the first floor, basement, and on the roof. The EML facility was formerly operated by DOE as an environmental radiochemistry laboratory, but is now organized under DHS. Currently, no handling of unsealed radioactive sources occurs within the facility.

Several areas of radiological contamination were known to exist on the fifth floor of the site from historical surveys and facility operations. In Lab 516, 15,000 disintegrations per minute per 100 square centimeters (dpm/100cm^2) fixed beta-gamma contamination was known to exist inside a cabinet. In Lab 518, 1,560 dpm/100 cm^2 of fixed alpha contamination was known on bench tops. In Lab 526, 70,000 dpm/100 cm^2 of fixed beta-gamma and 6,000 dpm/100 cm^2 fixed alpha contamination, as well as 52 dpm/100^2 of removable alpha contamination was known to exist in drawers, cabinets, on floors, and on bench tops (Brookhaven, 2005).

In the EML area of the building basement, radium contamination was known to exist on the floor and walls. The removable contamination in this area was encapsulated by the Environmental & Waste Management Services Division of Brookhaven National Laboratory (BNL) in June of 2004 (Brookhaven, 2004). However, reported estimates of the total activity encapsulated in

Room B-15 were not considered appropriate to support release decisions and FSS requirements. Removal of the encapsulated contamination was included for removal in this field effort.

1.2 Radionuclides of Concern

Several radionuclides of concern were identified in the FSSP as the result of historical operational radiological safety surveys, a comprehensive survey of the analytical laboratories performed by BNL, report dated October 3, 2005, and the historical operational knowledge of personnel at the facility. In addition, other radionuclides were identified during the course of the project. Table 1-1 is a list of radionuclides of concern (ROC) specifically identified or those with any significant likelihood of what might have been remaining at the site. ROCs specifically denoted as being at the facility in significant quantities are listed. However, the potential exists for other nuclides with atomic numbers up to 92 to have been historically present at the site in environmental samples or radionuclide standard solutions due to the fact that the EML licenses allowed possession of all of these nuclides in varying quantities. Isotopes with half-lives of less than 6 months are not likely to be present at the site in significant activity at the present time, and are not included in the list.

Table 1-1: Radionuclides of Concern

NUCLIDE	NAME	HALF-LIFE	PRINCIPAL EMISSIONS (MEGAELECTRON VOLTS [MEV])	SOURCE OF RADIONUCLIDE
NI-63	Nickel-63	**100.1 YR**	0.067 beta	standard solution
RA-226	Radium-226	**1,600 YR**	4.785 alpha 0.168 beta 0.186 gamma	standard solution
CS-137	Cesium-137	**30.17 YR**	0.511 beta 0.662 gamma (from Ba-137m)	standard solution
SR/Y-90	Strontium / Yttrium-90	**28.6 YR**	0.196 beta 0.935 beta 2.2 beta	standard solution
TC-99	Technetium-99	**21.3E4 YR**	0.293 beta	standard solution
TH-232	Thorium-232	**1.4E10 YR**	4.010 alpha (most abundant)	standard solution
U-235	Uranium-235	**7.04E8 YR**	4.396 alpha (most abundant) 0.014 beta (most abundant) 0.186 gamma (most abundant)	standard solution
U-238	Uranium-238	**4.47E9 YR**	4.196 alpha (most abundant) 0.029 beta (most abundant)	standard solution
PU-238	Plutonium-238	**87.75 YR**	5.499 alpha (most abundant) 0.021 beta (most abundant)	standard solution
PU-239/240	Plutonium-239/240	**2.41E4 YR**	5.155 alpha (most abundant) 0.029 beta (most abundant)	standard solution

2.0 DERIVED CONCENTRATION GUIDELINE LEVELS

Decommissioning planning was conducted in accordance with guidance presented in NUREG-1757, *Consolidated NMSS Decommissioning Guidance, Volumes 1 and 2,* (NRC, 2003a and 2003b). This section describes the establishment of derived concentration guideline levels (DCGLs) that were used to guide site decommissioning activities. DCGLs, expressed for surface activity in dpm/100cm^2, represent the residual radioactivity concentrations (above background) on surfaces that correspond to the allowable radiation dose limit, considering the collective risks to human health associated with anticipated potential exposure scenarios and pathways to a potential future site population. Demonstrating that residual radioactivity remaining at the site is statistically within site-specific DCGLs maintains compliance with acceptable risk to a potential future site population.

The Nuclear Regulatory Commission (NRC) has established a radiation dose limit of 25 millirem per year (mrem/yr) above background as the allowable annual dose to the public contributed by residual radioactivity at a site released for unrestricted use. In 10 CFR 20, Subpart E, *Radiological Criteria for License Termination*, the following release criteria are specified:

1. Residual radioactivity that is distinguishable from background and results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem/yr, including that from groundwater sources of drinking water; and
2. Residual radioactivity that has been reduced to as low as reasonably achievable (ALARA) levels.

The NRC standard of 25 mrem/yr was deemed applicable to the decommissioning of the EML as per DHS guidance, and therefore was the basis for demonstrating that the fifth floor of the GSA Building should be released for unrestricted use. Application of this DCGL ensures that the potential dose to the average member of the critical group will not exceed 25 mrem in any one year over a 1,000-year period.

The License Termination Rule (LTR) presented in 10 CFR 20, Subpart E, specifies an allowable dose limit of 25 mrem/yr. Supplemental information regarding the implementation of the LTR, including screening criteria for building surfaces and soil, has been published in the following Federal Register (FR) notices:

FR Volume 63, Number 222, November 18, 1998 (NRC, 1998);

FR Volume 64, Number 234, December 7, 1999 (NRC, 1999); and

FR Volume 65, Number 114, June 13, 2000 (NRC, 2000b).

As of the time of this survey, determination of the regulatory authority for release of the site, if any, had not been determined. Therefore, in addition to the NRC, the possibility of DOE authority for release was also considered in the development of the FSSP.

These screening criteria were used to establish instrument/analysis sensitivity requirements for decommissioning activities.

The DCGLs used to support decommissioning of EML are presented in Table 2-1.

Table 2-1: Surface Activity DCGLs for EML Final Status Survey

Agency / Reference	Alpha		Beta/Gamma	
	Total (dpm/100cm^2)	Removable (dpm/100cm^2)	Total (dpm/100cm^2)	Removable (dpm/100cm^2)
NRC 10 CFR 20.1402	Total dose to the public after decommissioning of not more than 25 mrem/yr			
NYCDOH §175.03 – Release of Materials or Facilities	2,500 Max 500 Average	100	0.2 mR/hr[b]	1,000
DOE 10 CFR 835 Appendix D	500[a]	20[a]	1,000[a]	200[a]
Chosen DCGL For DHS EML	***500[a]***	***20[a]***	***1,000[a]***	***200[a]***

Notes: a. Averaged over 1 m^2, provided no 100 cm^2 area exceeds 3 times the specified limit
b. Measured at 1 centimeter (cm) from the surface

The DCGLs chosen for this project were those listed in 10 CFR 835 Appendix D as they were the more conservative values for the radionuclides of concern listed in Table 1-1.

3.0 FINAL STATUS SURVEY DESIGN

This section summarizes the design of the final status surveys conducted at EML, as described in the *FSSP* (CABRERA, 2007a). The survey design discussed below is based on the technical guidance and statistical methods presented in the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (NRC, 2000), as required by *NUREG-1757, Consolidated NMSS Decommissioning Guidance, Vol. 2* (NRC, 2003b).

3.1 Determine Impacted and Non-Impacted Areas

Following field surveys conducted in March and November, 2007, it was determined that all areas of the 5th Floor utilized by EML should be classified as impacted. This determination was made after several survey unit surfaces were found to have previously undocumented radiological contamination. Specific areas covered under this evaluation include approximately 61,130 square feet [ft^2] on the fifth floor as described in the *FSSP*, which is attached as Appendix A.

3.2 Area Classification Based On Contamination Potential

Impacted areas were initially classified in the FSSP based on contamination potential as per guidance in MARSSIM sections 2.2, 4.4, 5.5.2, and 5.5.3 (NRC, 2000). Specifically,

- Class 1: The area had been contaminated above the release criteria, and it is possible to find radioactivity above the release criteria;
- Class 2: The area had radioactive material use, but it is unlikely to have radioactivity above the release criteria;
- Class 3: The area had some use of radioactive material, but it is very unlikely to have radioactivity above the release criteria.

During the course of the radiological remediation and final status survey, several areas were reclassified from the FSSP designations due to additional information obtained during field efforts such as newly identified surface contamination or the recovery of previously unidentified radiological sources.

3.3 Statistical Tests

3.3.1 Sign Test

The Sign test is designed to detect uniform contamination above screening limits throughout a survey unit (SU). It draws direct comparisons between SU data and the chosen release criteria (i.e., DCGL). The Null Hypothesis is assumed to be true unless the statistical test indicates that it should be rejected in favor of the alternative. The null hypothesis states that the probability of a measurement less than the DCGL is less than one-half (i.e. the 50th percentile (or median) is greater than the DCGL). With this in mind, SUs may meet the release criteria even though some measurements may be greater than some uncontaminated reference area measurements. The result of the hypothesis test determines whether or not the SU as a whole meets the release criteria.

If all of the sample results are less than the DCGL then no Sign test statistical evaluation is required.

3.3.2 Application of Sign Test for Multiple Surfaces

The typical approach for evaluating internal building surfaces using the MARSSIM protocol involves the Wilcoxon Rank Sum (WRS) test. The WRS test requires that an appropriate background (reference) unit be surveyed for each material type in a SU such that gross measurements may be used for evaluating survey results. However, application of the WRS test for complex buildings with many structural surfaces can be cumbersome, as a single SU may require several background reference areas for proper evaluation. To address situations like this, a method for applying the Sign test to multiple surfaces was developed. The procedures for this are described in Chapter 12 of NUREG-1505 (NRC 1998).

NUREG-1505 states " …the Sign test may be more appropriate when there are many different materials within what would otherwise logically be a single SU. As indicated at the beginning of this chapter (Chapter 12), to divide such a SU into separate parts, each requiring its own reference area is not only impractical, but may be inconsistent with the dose models used to determine the DCGLs." "Fortunately, there is a third option - to use the Sign test with paired observations. Each measurement in the SU is paired with an observation on a suitable reference

material. The Sign test is then performed on the difference. The tradeoff is the higher variability of the differences compared to a single measurement."

To account for this potential increased variability in measurement standard deviation from multiple surfaces, the planning sigma values used in the determination of the number of sample points per SU were doubled. Details of the SU design are provided in Section 3.8.

Representative background values to be used in the paired observations were collected in un-impacted areas of the buildings on similar building materials. The selection and measurement of the background reference areas were done at the start of the each field effort so they could be applied directly. A minimum of five (5) 1-minute fixed-point measurements were collected with the average used for subtraction from each systematic measurement location prior to evaluation using the Sign test.

3.3.3 Performing the Sign Test

The Sign test is applied as outlined in the following five steps from Section 8.3.2 of the MARSSIM. Each measurement had the appropriate background reading subtracted and the difference would be subject to the Sign test, outlined in the steps below:

<u>Step 1:</u> List the SU measurements, X_i, $i = 1, 2, 3, \ldots, N$.

<u>Step 2:</u> Subtract each measurement, X_i, from the DCGL to obtain the differences:

$$D_i = DCGL - X_i,\ i = 1, 2, 3, \ldots, N.$$

<u>Step 3:</u> Discard each difference that is exactly zero and reduce the sample size, N, by the number of such zero measurements.

<u>Step 4:</u> Count the number of positive differences. The result is the test statistic (S+). Note that a positive difference corresponds to a measurement below the DCGL and contributes evidence that the SU meets the release criterion.

<u>Step 5:</u> Large values of S+ indicate that the null hypothesis (that the SU exceeds the release criterion) is false. The value of S+ is compared to the critical values in

MARSSIM Appendix I, Table I.3. If S+ is greater than the critical value, *k*, the null hypothesis is rejected.

3.4 Elevated Measurement Comparison

If a measurement showed a location of elevated activity greater than the DCGL and further decontamination is not possible, then the area around the location would need to be surveyed per the elevated measurement comparison (EMC) procedure. The EMC is performed for both measurements obtained on the systematic/random sampling grid and for locations flagged by scanning measurements. Any measurement from the SU that was equal to or greater than an investigation level indicated an area of relatively high concentrations that should be investigated, regardless of the outcome of the nonparametric statistical tests.

Radiological contamination above the DCGL levels would require a breakup of the SU with reclassification to Class 1 of at least certain sections. The EMC consists of comparing each measurement from the SU to investigation levels (the DCGL for this survey). If such a situation arose, then the EMC procedure as specified in MARSSIM, Section 8.5.1 and/or decontamination would need to be performed.

During the course of the field effort, areas radiological contamination were decontaminated, or otherwise remediated or removed prior to performance of the MARSSIM survey. In each instance, decontamination efforts were successful in reducing surface contamination levels to below DCGLs. Therefore, implementation of EMC procedure was not necessary for any of the covered SUs.

3.5 SU Breakdown

Based primarily on the review of the *EML Facilities Historic Utilization Team Report, August 2006*, *Radiological Surveys of EML Laboratories, September 30, 2005*, *Brookhaven National Laboratories*, and contamination surveys during the first phases of this field effort, the list below was developed identifying impacted areas based on the historical presence of radioactive materials, separating them into survey units and classifying those survey units based on the likelihood of contamination and physical locations/separations of the areas.

SUs were labeled according to the following scheme: “Floor”-“Room”-”Room Breakdown”. For example, the SU for the inner compartment of room 528T is labeled 5-528T-I. Figure 3-1, the floor plan of EML on the 5th floor, shows the rooms and room numbers.

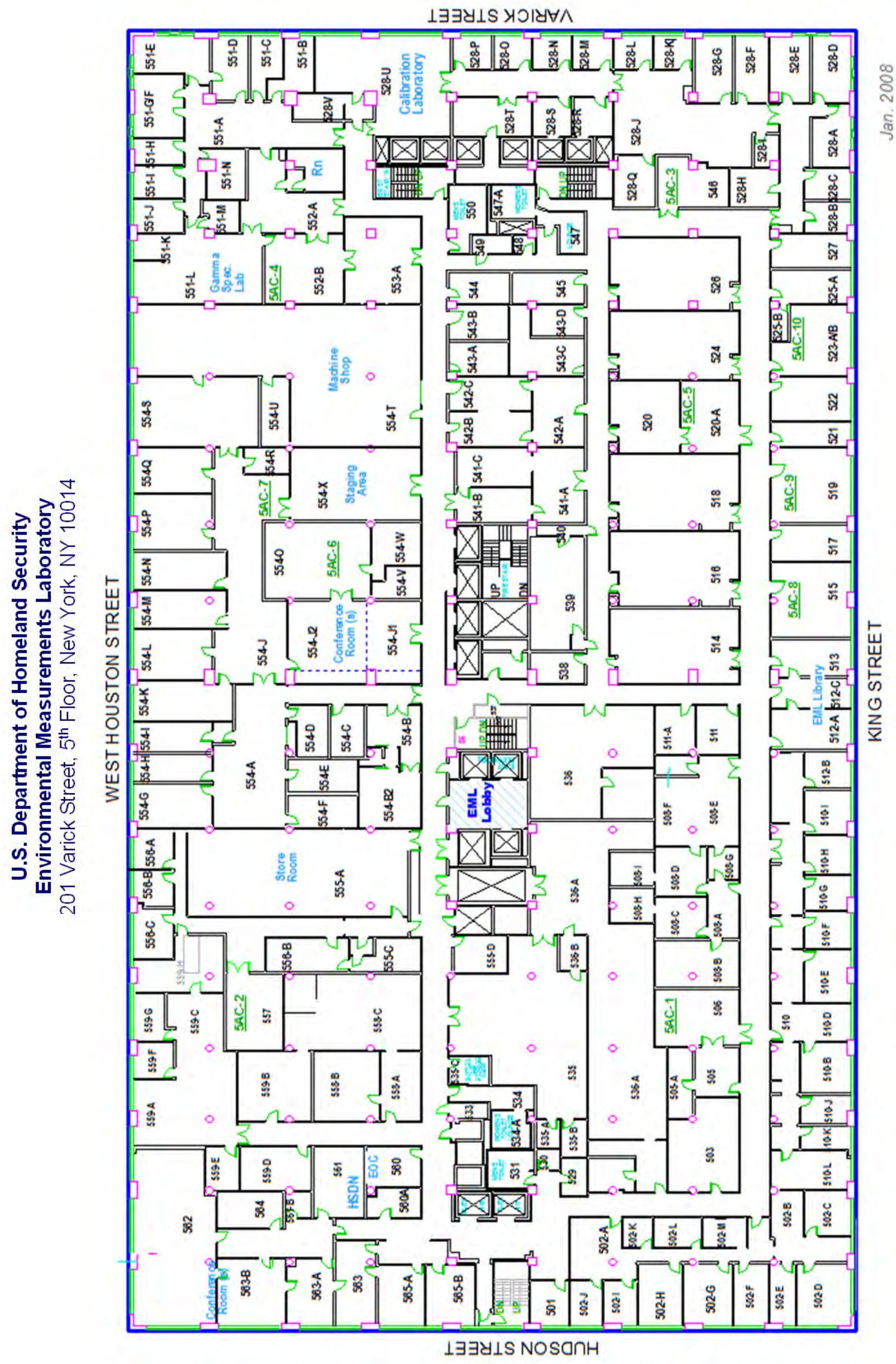

Figure 3.1. EML floor plan.

Impacted, Class 1 Areas: 5th floor rooms; 514, 516, 518, 520A, 520, 524, 525A, 525B, 526, 527, 528I, 528T (inner room), 536 (inner room), 538, 541A, 541B, 541C, 544, 552A, 552-RR (separate SU designation for the Radon Chamber in room 552A), 554V, 554-B2, 559G. Each room was designated a single SU with the exception of room 552A, which was divided into 2 survey units, one for the floor and one for the walls labeled 552A-F and 552A-W.

Impacted, Class 2 Areas: 5th floor areas: Three Class 2 SUs are defined here. The first SU, labeled 5-RL, is the hall way encircling the radiochemistry laboratories, plus rooms 539, 519, 528Q, 528T (outer room), 536 (outer room), and 542C. The second SU, labeled 5-SMG, is composed of rooms 554X, 554R, 554T, 554P, 551L, 551M. The third Class 2 SU, labeled 5-W, is composed of rooms 556A, 556B, 556C, and 503 in the west side.

Impacted, Class 3 Areas: 5th floor areas: Remaining areas not listed as Class 1, 2, or Non-Impacted.

Non-Impacted Areas: 5th floor areas: Utility closets, stairs, pipe chases, and the lobby.

3.6 SU Coverage

The coverage of beta and gamma measurements in each SU is dependent upon the survey class and the types of ROCs. General specifications for each SU class are provided below. Note that "Fixtures" includes features such as countertops, drawers, cabinets, and hoods.

Class 1

Floors, Lower Walls (< 2 meters [m]) and Fixtures)

Perform a 100% alpha/beta scan survey of surfaces. Collect fixed-point measurements at systematic locations using a triangular grid pattern. Floor areas limited to 100 square meters (m^2), where practical. Collect additional

fixed-point measurements at biased locations using scan described in 3.10.1 or professional judgment.

Upper Walls (> 2m) and Ceilings

Perform a minimum 25% alpha/beta scan survey on walls above 2 m and 10% alpha/beta scan survey on accessible ceiling surfaces. Collect fixed-point measurements at biased locations using professional judgment.

Class 2

Floors, Lower Walls (< 2m and Fixtures)

Perform a minimum 25% alpha/beta scan survey of surfaces. Collect fixed-point measurements at systematic locations using a triangular grid pattern. Floor area limit of 1,000 m^2 applied. Collect additional fixed-point measurements at biased locations using professional judgment.

Upper Walls and Ceilings

Perform a minimum 10% alpha/beta scan on walls above 2 m and accessible ceiling surfaces. Collect fixed-point measurements at biased locations using scan described in 3.10.1 or professional judgment.

Class 3

All Surfaces and Fixtures

Perform a minimum 10% alpha/beta scan survey of all surfaces. Collect fixed-point measurements at biased locations using professional judgment. No floor area size limit enforced.

The SUs are defined in this manner in order to simplify administration of the survey and handling of the data. Surveys of upper walls and ceilings are being administered as part of the survey of the lower floors and walls.

3.7 Release Criteria

3.7.1 Surface Contamination DCGLs

Screening values used were the DCGLs shown in Table 2-1.

In instances where a DCGL was exceeded in a Class 1 SU, the area was remediated as appropriate, with a complete resurvey performed after remediation.

In instances where a DCGL was exceeded in a Class 2 or Class 3 area, the room containing the contamination was removed from its SU and reclassified as a separate Class 1 SU. The SU was then remediated as necessary, and resurveyed again in its entirety as a Class 1 SU.

3.8 Sampling Grid Layout

3.8.1 Relative Shift

The relative shift describes the relationship of site residual radionuclide concentrations to the DCGL and is calculated using the following equation, found in Section 5.5.2.2 of MARSSIM (NRC, 2000):

$$\frac{\Delta}{\sigma} = \frac{DCGL - LBGR}{\sigma}$$

where:

σ	=	An estimate of the standard deviation of the concentration of residual radioactivity in the SU (which includes real spatial variability in the concentration as well as the precision of the measurement system). σ is estimated as 0.3 times the DCGL.
Δ	=	The width of the gray region, i.e., DCGL minus the lower bound of the gray region (LBGR). The gray region is defined as “the range of values of the parameter of interest for a SU where the consequences of making a decision error are relatively minor”.
DCGL	=	The derived concentration guideline level (i.e., release limit)
LBGR	=	Concentration at the LBGR. The LBGR effectively becomes the survey’s action level. For conservatism, the LBGR was set to 0.5 times the DCGL for this FSS.

3.8.2 Number of Sampling Points

The *FSSP* (CABRERA, 2007a) established the acceptable decision errors $\alpha=\beta=0.05$. Based on these acceptable decision errors and the relative shift, the minimum number of measurement locations in each SU was calculated per MARSSIM Section 5. This calculation includes the MARSSIM recommended 20% additional samples to protect against the possibility of lost or unusable data (Table 5.5 from the MARSSIM document).

Table 3-1 shows the MARSSIM-based statistical parameters used in a calculation of the target number of samples per survey area.

Table 3-1: Summary of MARSSIM Design Parameters for the Site FSS

MARSSIM Parameter	Alpha Static Measurement[1] (cpm)	Beta Static Measurement[1] (cpm)	Alpha Smear (dpm/100 cm^2)	Beta Smear (dpm/100 cm^2)
σ	30[1,2]	60[1,2]	6[2]	60[2]
DCGL	100[4]	200[3]	20	200
LGBR	50	100	10	100
Relative Shift (Δ/σ)	1.67	1.67	1.67	1.67
Pr (from MARSSIM Tbl. 5.4)	0.95	0.95	0.95	0.95
N	14	14	14	14
N (including 20% overage)[5]	*17*	*17*	*17*	*17*

Notes:
1. Static counts to be performed with Ludlum 43-68 proportional detector. Count time = 1 min.
2. Sigma values for static measurements and smears were set at 0.3 times the DCGL to account for potential added variability (see Section 3.3.2)
3. 200 counts per minute (cpm) is equivalent to the beta DCGL of 1,000 disintegrations per minute per 100 centimeters squared (dpm/100 cm^2) assuming 20 % efficiency for the Ludlum 43-68 probe.
4. 100 counts per minute (cpm) is equivalent to the beta DCGL of 500 disintegrations per minute per 100 centimeters squared (dpm/100 cm^2) assuming 20 % efficiency for the Ludlum 43-68 probe.
5. MARSSIM Sec. 5.5.2.1 recommends that the calculated number of samples per SU (N) be increased by 20% to account for potentially lost or unusable data. Final N rounded up to nearest whole number.

The LGBR was chosen as one-half of the DCGL as per guidance provided in the MARSSIM. The standard deviation for static and smear measurements were set at 30% of the DCGL as per MARRSIM recommendation when site specific standard deviation data is not available.

The results show that all of the measurements are sufficiently sensitive to allow a relatively small number of MARSSIM-type systematic measurements to be performed in each SU (i.e., 17). Scans and biased measurements are also important in demonstrating that the residual radioactivity levels are less than the DCGLs.

3.8.3 SU Grid Spacing

Grid spacing and placement of fixed-point measurement locations within each SU was based on

a relative coordinate system.

The spacing of the data points for Class 1 and Class 2 areas is determined by:

$$L = \sqrt{\frac{A}{0.866\, n}}$$

where:

L = grid spacing

A = survey unit area (including wall area)

n = number of data points

The starting point is randomly selected and the data points are located within the survey unit using a triangular grid for Class 1 or Class 2 areas. The systematic locations for floor layouts will also include the first 2 meters of each wall which may be folded out or otherwise placed on the drawing of the survey area such that the floor grid also overlays the wall surface. If a grid point falls on a fixture such as a countertop, then the fixture was measured and so noted in the documentation.

Locations of measurement locations in Class 3 SUs were determined by multiplying the east-west (Y) and the north-south (X) dimensions of each SU by a randomly generated number between 0 and 1 for each dimension. For consistency, the southwest corner of each SU was used as the origin for each SU. Sample locations were calculated using a computer to determine random numbers and plot data point locations on a survey map. To facilitate field measurements, the calculated coordinates were rounded to the nearest whole number of meters.

3.9 Background Survey Areas

Determination of background values is of the utmost importance in building decommissioning projects. Since ‘net’ residual contamination values, or the difference between a sample count rate and background, are used to assert whether a particular SU satisfies the criteria for unrestricted release, application of accurate and applicable background values is crucial to proper decision-making. In this light, background measurements must be made in non-impacted areas

on building surfaces expected during the FSS. The selection and measurement of the background reference areas was done at the start of the fieldwork for each mobilization. Representative measurements of various flooring and wall materials were collected with each detector used so an applicable background could be applied before direct comparison with a DCGL value or application of the Sign test. In order to account for instrument response to ambient background, which can change from location to location, instrument background measurements were performed on each material encountered.

3.10 Survey Methods and Instrumentation

The purpose of this section is to describe direct radiation measurement and sample collection and analysis techniques that were implemented during the Site FSS. Physical and performance characteristics of each detector probe are provided in Table 3-2.

Table 3-2: FSS Detector Probe Characteristics

Detector	Application	Detector Type	Radiation Sensitivity	Active Area (cm^2)
Ludlum 44-9	Building, system, equipment surfaces; personnel frisking	Geiger-Mueller	Beta, Gamma	15
Ludlum 43-68	Small area surfaces (bench tops, drawers)	Gas Proportional	Alpha, Beta	126
Ludlum 43-37	Large area surfaces (floors, walls, bench tops)	Gas Proportional	Alpha, Beta	582
Ludlum 239-1F Floor Monitor (43-37 detector)	Smooth floor surfaces	Gas Proportional	Alpha, Beta	582
Ludlum 2929 Dual Scaler (43-10-1 detector)	Removable Contamination (Smear) Counter	Dual Channel “Phoswich”	Alpha, Beta	N/A
Bicron MicroRem, and Ludlum 44-2 (or equivalent)	Gamma radiation scans and counts	(1-inch by 1-inch Sodium Iodide [NaI])	Gamma	N/A

3.10.1 Surface Alpha/Beta Radioactivity Scans

<u>Applicability</u>:

Impacted areas that have the potential for alpha-emitting and beta-emitting radionuclide surface contamination were scanned as described in this section. For the DHS EML survey, this includes all impacted areas. Floors, walls, bench tops, and cabinet interiors wee scanned as described in Section 3.6.

Instrumentation:

The following detectors were used per the judgment of the survey supervisor:

- Gas proportional detector (Ludlum 43-68, Ludlum 43-37, or equivalent) for any large surfaces
- Geiger Mueller (Ludlum 44-9 or equivalent) for small surfaces or other hard-to-reach places

Scan measurement sensitivities are presented in the *FSSP* (CABRERA, 2007a), attached as Appendix A.

Technique:

The surfaces were scanned for alpha and beta contamination by moving the probe in straight paths with spacing that ensured that the minimum surface area was covered as required by the SUs classification. The rate meter was set to alarm at a preset level indicating that contamination is being detected that is approaching a screening value, and the technician was familiar with detecting an audible or visible increase in count rate over the action level. Two scans were performed – once in alpha detection mode, and once in beta detection mode (for the 43-68 and 43-37).

If background response varied greatly during scan survey activities, instrument background measurements were performed at representative measurement locations.

The scan survey action level was a sustained instrument response above the ambient level. Action levels were calculated in "gross CPM" for a given area with an asserted background level. If a survey results in locations above the action level, the following additional data were also collected:

- A 60 second static measurement at the location ("biased count") for alpha/beta;
- A "biased" smear sample to be analyzed for alpha/beta, or sent for isotopic analysis as the need was determined.

Data Recording:

Any biased measurements resulting from an elevated scan reading were recorded, including location, count or count rate reading, and a description of the object of interest.
A field scan sheet was completed for each area of the survey unit recording maximum and average count rates.

3.10.2 Fixed-Point Measurements

Applicability:
Fixed-point measurements were defined as static counts performed with a portable instrument. They were performed as part of the statistical survey or as biased measurements to investigate elevated scan readings.

Instrumentation:
A Ludlum 43-68 probe was used to perform and document fixed-point measurements.

Technique:
Fixed-point measurements were 1-minute in duration with the instrument placed in scaler mode. The fixed-point (static) survey action level was the DCGL plus the average background specific to the material type being evaluated.

Data Recording:
Fixed point measurements were recorded, including location (grid point or recognizable object), count rate (or exposure rate) reading, distance from the object of interest (if gamma reading), and a description of the object of interest as applicable.

3.10.3 Smear Sample Collection and Analysis

Applicability:

Selected building surfaces had smear samples taken to assess the presence of removable contamination. These smears were taken at every location that a fixed-point measurement was taken and at any other locations deemed necessary based on visual inspections and professional judgment.

Technique:

Smear samples were collected by wiping the area with a dry filter while applying moderate pressure. Smears were counted on-site using a Ludlum 2929 alpha/beta dual-scaler.

Data Recording:

Smear samples were recorded, including location (grid point or recognizable object), and a description of the object of interest as applicable. A chain of custody (COC) form was completed and included with smears sent off-site for analysis.

3.10.4 Exposure Rate Surveys

Prior to conducting the alpha/beta scan surveys in each SU, an exposure rate survey was performed. No exposure rates elevated above twice background were encountered during the course of the project.

4.0 REMEDIATION ACTIVITIES

As a result of surveys conducted, residual radiological surface contamination was identified in rooms 516, 518, 525B, 526, 528T, 541A, 544, 552A, and 554-B2. Affected SUs were decontaminated via surface activity removal efforts including minor wiping, scrubbing or mechanical grinding, and disassembly and removal of contaminated objects such as hoods and bench tops, and floor tiles. All contaminated materials including intrinsic derived waste (IDW) from remediation efforts were wrapped, removed from the 5th floor to the controlled basement areas of the EML facility to await packaging, transportation, and disposal.

4.1 Room 516

This room was used as a radiochemistry laboratory and consists of Hoods, Sinks, Lab Benches, drawers, and shelving. Contamination was identified in this room prior to commencement of this project (BNL, 2005). Contaminated areas were delineated via survey prior to commencement of decontamination efforts and included bench tops, floors, drawers, and hoods.

Several surface areas of bench tops were decontaminated via light scrubbing. Other bench tops were removed or had contaminated sections cut out and removed. Light decontamination was successful on most surfaces including the floor, and several contaminated items were removed from the room for disposal.

4.2 Room 518

This room, much like 516, was used as a radiochemistry laboratory and consists of Hoods, Sinks, Lab Benches, drawers, and shelving. Contamination was identified in this room prior to commencement of this project (BNL, 2005). Contaminated areas were delineated via survey prior to commencement of decontamination efforts and included bench tops, floors, drawers.

Several surface areas of bench tops were decontaminated via light scrubbing. Other bench tops were removed or had contaminated sections cut out and removed. Light decontamination was successful on most surfaces including the floor, and several contaminated items were removed from the room for disposal.

4.3 Room 525A

In the center of this room, a small spot of alpha contamination was identified during Class 2 survey. The room was decontaminated via light scrubbing, reclassified Class 1, and resurveyed IAW the FSSP. No other contamination was identified during the survey.

4.4 Room 525B

In this room, beta/gamma contamination was identified on the surface of two desk drawers of a desk in the room. The two desk drawers were removed, the room was reclassified Class 1, and resurveyed IAW the FSSP. No other contamination was identified during the survey.

4.5 Room 526

This room was also used as a radiochemistry laboratory and consists of Hoods, Sinks, Lab Benches, drawers, and shelving. Contamination was identified in this room prior to commencement of this project (BNL, 2005). Contaminated areas were delineated via survey prior to commencement of decontamination efforts and included bench tops, floors, drawers, and hoods.

Several surface areas of bench tops were decontaminated via light scrubbing. Other bench tops were removed or had contaminated sections cut out and removed. Light decontamination was successful on many areas of the drawers, floors, and hoods.

One small section of the floor could not be decontaminated via light efforts. Contaminated floor tiles were removed via asbestos subcontractor and packaged for waste. Mechanical grinding under the floor tiles was successful in removing the remainder of the contamination.

4.6 Room 528T

This room contains an inner closet in which contamination was identified. The closet consists of shelving filled with boxes of miscellaneous equipment and samples. Class 3 surveys in this room, identified beta/gamma activity on the shelving. Contents on the shelving were surveyed with contaminated items being removed. The inner room was reclassified to Class 1 and resurveyed. No further contamination was found.

4.7 Room 541A

This room contained large numbers of archived samples. During the Class 3 survey, several of these samples were identified as having a radiological component. Contaminated surfaces were

found on boxes. All items in this room were surveyed individually with contaminated items being segregated. The room was then reclassified Class 1, and no other contamination was identified.

4.8 Room 544

This was a laboratory room with a sink, lab benches, and shelving. This room was filled with many boxes and lab items. Drawers and shelves were filled. Several lead shields ("pigs") were stored in this room.

Fixed and Removable alpha and beta contamination (7,020 dpm/100cm^2 alpha fixed, 3,000 dpm/100cm^2 beta fixed; 2,685 dpm/100cm^2 alpha removable, 2,620 dpm/100cm^2 beta removable; maximums) was identified on multiple surfaces in this room including walls, floors, bench top, and the sink. All items in this room were surveyed individually for contamination.

All items from this room were removed following individual survey with contaminated items being segregated for disposal. Items were packaged and stored on the basement floor of the facility. Several of the lead shielding pigs were identified as contaminated and were removed to the basement for later characterization.

Light decontamination efforts including scrubbing were not sufficient to decontaminate most of the bench top and sink. These items were removed and packaged for disposal. After dismantling the sink, contamination was found to be present above action levels in the drain system. The entire sink was removed including all associated drain piping from room 544.

Light decontamination efforts for the floor were not successful in removing contamination levels to below action levels. Therefore, floor tiles were removed via asbestos subcontractor. Resurvey of the bare concrete floor indicated several areas of contamination remaining. The floor was then decontaminated via mechanical grinding to a depth of approximately ¼ inch in these areas. This effort proved effective in removing the contamination.

Sections of the wall were also decontaminated via mechanical grinding to remove contamination.

4.9 Room 552A

In this room, beta/gamma surface contamination was identified in several areas of a lab hood. The areas could not be decontaminated. The lab hood was disassembled with the contaminated sections segregated as waste.

4.10 Room 554-B2

This room contained miscellaneous equipment, lab items, and samples. During the Class 3 survey, several of these samples were identified as having a radiological component. All items in this room were surveyed individually with contaminated items being segregated. The room was then reclassified Class 1 with contamination being removed prior to survey.

5.0 FINAL STATUS SURVEY RESULTS

The fifth floor of the EML consists of laboratories, offices, building service/equipment rooms, corridors, janitor’s closets, stairwells, and elevators. The elevators, stairwells, building services/equipment rooms, and the lobby are considered areas that are not impacted by historical radioactive materials usage in the EML. The final total impacted areas of this floor include 24 Class 1 SUs, 3 Class 2 SUs, and 1 Class 3 Survey Unit as shown Table 5-1.

Table 5-1: 5th Floor Survey Units

Survey Unit	Area	MARSSIM Class	Notes
5-514	Room 514	1	EML Identified area, BNL Survey (2004)
5-516	Room 516	1	EML Identified area, BNL Survey (2004)
5-518	Room 518	1	EML Identified area, BNL Survey (2004)
5-520	Room 520	1	EML Identified area, BNL Survey (2004)
5-520A	Room 520A	1	EML Identified area, BNL Survey (2004)
5-524	Room 524	1	EML Identified area, BNL Survey (2004)
5-526	Room 526	1	EML Identified area, BNL Survey (2004)
5-552-RR	552 radon room	1	EML identified area, History Utilization Team report
5-559G	Room 559G	1	Contamination Found during Cabrera survey
5-528I	Room 528I	1	EML identified area, History Utilization Team report
5-527	Room 527	1	EML identified area, History Utilization Team report
5-525A	Room 525A	1	Contamination Found during Cabrera survey
5-525B	Room 525B	1	Contamination Found during Cabrera survey
5-528T	Room 528T inner room	1	EML identified area, History Utilization Team report
5-544	Room 544	1	Contamination Found during Cabrera survey
5-552A-W	Room 552A Walls	1	EML identified area, History Utilization Team report
5-552A-F	Room 552A Floor	1	
5-554V	Room 554V	1	EML identified area, History Utilization Team report
5-554-B2	Room 554-B2	1	EML identified to Cabrera after mobilization to site
5-541A	Room 541A	1	EML identified area, History Utilization Team report
5-541B	Room 541B	1	EML identified area, History Utilization Team report
5-541C	Room 541C	1	EML identified area, History Utilization Team report
5-538	Room 538	1	EML identified area, History Utilization Team report
5-536	Room 536 inner room	1	EML identified to Cabrera after mobilization to site
5-RL	Rooms 539, 519, 528Q, 528T (outer room), 536 (outer room), 542C and hallway around Radiochemistry labs	2	EML identified area, History Utilization Team report
5-SMG	Rooms 554X, 554R, 554T, 554P, 551L, and 551M	2	EML identified area, History Utilization Team report
5-W	Rooms 556A, 556B, 556C, and 503	2	EML identified area, History Utilization Team report
5-R3	Remaining 5th Floor Area	3	EML identified area, History Utilization Team report

The impacted rooms consisted of floors, walls, ceilings, and building fixtures. Building fixtures are considered to be permanently mounted components, such as lab benches and countertops, sinks, ventilation hoods, heating and ventilating ductwork, filtering housings, and building system piping and conduit.

5.1 Scan Survey Results

Gross alpha and beta scans were performed separately over building and fixture horizontal and vertical surfaces at a scan density in accordance with the MARSSIM classification of the specific room or SU in the FSSP (CABRERA, 2007). Floors and other large-area surfaces were scanned for surface contamination utilizing Ludlum Model 43-37 large-area (582 cm² active window area) gas proportional detectors coupled to Ludlum Model 2360 scaler/rate meters. Smaller surfaces, such as inside hoods or drawers, were scanned with Ludlum Model 43-68 gas proportional detectors (126 cm² active window area) coupled to Ludlum Model 2224 or Model 2360 scaler/rate meters. Scan Action Levels for alpha and beta measurements were developed for each scan instrument to represent residual radioactivity levels that were 50% of the DCGL. These Action Levels are listed on each field scan information sheet presented in Appendix C. Scans were performed and biased measurements collected where appropriate at additional locations based on initial scan results and professional judgment. Certain locations with clearly elevated activity were decontaminated/removed and resurveyed until acceptable results were achieved in accordance with the ALARA concept. All final alpha and beta scan results were less than the scan Action Levels for each SU.

5.2 Surface Activity Measurements

FSS measurements were collected from building and fixture surfaces in accordance with the FSSP. All FSS measurements represent the final, post-remediation (where necessary) surfaces and materials. FSS data consisted of Systematic and Biased static integrated alpha and beta measurements for fixed surface activity, and smear measurements for transferable alpha and beta activity. The distinctions between these are:

Systematic measurements:

- Are collected from a random start, systematic grid at the minimum number of survey locations within a SU as prescribed in the FSSP;

- Must conform to the statistical tests required to demonstrate DCGL compliance; and

- Must conform to $DCGL_{EMC}$ requirements (EMC procedure not employed for 5th floor SUs).

Biased measurements:

- Are collected to investigate in-process field measurements or as post-remediation samples to determine the effectiveness of remedial action:

- Are compared to DCGL requirements; and

- Must conform to $DCGL_{EMC}$ requirements (EMC procedure not employed for 5th floor SUs).

The statistical tests applied to interpret survey data in regard to the DCGL were in accordance with MARSSIM for a radionuclide contaminant not present in background, and are:

1) If all measurements within a survey unit were less than the DCGL the unit met the release criteria.

2) If the average of all measurements was greater than the DCGL the unit did not meet the release criteria.

3) If the SU average was less than the DCGL but any individual measurement was greater, a Sign Test and elevated measurement comparison were conducted.

The Sign Test, a nonparametric statistical test, is designed to detect uniform failure of compliance with release criteria for systematic surface samples throughout a SU. The Sign test assumes that the contaminants are not present in background or are present in such small fractions of the DCGL as to be considered insignificant. Therefore, ROC activity concentrations are normally compared directly to the DCGL. However, for the DHS EML FSS with the

potential for high variability of background due to the many different building materials, a Sign test with paired observations was used. Each measurement in the survey unit is paired with an observation on a suitable reference (background) material. The Sign test is then performed on the difference. The tradeoff is the higher variability of the differences compared to a single measurement.

To account for this potential increased variability in measurement standard deviation from multiple surfaces, the planning sigma values used in the determination of the number of sample points per SU were doubled. Details of the SU design are provided in Section 3.

In addition to the DCGL evaluation, results for each FSS sample location were evaluated to ensure that none exceeded the $DCGL_{EMC}$ investigation level. If a measurement would have exceeded a $DCGL_{EMC}$ investigation level, additional investigation would have been performed at least locally, to determine the actual extent of the elevated activity concentration. The use of the $DCGL_{EMC}$ against the investigation results was an assurance that unusually large measurements would have been identified and received proper attention for the potential for significant dose contributions, regardless of the outcome of the Sign Test. As no individual post-decontamination measurements exceeded DCGLs, $DCGL_{EMC}$ procedures were neither necessary, nor employed.

All FSS results and forms are presented in Appendix C. All FSS analyses (e.g., DCGL evaluations, Sign Tests) are presented in Appendix D. FSS instrumentation calibrations and certificates are presented in Appendix E.

5.2.1 Systematic Measurements

There were a total of 476 systematic total and removable surface activity measurements collected from the fifth floor. All final total and removable surface activity measurements satisfy the residual surface activity DCGLs presented in Table 2-1.

5.2.2 Biased and Property Measurements

Biased fixed-point and removable surface activity measurements were also collected from the fifth floor. All biased total and removable surface activity measurements satisfy the relevant

residual surface activity DCGLs presented in Table 2-1. Total and removable surface activity measurements were also collected from various pieces of property (e.g., lead bricks, laboratory instruments, laboratory equipment, etc) located throughout the rooms in the fifth floor. Pieces of property with elevated activity were either decontaminated or removed for disposal as radioactive waste.

5.3 MARSSIM-Based Evaluation of FSS Results

FSS results were evaluated in accordance with MARSSIM guidance. No final survey results exceeded the DCGL for each ROC and therefore comparison to the DCGL elevated measurement criteria, $DCGL_{EMC}$, was not required. In addition, since no survey measurement in the FSS exceeded the DCGL, accounting for material-specific background, the application of Sign Tests were not required.

Based on the results of these FSS activities, each SU on the fifth floor meets the screening criteria of NUREG-1757, Vol. 1, Appendix B, release criteria of NYCDOH 175.03 *Release of Materials or Facilities*, and the release criteria of DOE 10 CFR 835, Appendix D as presented in Table 2-1 in Section 2.0. According to the *FSSP* decision methodology, these areas meet the criteria for unrestricted release.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Field activities conducted as part of the decommissioning effort were performed in accordance with written procedures and/or protocols in order to ensure consistent, repeatable results. Data generated during the FSS met the Quality Assurance (QA)/Quality Control (QC) requirements outlined in the *FSSP* (CABRERA, 2007a).

6.1 Survey Instrumentation Quality Control

The CABRERA Project Health Physicist (HP) was responsible for determining the instrumentation required to complete the requirements of this FSS. Only instrumentation approved by the CABRERA Project HP was used to collect radiological data. The CABRERA Project HP was responsible for ensuring individuals were appropriately trained to use project instrumentation and other equipment, and that instrumentation met the required detection sensitivities. Instrumentation was operated in accordance with either a written procedure or manufacturers' manual, as determined by the CABRERA Project HP. The procedure and/or manual provided guidance to field personnel on the proper use and limitations of the instrument.

6.1.1 Calibration Requirements

Instruments used during project performance had current calibration and maintenance records on site for review and inspection. The records included the following:

- name of the equipment
- equipment identification (model and serial number)
- manufacturer
- date of calibration
- calibration due date

Instrumentation was maintained and calibrated to manufacturers' specifications to ensure that required traceability, sensitivity, accuracy and precision of the equipment/instruments were maintained. Instruments were under current calibration. The calibration records for each instrument used during this characterization survey are presented in Appendix E.

6.1.2 Instrument QC Source Checks

Prior to daily use, project instrumentation was QC checked by comparing instrument response to a benchmark response. Prior to the commencement of field operations, site reference locations

were selected for performance of these checks; subsequent QC checks were performed at these locations. QC source checks consisted of a one-minute integrated count with the designated source positioned in a reproducible geometry performed at the reference location. Prior to the start of initial surveys, this procedure was repeated ten times to establish average instrument response. The QC results for each instrument used during this characterization survey are presented in Appendix E.

6.1.3 Direct Radiation Measurement Instrumentation QC

Instrument responses to designated QC check sources were recorded and evaluated against the average established at the start of the field activities. An acceptance criterion of ± 20% was required for direct measurement detectors. A QC count outside the respective screening limit would require informing the Project Manager (PM), or designee, a detector evaluation, and could have resulted in the detection system being removed from service for corrective action. Direct measurement detectors that were used during field activities passed QC evaluations daily. The QC results for each instrument used during this characterization survey are presented in Appendix D.

7.0 HEALTH AND SAFETY

Health and safety measures were employed during conduct of FSS activities, in accordance with the project Site Safety and Health Plan (CABRERA, 2007b).

7.1 General Health and Safety Measures

Daily health and safety activities were performed in accordance with the project Health and Safety Plan, including conducting Daily Safety meetings, prior to the performance of survey activities each day. These daily safety meetings allowed for discussion of daily safety measures required based on the activities planned for each day. The Site Safety and Health Plan was reviewed by CABRERA project personnel prior to the performance of characterization survey activities. No reported injuries took place during the characterization survey field effort.

7.2 Radiological Health and Safety Measures

General radiological health and safety measures were performed in accordance with the project Site Safety and Health Plan (CABRERA, 2007b) and CABRERA Standard Operating Procedures (SOPs).

8.0 SUMMARY OF RESULTS AND CONCLUSIONS

Final Status Surveys were conducted at EML in accordance with MARSSIM guidance using 10 CFR 835 criteria for final release. None of the final FSS fixed or removable survey results, as presented in Appendix C, exceeded the corresponding DCGL. Data obtained from this FSS effort support the release of the EML 5^{th} floor for unrestricted use.

9.0 REFERENCES

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APPENDIX A

FINAL STATUS SURVEY PLAN

FINAL STATUS SURVEY PLAN

Environmental Measurements Laboratory – Department of Homeland Security,
New York, NY

JMC Project: DHS 2006-001

Prepared for:

U.S. Army Sustainment Command
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ACRONYMS AND ABBREVIATIONS

α, β, γ	Alpha, Beta, and Gamma radiation
σ	Sigma (Standard Deviation)
Δ	Delta (or Change In)
µR/hr	microRoentgen per hour
ASC	U.S. Army Sustainment Command
^{14}C	Carbon-14
cm	centimeter
CABRERA	Cabrera Services, Inc.
COC	Chain of Custody
cpm	counts per minute
DCGL	Derived Concentration Guideline Level
$DCGL_{EMC}$	Derived Concentration Guideline Level, Elevated Measurement Comparison
DHS	Department of Homeland Security
DOE	Department of Energy
dpm	disintegrations per minute
dpm/100cm^2	disintegrations per minute per 100 centimeters squared
DQO	Data Quality Objective
EMC	Elevated Measurement Comparison
EML	Environmental Measurements Laboratory
FSS	Final Status Survey
FSSP	Final Status Survey Plan
^{3}H	Hydrogen-3 (Tritium)
HRA	Historical Radiological Assessment
LBGR	Lower Bound of the Grey Region
LSC	Liquid Scintillation Counting
M	meter
m^2	square meters
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
MeV	mega electron volts
mrem/yr	millirem per year
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission

QA	Quality Assurance
QC	Quality Control
^{226}Ra	Radium-226
RAM	radioactive materials
ROC	Radionuclide of Concern
SOP	Standard Operating Procedure
SOR	Sum of the Ratios (equivalent to the sum of the fractions)
SU	Survey Unit
WRS	Wilcoxon Rank Sum (statistical test)

1.0 INTRODUCTION

Cabrera Services, Inc. (CABRERA) is under contract to the U.S. Army Sustainment Command (ASC) to complete project tasks in accordance with CABRERA project proposal number 06-091, dated 27 June, 2006 (DHS 2006-001*)*. The Department of Homeland Security (DHS) requires the preparation and implementation of a Final Status Survey Plan (FSSP) to address the radiological status of the Environmental Measurements Laboratory (EML) facilities in the General Services Administration building, 201 Varick Street in lower Manhattan, NY. The project plans consist of the Final Status Survey plan (FSSP) herein, a project Site Specific Health and Safety Plan, and a Quality Assurance / Quality Control (QA/QC) Plan. Data collected from this FSSP will be used to develop a Final Status Survey Report for use by DHS in obtaining unrestricted release approval by appropriate regulatory authority of all areas addressed in the Description of Work.

This FSSP has been designed using the approach outlined in NUREG-1575, rev. 1, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (Nuclear Regulatory Commission [NRC], 2000). The document offers guidance of decommissioning efforts and documentation which includes the following elements pertinent to the activities outlined in this plan:

- Identification of survey units (SUs) and classification of SUs by contamination potential
- Estimation of the number of measurement locations
- Selection of instrumentation and measurement techniques
- Data Collection
- Data Evaluation

Final Status Survey (FSS) activities, involving work with radioactive materials, will be performed in accordance with CABRERA's Radiation Protection Program, and under CABRERA's NRC Materials License No. 06-30556-01 (copy attached).

1.1 Objective

The objective of this FSS is to obtain data of sufficient quality and quantity to prove, within a specified degree of confidence, that residual radioactivity levels within the survey areas meet the limits for unrestricted release.

1.2 Site Background

EML is located in a 5-story GSA Building located in lower Manhattan, NY at 210 Varick Street. EML occupies the entire fifth floor of the facility, and small areas in the first floor and basement.

The EML facility was formerly operated by Department of Energy (DOE) as an environmental radiochemistry laboratory, and now falls under the DHS. Currently, no handling of unsealed radioactive sources occurs within the facility. Upon completion of unrestricted release of the facility, EML intends to retain possession of a handful of sealed radioactive sources under NRC licensure.

1.2.1 Radiological Contamination

Several areas of radiological contamination are known to exist on the fifth floor of the site from historical surveys. In Lab 516, 15,000 disintegrations per minute per 100 square centimeters (dpm/100cm^2) fixed beta-gamma contamination is known to exist inside a cabinet. In Lab 518, 1560 dpm/100 cm^2 of fixed alpha contamination is known on bench tops. In Lab 526, 70,000 dpm/100 cm^2 of fixed beta-gamma and 6,000 dpm/100 cm^2 fixed alpha contamination, as well as 52 dpm/100^2 of removable alpha contamination, is known to exist in drawers, cabinets, and on floors, and bench tops (Brookhaven, 2005).

In the EML area of the building basement, radium contamination is known to exist on the floor and walls. The removable contamination in this area was encapsulated by the Environmental & Waste Management Services Division of Brookhaven National Laboratory (BNL) in June of 2004 (Brookhaven, 2004). However, reported estimates of the total activity encapsulated are not considered appropriate to support release decisions and FSS requirements.

1.3 Radionuclides of Concern

Operational radiological safety surveys have been performed routinely during the use of the facility for radiochemistry. A comprehensive survey of the analytical laboratories was performed by BNL, report dated October 3, 2005. Common good laboratory practices were used to remove and dispose of contamination as it was generated or discovered. Based on the historical information available, the following is a list of radionuclides of concern (ROC) with any significant likelihood of remaining at the sight. ROCs specifically denoted as being at the facility are listed. However, the potential exists for all other nuclides with atomic numbers up to 92 to have been historically present at the site in radioanalytic samples due to the fact that the EML licenses allowed possession of all of these nuclides in varying quantities. Isotopes with half-lives of less than 6 months are not likely to be present at the site in significant activity at the present time are not included in the list.

Table 1-1. Radionuclides of Concern

Nuclide	Name	Half-Life	Principal Emissions (megaelectron volts [MeV])	Source of Radionuclide
Ni-63	Nickle-63	100.1 yr	0.067 beta	Radioanalytic Sample
Ra-226	Radium-226	5.75 yr	4.785 alpha 0.168 beta 0.186 gamma	Radioanalytic Sample
Cs-137	Cesium-137	30.17 yr	0.511 beta 0.666 gamma (from Ba-137m)	Radioanalytic Sample
Sr/Y-90	Strontium / Yttrium-90	28.6 yr	0.196 beta 0.935 beta 2.2 beta	Radioanalytic Sample
Tc-99	Technetium-99	21.3E4 yr	0.293 beta	Radioanalytic Sample
U-235	Uranium-235	7.04E8 yr	4.396 alpha (most abundant) 0.014 beta (most abundant) 0.186 gamma (most abundant)	Radioanalytic Sample
U-238	Uranium-238	4.47E9 yr	4.196 alpha (most abundant) 0.029 beta (most abundant)	Radioanalytic Sample
Pu-238	Plutonium-238	87.75 yr	5.499 alpha (most abundant) 0.021 beta (most abundant)	Radioanalytic Sample
Pu-239/240	Plutonium-239/240	2.41E4 yr	5.155 alpha (most abundant) 0.029 beta (most abundant)	Radioanalytic Sample

2.0 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and quantitative statements that establish a systematic procedure for defining the criteria by which data collection design is satisfied in order to make determinations regarding remediated properties. The DQOs for the Site FSS include:

- Identifying the project problem;
- Defining the data necessary for achieving the end use decisions;
- Determining the appropriate method of data collection; and
- Specifying the level of decision errors acceptable for establishing the quantity and quality of data needed to support the project decisions.

2.1 Step 1: State the Problem

Radioactive material was used within the facility during environmental sample processing and analysis activities. The objective of FSS activities is to obtain data of sufficient quality and quantity to support unrestricted release of the facility to the general public.

2.2 Step 2: Identify the Decision

2.2.1 Principal Study Question

Do the concentrations of the ROCs remaining as contamination in the building exceed applicable levels for unrestricted release?

2.2.2 Decision Statement

The following statement assumes that ROC concentrations exceed release levels. If ROC concentrations inside laboratories do not exceed the derived concentration guideline limit (DCGL), the facility will satisfy the release criterion.

- Determine whether survey unit (SU) ROC concentrations inside the building exceed background concentrations by more than the applicable release criteria.

2.3 Step 3: Identify Inputs to the Decision

This section lists the data needs, describes the sources of that data, and discusses the means of obtaining the required data. The following site information must be determined in order to resolve applicable decision statements:

- Concentration of residual ROCs in survey areas. This information will be used to determine if an area is impacted. Obtaining this data will facilitate cost effective decision-making regarding the project's direction and duration.

Concentrations of residual radioactive material in the survey units will be determined by

means of:

- Direct surface radioactivity measurements
- Removable radioactivity measurements (e.g., liquid scintillation counter results)
- Exposure rate surveys

2.4 Step 4: Define the Study Boundaries

The populations of interest are the concentrations of ROCs on building surfaces and fixtures. The area of interest is horizontally and vertically limited to impacted areas located inside the building areas addressed in this FSS.

Constraints on data collection include inaccessible areas, such as pipe runs between drains and cleanout traps. In these instances, decisions may be made based on data collected from the areas where radioactive material may have entered the system.

2.5 Step 5: State the Decision Rules

2.5.1 Surface Radioactivity Scan Surveys

If areas of elevated radioactivity are identified during scan surveys, identified areas will be decontaminated as appropriate and re-surveyed. Smear samples will also be collected and analyzed from these areas.

2.5.2 Basic Procedure

The general approach to SU surveys of this FSS will be as follows:

Step 1: Perform area alpha/beta gamma scans of applicable surface areas, noting areas of contamination which exceed scan action levels.

Step 2: If contamination is found, quantify through static measurements and smears as described in this FSS. If contamination exceeds DCGL, efforts will be made to decontaminate. The SU will be reclassified as necessary, and rescanned. If no scans are above DCGL, proceed with the next step. If area is still contaminated above DCGL, repeat contamination efforts.

Step 3: After all scans have been completed and no areas exceeding DCGLS are identified, systematic static measurements and smears will be taken as per layout for the particular SU. Collect static and smear biased measurements using professional judgment.

Step 4: Apply statistical tests as described in this FSS. If the SU fails the test, or biased/statistical survey points exceed $DCGL/DCGL_{emc}$, return to Step 2. Otherwise proceed to the next Step.

Step 5: Document all survey data. SU complete.

2.6 Step 6: Define Acceptable Decision Errors

Appendix D in MARSSIM (NRC, 2000) provides a discussion regarding decision errors. This discussion includes the concept that acceptable error rates must be balanced between the need to make appropriate decisions and the financial costs of achieving high degrees of certainty.

Errors can be made when making site remediation decisions. The use of statistical methods allows for controlling the probability of making decision errors. When designing a statistical test, acceptable error rates for incorrectly determining that a site meets or does not meet the applicable decommissioning criteria must be specified. In determining these error rates, consideration should be given to the number of sample data points that are necessary to achieve them. Lower error rates require more measurements, but result in statistical tests of greater power and higher levels of confidence in the decisions. In setting error rates, it is important to balance the consequences of making a decision error against the cost of achieving greater certainty.

Acceptability decisions are often made based on acceptance criteria. If the mean and median concentrations of a contaminant are less than the associated acceptance criteria, for example, the results can usually be accepted. In cases where data results are not so clear, statistically based decisions are necessary. Statistical acceptability decisions, however, are always subject to error. Two possible error types are associated with such decisions.

The first type of decision error, called a Type I error, occurs when the null hypothesis is rejected when it is actually true. The probability of a Type I error is usually denoted by alpha (α). The maximum Type I error rate is 0.05.

The second type of decision error, called a Type II error, occurs when the null hypothesis is not rejected when it is actually false. The probability of a Type II error is usually denoted by beta (β). The power of a statistical test is defined as the probability of rejecting the null hypothesis when it is false. It is numerically equal to $1-\beta$ where β is the Type II error rate. Potential consequences of Type II errors include unnecessary remediation expense and project delays.

For the purposes of this FSS, the acceptable error rate for both Type I and Type II errors is five percent (i.e., $\alpha = \beta = 0.05$).

3.0 SURVEY DESIGN AND METHODOLOGY

3.1 Determine Impacted and Non-Impacted Areas

In order to determine the scope of the FSS, a historical review of licensed radioactive material usage at the facility was performed. The purpose of the review was to:

1. Identify radionuclides used, and which rooms/labs/areas were used or were potentially contaminated,
2. Identify areas that may have been previously released, and
3. Identify and quantify actual areas of contamination.

This information was then used to determine if certain areas were impacted by radionuclide usage. Specific areas covered under this FSS Plan include the fifth floor (approximately 61,130 ft^2), a 2,500 ft^2 area on the first floor utilized by EML, and a 3,100 ft^2 area of the basement. Impacted/Non-Impacted areas are discussed in Section 3.5 of this FSS.

3.2 Area Classification Based On Contamination Potential

Impacted areas were then classified based on contamination potential as per guidance in MARSSIM sections 2.2, 4.4, 5.5.2, and 5.5.3 (NRC, 2000). Namely,

- Class 1: The area had been contaminated above the release criteria, and it is possible to find radioactivity above the release criteria;
- Class 2: The area had radioactive material use, but it is unlikely to have radioactivity above the release criteria;
- Class 3: The area had some use of radioactive material, but it is very unlikely to have radioactivity above the release criteria.

3.3 Statistical Tests

3.3.1 Sign Test

The Sign test is designed to detect uniform failure of remedial action throughout a SU. It draws direct comparisons between SU data and the chosen release criteria, i.e. DCGL. The Null Hypothesis is assumed to be true unless the statistical test indicates that it should be rejected in favor of the alternative. The null hypothesis states that the probability of a measurement less than the DCGL is less than one-half, i.e. the 50th percentile (or median) is greater than the DCGL. With this in mind, SUs may meet the release criteria even though some measurements may be greater than some reference area measurements. The result of the hypothesis test determines whether or not the SU as a whole meets the release criteria.

If all of the sample results are less than the DCGL then no Sign test statistical evaluation is required.

3.3.2 Application of Sign Test for Multiple Surfaces

The typical approach for evaluating internal building surfaces using the MARSSIM protocol involves the Wilcoxon Rank Sum (WRS) test. The WRS test requires that an appropriate background (reference) unit be surveyed for each material type in a survey unit such that gross measurements may be used for evaluating survey results. However, application of the WRS test for complex buildings with many structural surfaces can be cumbersome, as a single SU may require several background reference areas for proper evaluation. To address situations like this, a method for applying the Sign test to multiple surfaces was developed. The procedures for this are described in Chapter 12 of NUREG-1505. (NRC 1998)

NUREG-1505 states " …the Sign test may be more appropriate when there are many different materials within what would otherwise logically be a single survey unit. As indicated at the beginning of this chapter (Chapter 12), to divide such a survey unit into separate parts, each requiring its own reference area is not only impractical, but may be inconsistent with the dose models used to determine the DCGLs." "Fortunately, there is a third option - to use the Sign test with paired observations. Each measurement in the survey unit is paired with an observation on a suitable reference material. The Sign test is then performed on the difference. The tradeoff is the higher variability of the differences compared to a single measurement."

To account for this potential increased variability in measurement standard deviation from multiple surfaces, the planning sigma values used in the determination of the number of sample points per SU were doubled from their observed values during the Scoping Survey. Details of the SU design are provided in the sections to follow.

Representative background values to be used in the paired observations will be collected in unimpacted areas of the buildings on similar building materials (see Section 3.9). The selection and measurement of the background reference areas will be done prior to the execution of the field work so they can be applied directly. A minimum of five (5) 1-minute fixed-point measurements will be collected with the average used for subtraction from each systematic measurement location prior to evaluation using the Sign test.

3.3.3 Performing the Sign Test

The Sign test is applied as outlined in the following five steps from Section 8.3.2 of the MARSSIM. Each measurement will have the appropriate background reading subtracted and the difference would be subject to the Sign test, outlined in the steps below:

Step 1: List the SU measurements, X_i, $i = 1, 2, 3, \ldots, N$.

Step 2: Subtract each measurement, X_i, from the DCGL to obtain the differences:

$D_i = DCGL - X_i,\ i = 1, 2, 3, \ldots, N.$

Step 3: Discard each difference that is exactly zero and reduce the sample size, N, by the number of such zero measurements.

Step 4: Count the number of positive differences. The result is the test statistic (S+). Note that a positive difference corresponds to a measurement below the DCGL and contributes evidence that the SU meets the release criterion.

Step 5: Large values of S+ indicate that the null hypothesis (that the SU exceeds the release criterion) is false. The value of S+ is compared to the critical values in MARSSIM Appendix I, Table I.3. If S+ is greater than the critical value, *k*, the null hypothesis is rejected.

3.3.4 Multiple Radiation Measurements

Statistical tests will be performed for all types of radiation included in the survey (i.e. alpha & beta).

3.4 Elevated Measurement Comparison

If a measurement shows a location of elevated activity greater than the DCGL and further decontamination is not possible, then the area around the location will need to be surveyed per the EMC procedure. The EMC is performed for both measurements obtained on the systematic/random sampling grid and for locations flagged by scanning measurements. Any measurement from the survey unit that is equal to or greater than an investigation level indicates an area of relatively high concentrations that should be investigated, regardless of the outcome of the nonparametric statistical tests.

Radiological contamination above the DCGL levels would require a breakup of the SU with reclassification to Class 1 of at least certain sections. The EMC consists of comparing each measurement from the survey unit to investigation levels (the DCGL for this survey). If such a situation arises, then the EMC procedure as specified in MARSSIM, Section 8.5.1 and/or decontamination will need to be performed.

3.5 Survey Unit Breakdown

Based primarily on the review of the *EML Facilities Historic Utilization Team Report, August 2006*, and *Radiological Surveys of EML Laboratories, September 30, 2005, Brookhaven National Laboratories*, the list below was developed identifying impacted areas based on the historical presence of radioactive materials, separating them into survey units and classifying those survey units based on the likelihood of contamination and physical locations/separations of the areas.

Impacted, Class 1 Areas: 5th floor rooms; 541A, 541B, 541C, 544, 552A, 554R, 514, 515, 518, 520A, 520, 524, 525. Basement rooms B15, B15A.

Impacted, Class 2 Areas: 5th floor areas: Two Class 2 SUs are defined here. First is the hall way encircling the radiochemistry laboratories. A second SU is composed of the Gamma Spec. Lab., the Machine Shop, and the Staging Area (Rooms 551L, 554T, 554X). Basement: All EML areas not classified as Class 1 areas. 1st floor: Lab#1, Lab #2, and area around the Dust Collector.

Impacted, Class 3 Areas: 5th floor areas: Remaining areas on eastern half of the floor excluding stairs, utility closets, pipe chases and other inaccessible areas. 1st floor: remaining EML areas not listed as Class 1 or 2.

Non-Impacted Areas: 5th floor areas: West Half of the floor, utility closets, stairs, pipe chases.

Graphical representations of these areas are provided in Appendix B.

3.6 Survey Unit Coverage

The coverage of beta and gamma measurements in each SU is dependent upon the survey class and the types of ROCs. General specifications for each SU class are provided below. Note that "Fixtures" includes features such as countertops, drawers, cabinets, and hoods.

The SUs are defined in this manner in order to simplify administration of the survey and handling of the data. Surveys of upper walls and ceilings are being administered as part of the survey of the lower floors and walls.

<u>Class 1</u>

Floors, Lower Walls (< 2 meters [m]) and Fixtures

Perform a 100% beta scan survey of surfaces. Collect fixed-point measurements at systematic locations using a triangular grid pattern. Floor areas limited to 100 square meters (m^2), where practical. Collect additional fixed-point measurements at biased locations using scan described in 3.10.1 or professional judgment.

Upper Walls (> 2m) and Ceilings

Perform a minimum 25% scan survey on walls above 2m and 10% scan survey on accessible ceiling surfaces. Collect fixed-point measurements at biased locations using professional judgment.

<u>Class 2</u>

Floors, Lower Walls (< 2m) and Fixtures

Perform a minimum 25% scan survey of surfaces. Collect fixed-point measurements at systematic locations using a triangular grid pattern. Floor area limit of 1,000 m^2 applied. Collect additional fixed-point measurements at biased locations using professional judgment.

Upper Walls and Ceilings

Perform a minimum 10% scan on walls above 2m and accessible ceiling surfaces. Collect fixed-point measurements at biased locations using scan described in 3.10.1 or professional judgment.

Class 3

All Surfaces and Fixtures

Perform a minimum 10% scan survey of all surfaces. Collect fixed-point measurements at biased locations using professional judgment. No floor area size limit enforced.

3.7 Release Criteria

3.7.1 Surface Contamination DCGLs

Screening values are used as the DCGLs as shown in Table 3-1. If these values are exceeded during the survey, an evaluation will need to be performed to ensure that the prospective dose due to residual radioactivity is not to exceed 25 millirem in any year. Since data about possible isotopes is scarce, the preferred method is to apply conservative screening values. For consistency with prior DOE surveys, the most restrictive contamination limits published in 10 CFR 835 Appendix D are used for this FSS.

Table 3-1. Surface Activity DCGLs for EML FSS

Agency / Reference	Alpha Total (dpm/100cm^2)	Alpha Removable (dpm/100cm^2)	Beta/Gamma Total (dpm/100cm^2)	Beta/Gamma Removable (dpm/100cm^2)
NRC 10 CFR 20.1402	Total dose to the public after decommissioning of not more than 25 mrem/yr			
NYCDOH §175.03 – Release of Materials or Facilities	2,500 Max 500 Average	100	0.2 mR/hr[b]	1,000
DOE 10 CFR 835 Appendix D	500[a]	20[a]	1,000[a]	200[a]
Chosen DCGL For DHS EML	***500[a]***	***20[a]***	***1,000[a]***	***200[a]***

Notes: a. Averaged over 1 m^2, provided no 100 cm^2 area exceeds 3 times the specified limit
b. Measured at 1 centimeter (cm) from the surface

3.8 Sampling Grid Layout

3.8.1 Relative Shift

The relative shift describes the relationship of site residual radionuclide concentrations to the DCGL and is calculated using the following equation, found in Section 5.5.2.2 of MARSSIM (NRC, 2000):

$$\frac{\Delta}{\sigma} = \frac{DCGL - LBGR}{\sigma}$$

where:

σ = An estimate of the standard deviation of the concentration of residual radioactivity in the survey unit (which includes real spatial variability in the concentration as well as the precision of the measurement system). σ is estimated as 0.3 times the DCGL.

Δ = The width of the gray region, i.e., DCGL-LBGR

DCGL = The derived concentration guideline level (i.e., release limit)

LBGR = Concentration at the lower bound of the gray region. The LBGR effectively becomes the survey's action level. For conservatism, the LBGR will be set to 0.5 times the DCGL for this FSS.

3.8.2 Number of Sampling Points

Section 2.6 establishes the acceptable decision errors α=β=0.05. Based on these acceptable decision errors and the relative shift, the minimum number of measurement locations in each SU was calculated per MARSSIM Section 5. This calculation includes the MARSSIM recommended 20% additional samples to protect against the possibility of lost or unusable data (Table 5.5 from the MARSSIM document).

Table 3-2 shows the MARSSIM-based statistical parameters used in a calculation of the target number of samples per survey area.

Table 3-2. Summary of MARSSIM Design Parameters for the Site FSS

MARSSIM Parameter	Alpha Static Measurement[1] (cpm)	Beta Static Measurement[1] (cpm)	Alpha Smear (dpm/100 cm^2)	Beta Smear (dpm/100 cm^2)
σ	30[1,2]	60[1,2]	6[2]	60[2]
DCGL	100[4]	200[3]	20	200
LGBR	50	100	10	100
Relative Shift (Δ/σ)	1.67	1.67	1.67	1.67
Pr (from MARSSIM Tbl. 5.4)	0.95	0.95	0.95	0.95
N	14	14	14	14
N (including 20% overage)[5]	*17*	*17*	*17*	*17*

Notes:

1. Static counts to be performed with Ludlum 43-68 proportional detector. Count time = 1 min.
2. Sigma values for static measurements and smears were set at 0.3 times the DCGL to account for potential added variability (see Section 3.3.2)
3. 200 counts per minute (cpm) is equivalent to the beta DCGL of 1,000 disintegrations per minute per 100 centimeters squared (dpm/100 cm^2) assuming 20 % efficiency for the Ludlum 43-68 probe.
4. 100 counts per minute (cpm) is equivalent to the beta DCGL of 500 disintegrations per minute per 100 centimeters squared (dpm/100 cm^2) assuming 20 % efficiency for the Ludlum 43-68 probe.
5. MARSSIM Sec. 5.5.2.1 recommends that the calculated number of samples per SU (N) be increased by 20% to account for potentially lost or unusable data. Final N rounded up to nearest whole number.

The LGBR was chosen as one-half of the DCGL as per guidance provided in the MARSSIM. The standard deviation for static and smear measurements were set at 30% of the DCGL as per MARRSIM recommendation when site specific standard deviation data is not available.

The results show that all of the measurements are sufficiently sensitive to allow a relatively small number of MARSSIM-type systematic measurements to be performed in each SU (i.e., 17). Scans and biased measurements are also important in demonstrating that the residual radioactivity levels are less than the DCGLs.

3.8.3 SU Grid Spacing

Grid spacing and placement of fixed-point measurement locations within each SU will be based on a relative coordinate system.

The spacing of the data points for Class 1 and Class 2 areas is determined by:

$$L = \sqrt{\frac{A}{0.866\,n}}$$

where:

L = grid spacing
A = survey unit area (including wall area)
n = number of data points

The starting point is randomly selected and the data points are located within the survey unit using a triangular grid for Class 1 or Class 2 areas. The systematic locations for floor layouts will also include the first 2 meters of each wall which may be folded out or otherwise placed on the drawing of the survey area such that the floor grid also overlays the wall surface. If a grid point falls on a fixture such as a countertop, then the fixture will be measured and so noted in the documentation.

Locations of measurement locations in Class 3 SUs are determined by multiplying the east-west (Y) and the north-south (X) dimensions of each survey unit by a randomly generated number between 0 and 1 for each dimension. For consistency, the southwest corner of each survey unit will be the origin. Sample locations will be calculated using a computer to determine random numbers and plot data point locations on a survey map. To facilitate field measurements, the calculated coordinates will be rounded to the nearest whole number of meters.

3.9 Background Survey Areas

Determination of background values is of the utmost importance in building decommissioning projects. Since ‘net’ residual contamination values, or the difference between a sample count rate and background, are used to assert whether a particular SU satisfies the criteria for unrestricted release, application of accurate and applicable background values is crucial to proper decision-making. In this light, background measurements must be made in non-impacted areas on building surfaces expected during the FSS. The selection and measurement of the background reference areas must be done before the execution of field work. Representative measurements of various flooring and wall materials must be collected with each detector used so an applicable background can be applied before direct comparison with a DCGL value or application of the Sign test. In order to account for instrument response to ambient background, which can change from location to location, instrument background measurements will be performed on each material encountered.

3.10 Survey Methods and Instrumentation

The purpose of this section is to describe direct radiation measurement and sample collection and analysis techniques that will be implemented during the Site FSS. Physical and performance characteristics of each detector probe are provided in Table 3-3.

Table 3-3. FSS Detector Probe Characteristics

Detector	Application	Detector Type	Radiation Sensitivity	Active Area (cm^2)
Ludlum 44-9	Building, system, equipment surfaces; personnel frisking	Geiger-Mueller	Beta, Gamma	15
Ludlum 43-68	Large area surfaces (floor, walls, bench tops, drawers)	Gas Proportional	Alpha, Beta	126
Ludlum 239-1F Floor Monitor (,43-37 detector)	Smooth floor surfaces	Gas Proportional	Alpha, Beta	582
Ludlum 2929	Removable Contamination (Smear) Counter	Dual Channel "Phoswich"	Alpha, Beta	N/A
Bicron MicroRem, and Ludlum 44-2 (or equivalent)	Gamma radiation scans and counts	(1-inch by 1-inch Sodium Iodide [NaI])	Gamma	N/A

3.10.1 Surface Alpha/Beta Radioactivity Scans

Applicability:

Impacted areas that have the potential for alpha-emitting and beta-emitting radionuclide surface contamination shall be scanned as described in this section. For the DHS EML survey, this includes all impacted areas. Floors, walls, bench tops, and cabinet interiors shall be scanned as described in Section 3.6.

Instrumentation:

The following detectors shall be used per the judgment of the survey supervisor:

- Gas proportional detector (Ludlum 43-68, Ludlum 43-37, or equivalent) for any large surfaces
- Geiger Mueller (Ludlum 44-9 or equivalent) for small surfaces or other hard-to-reach places

Scan measurement sensitivities are presented in Appendix C.

Technique:

The surfaces will be scanned for alpha and beta contamination by moving the probe in straight paths with spacing that will ensure that the minimum surface area is covered as required by the SUs classification. The ratemeter will be set to alarm at a preset level indicating that contamination is being detected that is approaching a screening value or the technician shall be familiar with detecting an audible or visible increase in count rate

over the action level. Two scans will be performed – once in alpha detection mode, and once in beta detection mode (for the 43-68 and 43-37).

If background response varies greatly during scan survey activities, instrument background measurements may be performed at representative measurement locations.

The scan survey action level will be a sustained instrument response above the ambient level. Action levels will be calculated in "gross CPM" for a given area with an asserted background level. If a survey results in locations above the action level, the following additional data will also be collected:

- A 60 second static measurement at the location ("biased count") for beta/alpha;
- A "biased" smear sample to be analyzed for alpha/beta, or sent for isotopic analysis as the need is determined.

<u>Data Recording:</u>

All scan readings need not be recorded. Any biased measurements resulting from an elevated scan reading shall be recorded, including location, count or count rate reading, and a description of the object of interest. Each survey unit scanned will be documented with an "average" and a "maximum" count rate as determined by the surveyor, for each area surface.

3.10.2 Fixed-Point Measurements

<u>Applicability</u>:

Fixed-point measurements (for both beta/alpha and low-energy beta/tritium) are defined as static counts performed with a portable instrument. They may be performed as part of the systematic or random gridded survey, or as biased measurements to investigate elevated scan readings.

<u>Instrumentation:</u>

Ludlum 43-68, or equivalent, will be used to perform and document fixed-point alpha/beta measurements.

<u>Technique:</u>

Fixed-point measurements should be at least 1-minute in duration with the instrument placed in scaler mode. If the instrument does not have scaler capability, a count rate indication is acceptable provided a 1-minute static reading is taken with the instrument's meter set to "slow response." The highest indicated count rate shall be recorded as the result of the fixed-point measurement.

The fixed-point (static) survey action level will be the DCGL plus the average background specific to the material type being evaluated.

Data Recording:

Fixed point measurements shall be recorded, including location (grid point or recognizable object), count rate (or exposure rate) reading, distance from the object of interest (if gamma reading), and a description of the object of interest as applicable.

3.10.3 Smear Sample Collection and Analysis

Applicability:

Selected building surfaces will have smear samples taken to assess the presence of removable contamination. Smears will be taken at every location that a fixed-point measurement is taken and at any other locations deemed necessary based on visual inspections and professional judgment.

Technique:

The amount of removable contamination per 100 cm^2 of surface area will be determined by wiping that area with a dry filter, applying moderate pressure, and analyzing the smears as appropriate. Smears will be counted on an on-site Ludlum 2929 alpha/beta dual-scaler and/or a liquid scintillation counter, depending upon the nature of the ROCs expected.

Data Recording:

Smear samples shall be recorded, including location (grid point or recognizable object), and a description of the object of interest as applicable. A chain of custody (COC) form must be completed if the smears are to be sent off-site for analysis.

3.10.4 Basement Radium Encapsulation

For the purpose of this field effort, the basement areas with known encapsulated Ra-226 contamination will be surveyed consistent with the directions of this FSS. More information on the extent and quantity of the fixed Ra-226 contamination is necessary to determine if the contamination needs to be removed or can remain in place. Sampling for analytical analysis and/or *in situ* gamma spectrocscopy measurements will be performed in conjunction with the surveys described in this FSS to quantify the encapsulated Ra-226 contamination. Removal, if required, and resurvey of this area would occur as a Phase II activity of the Decommissioning Plan.

4.0 SURVEY QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

4.1.1 General

Measurements performed and samples collected for the FSS will be performed in accordance with standard QC requirements. Duplicate analyses, sample chain of custody, instrument performance checks, control of field survey data and databases, and QC investigations provide a high level of confidence in the data collected to support the

survey outcome.

4.1.2 Instrument Calibration

All instruments used during the course of the survey must have been calibrated by a licensed instrument calibration firm to standards traceable to the National Institute of Standards and Technology (NIST).

4.1.3 Daily QC Checks

QC measurements must be performed daily, prior to survey data collection, for all on-site field and laboratory-based instruments. A consistent, controlled area should be used to perform these checks. Both background and check source responses shall be assessed. A check source of radioactivity shall be used that is appropriate for the type of radioactivity to be measured by the instrument. Initial instrument background and check source response shall be determined before the instrument is used for the FSS by performing 10 consecutive measurements for each test (background and source) and calculating the mean response and its standard deviation (σ). These 10 initial QC readings per test will be the basis for assessing the operability of the instruments for the duration of the FSS.

QC criteria for beta/gamma instruments to be used during daily QC checks follow:

- If any single QC check is found to be outside of 2σ (Investigation Level), the measurement is to be repeated.
- If the second count is also found to be outside of 2σ, the instrument is to be investigated to assess if any external biases or instrument physical damage is present.
- If any single reading is found to be outside of a 3σ boundary (Action Level), the instrument must be taken out of service and the situation resolved by the survey supervisor. (Highly fluctuating source or background responses may be due to a bad cable, insufficient gas purge, bad detector tube, or malfunctioning electronics.)

Background and source checks shall be documented by the survey supervisor or designate.

4.1.4 Analytical Support Services

In the event that samples are collected for analysis by a contract laboratory, the laboratory will be required to maintain an approved QA Program and current Materials License to possess radioactive material.

5.0 REFERENCES

(Brookhaven, 2005) *Radiological Surveys of EML Laboratories.* Brookhaven National Laboratories. September 30, 2005.

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(EML, 2006) *EML Facilities Historic Utilization Team Report.* Environmental Measurements Laboratory, August 2006

(NRC, 1998) NUREG-1505, Rev.1, *A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys*, U.S. Nuclear Regulatory Commission, June 1998.

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(NRC, 2003) NUREG-1757, *Consolidated NMSS Decommissioning Guidance*, Rev. 1, U.S. Nuclear Regulatory Commission, September 2003.

(NRC, 2003b) Title 10, Code of Federal Regulations, Part 20, Paragraph 1402, "*Radiological Criteria for Unrestricted Use*."

APPENDIX A

Survey Unit Sampling and Analysis Matrix

FSS Sample Collection Minimum Number and Type (see Notes page for descriptions and assumptions)					
Survey Unit No.	**Survey Unit Information & Comments**	**SU Class**	**Alpha Beta Scan**	**Alpha Beta Static Counts**	**Removable Contam. (Smears)**
5-541A	Fifth Floor Room 541A	3	a	17 d	17 e (+biased)
5-541B	Fifth Floor Room 541B	3	a	17 d	17 e (+biased)
5-541C	Fifth Floor Room 541C	3	a	17 d	17 e (+biased)
5-544	Fifth Floor Room 544	3	a	17 d	17 e (+biased)
5-552A	Fifth Floor Room 552A	3	a	17 d	17 e (+biased)
5-554R	Fifth Floor Room 554R	3	a	17 d	17 e (+biased)
5-514	Fifth Floor Room 514	3	a	17 d	17 e (+biased)
5-515	Fifth Floor Room 515	3	a	17 d	17 e (+biased)
5-518	Fifth Floor Room 518	3	a	17 d	17 e (+biased)
5-520A	Fifth Floor Room 520A	3	a	17 d	17 e (+biased)
5-520	Fifth Floor Room 520	3	a	17 d	17 e (+biased)
5-524	Fifth Floor Room 524	3	a	17 d	17 e (+biased)
5-525	Fifth Floor Room 525	3	a	17 d	17 e (+biased)
B-B15	Basement Room B15	3	a	17 d	17 e (+biased)
B-B15A	Basement Room B15A	3	a	17 d	17 e (+biased)
5-RL	Hallway surrounding the Radiochemistry Labs	2	b	17 d	17 e (+biased)

FSS Sample Collection Minimum Number and Type (see Notes page for descriptions and assumptions)					
Survey Unit No.	**Survey Unit Information & Comments**	**SU Class**	**Alpha Beta Scan**	**Alpha Beta Static Counts**	**Removable Contam. (Smears)**
5-SMG	Fifth Floor Rooms 554X (Staging), 554T (Machine Shop), and 551L (Gamma Spec Lab)	2	b	17 d	17 e (+biased)
B-R2	Basement Floor – All EML areas not Class 1	2	b	17 d	17 e (+biased)
1-L1	First Floor Lab #1	2	b	17 d	17 e (+biased)
1-L2	First Floor Lab #2	2	b	17 d	17 e (+biased)
1-Dust	First Floor – Area around Dust Collector	2	b	17 d	17 e (+biased)
5-R3	Fifth Floor – Remaining portion of eastern half of floor not designated Class 1 or 2 excluding utility closets, pipe chases, stairs	3	c	17 d	17 e (+biased)
1-R3	First Floor – Remaining portion of EML area not designated Class 1 or 2 excluding utility areas, pipe chases, stairs	3	c	17 d	17 e (+biased)

<u>TABLE NOTES</u>

a Perform 100% alpha/beta scan survey on floor, bench-tops, and lower wall surfaces (up to 6'), 10% scan on upper wall surfaces (> 6'), and 10% scan on accessible ceiling areas. Class 1 SUs.

b Perform 25% scan survey on floor, bench-tops, and lower wall surfaces (up to 6'). Upper walls (> 6') will be scanned only as accessible from the floor elevation. Class 2 SUs.

c Perform 10% scan survey on floor, bench-tops, and lower wall surfaces. Class 3 SUs.

d Fixed, static-count alpha/beta measurements will be performed at systematic or random locations (depending upon SU classification) in the quantities listed in the table with an alpha/beta sensitive instrument.

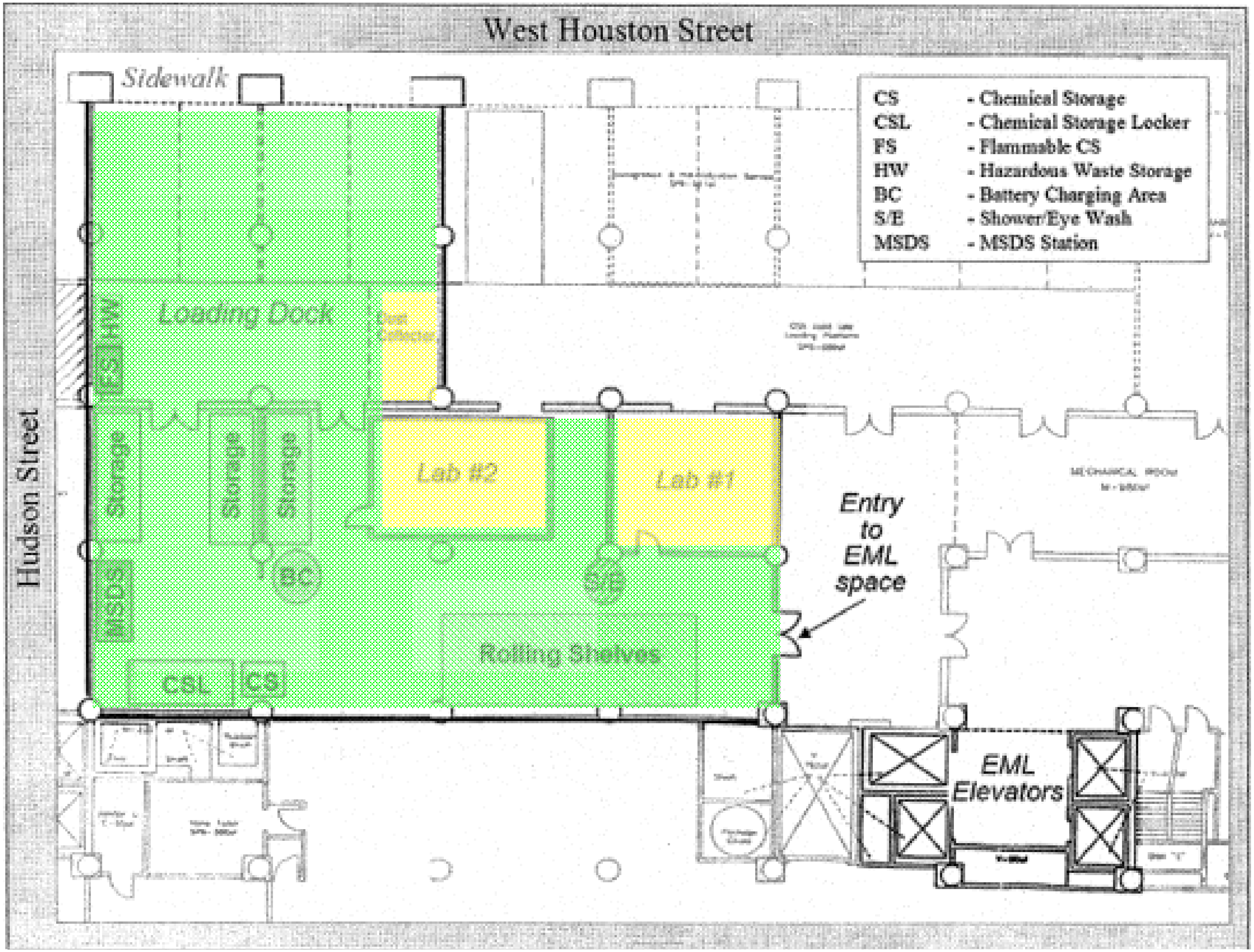
e Smears for removable contamination will be performed at systematic or random locations (depending upon SU classification) in the quantities listed in the table. Additional biased smears will be performed at points of likely or suspect contamination, and at areas of elevated scan measurements.

APPENDIX B

Maps of Survey Units with MARSSIM Classifications

Impacted areas addressed in this FSS are shaded in the maps.

Class 1: Red Shaded
Class 2: Yellow Shaded
Class 3: Green Shaded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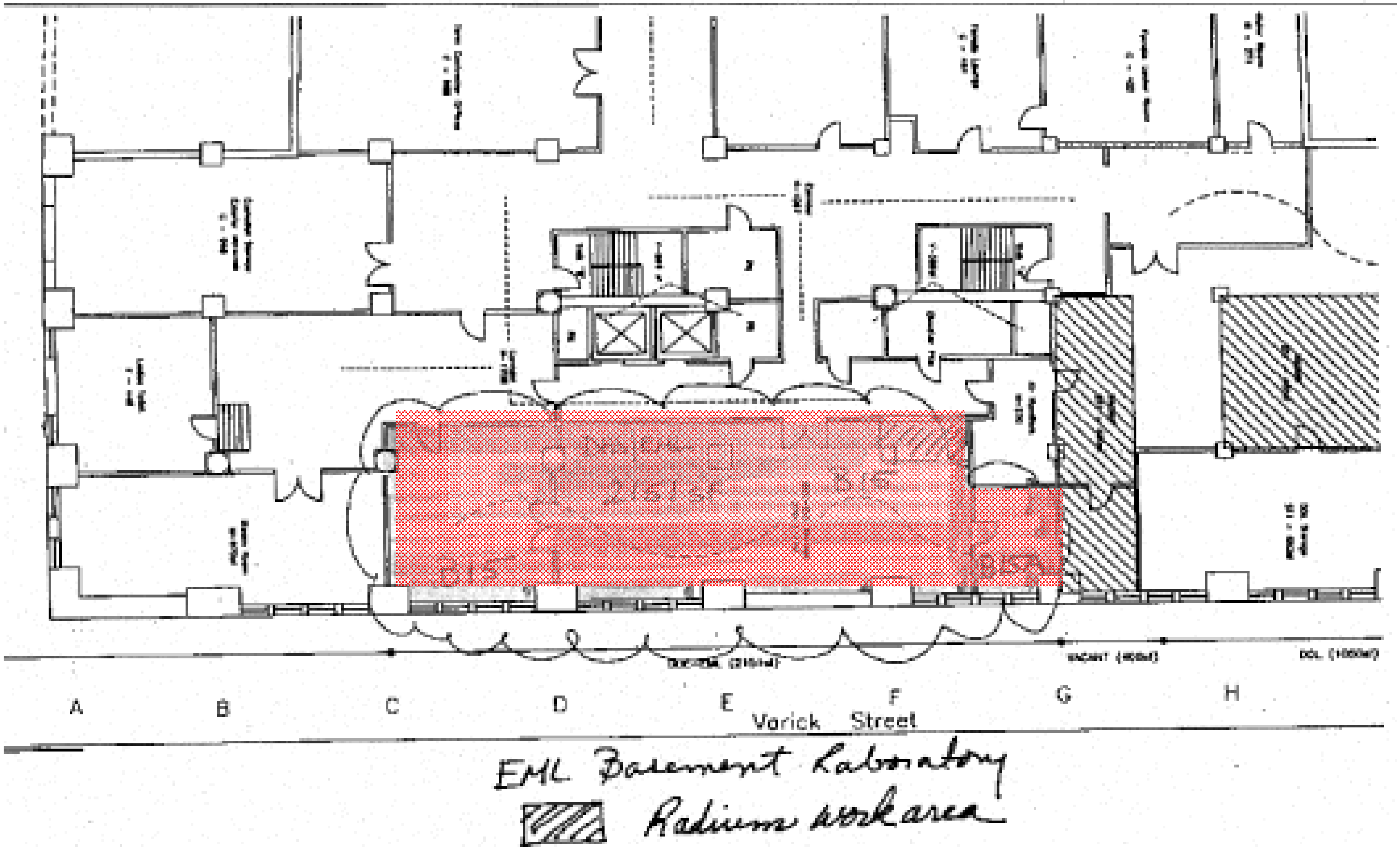
Sidewalk
Hudson Street
CS - Chemical Storage
CSL - Chemical Storage Locker
FS - Flammable CS
HW - Hazardous Waste Storage
BC - Battery Charging Area
S/E - Shower/Eye Wash
MSDS - MSDS Station
Loading Dock
Dust Collector
HW
FS
Storage
Storage
Storage
Lab #2
Lab #1
BC
S/E
MSDS
CSL
CS
Rolling Shelves
Entry to EML space
EML Elevators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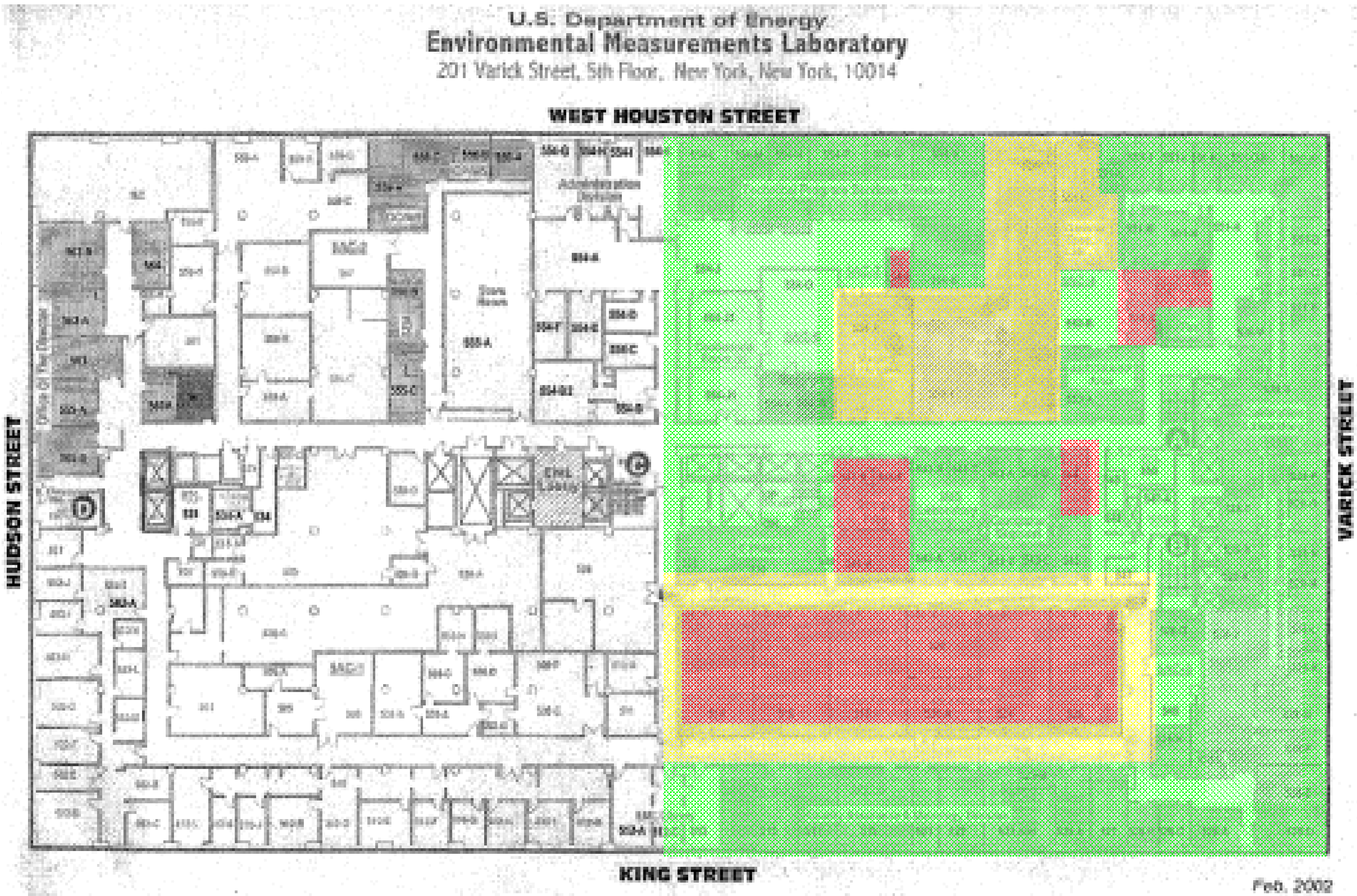
B
C
D
E
F
G
H
Varick Street
EML Basement Laboratory
Radium work area
B15
B15A


U.S. Department of Energy
Environmental Measurements Laboratory
201 Varick Street, 5th Floor, New York, New York, 10014
WEST HOUSTON STREET
HUDSON STREET
VARICK STREET
KING STREET
Feb. 2002

APPENDIX C

Calculation of Minimum Detectable Concentrations

Determine Scan MDC

The methodology used in NUREG-1507 was used in determining minimum detectable scan sensitivity and the results are presented below for an example instrument utilized.

Scanning is often performed during radiological surveys in support of decommissioning to identify the presence of any locations of elevated direct radiation (hot spots). The probability of detecting residual contamination in the field is not only affected by the sensitivity of the survey instrumentation when used in the scanning mode of operation, but also by the surveyor's ability. The surveyor must decide whether the signals represent only the background activity, or whether they represent residual contamination in excess of background.

The minimum detectable concentration of a scan survey (scan MDC) depends on the intrinsic characteristics of the detector (efficiency, window area, etc.), the nature (type and energy of emissions) and relative distribution of the potential contamination (point versus distributed source and depth of contamination), the scan rate and other characteristics of the surveyor. Some factors that may affect the surveyor's performance include the costs associated with various outcomes—e.g., cost of missed contamination versus cost of incorrectly identifying areas as being contaminated —and the surveyor's a priori expectation of the likelihood of contamination present. For example, if the surveyor believes that the potential for contamination is very low, as in an unaffected area, a relatively large signal may be required for the surveyor to conclude that contamination is present.

A discussion of the calculation of scanning minimum detectable concentration (MDC) and the scanning minimum detectable count rate (MDCR) is provided in the MARSSIM (NRC 2001). More detail on signal detection theory and instrument response is provided in NUREG-1507, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, December 1997, from which the following discussion is drawn.

Minimum Detectable Beta Count Rate and Surveyor Efficiency

The framework for determining the scan sensitivity is based on the premise that there are two stages of scanning. That is, surveyors do not make decisions on the basis of a single indication, rather, upon noting an increased number of counts, they pause briefly and then decide whether to move on or take further measurements. Thus, scanning consists of two components: continuous monitoring and stationary sampling. In the first component, characterized by continuous movement of the probe, the surveyor has only a brief "look" at potential sources, determined by the scan speed. The surveyor's willingness to decide that a signal is present at this stage is likely to be liberal, in that the surveyor should respond positively on scant evidence, since the only "cost" of a false positive is a little time. The second component occurs only after a positive response was made at the first stage. This response is marked by the surveyor interrupting his scanning and holding the probe stationary for a period of time, while comparing the instrument output signal

during that time to the background counting rate. Owing to the longer observation interval, sensitivity is relatively high. For this decision, the criterion should be more strict, since the cost of a “yes” decision is to spend considerably more time taking a static measurement or a sample.

Since scanning can be divided into two stages, it is necessary to consider the survey’s scan sensitivity for each of the stages. Typically, the minimum detectable count rate (MDCR) associated with the first scanning stage will be greater due to the brief observation intervals of continuous monitoring—provided that the length of the pause during the second stage is significantly longer. Typically, observation intervals during the first stage are on the order of 1 or 2 seconds, while the second stage pause may be several seconds long. The greater value of MDCR from each of the scan stages is used to determine the scan sensitivity for the surveyor.

The minimum detectable number of net source counts in the interval is denoted by s_i. Therefore, for an ideal observer, the number of source counts required for a specified level of performance can be arrived at by multiplying the square root of the number of background counts by the detectability value associated with the desired performance (as reflected in d’) as shown in [Equation 6-8, MARSSIM]:

$$s_i = d' (b_i)^{1/2}$$

where the value of d’ is selected from MARSSIM Table 6.5 based on the required true positive and false positive rates and b_i is the number of background counts in the interval.

The minimum detectable source count rate (MDCR), in cpm, detectable during the observation interval i, in seconds, by an “ideal” surveyor may be calculated by [Equation 6-9, MARSSIM]:

$$MDCR = s_i \times (60 / i)$$

For the case of real surveyors who are not equivalent to the “ideal” construct, MARSSIM recommends assuming an efficiency value at the lower end of the observed range of 0.75 – 0.50 (i.e., p = 0.5) when making MDCR estimates. Thus, the required number of net source counts for the surveyor, $MDCR_{surveyor}$, is determined by dividing the MDCR by the square root of p.

Consider the calculation of the MDCR for the case of a 126 cm^2 gas flow proportional detector set up to detect beta radiation. The observed background level is 150 cpm. The desired level of performance, 95% correct detections and 60% false positive rate, results in a d’ of 1.38 [Table 6-5, MARSSIM]. Assume a scan rate of one probe width per second, which results in an observation interval of 1 second, assuming a contaminated area of 100 cm^2. The $MDCR_{surveyor}$ may be calculated assuming a surveyor efficiency (p) of 0.5 as follows:

1) b_i = (150 cpm) × (1 sec) × (1 min/60 sec) = 2.5 counts

2) MDCR = (1.38) × (2.5) $^{1/2}$ / (1 sec) × (60 sec/1 min) = 131 cpm

3) $MDCR_{surveyor}$ = 131 / (0.5) $^{1/2}$ = 185 cpm net above background

The minimum number of source counts required to support a given level of performance for the final detection decision (second scan stage) can be estimated using the same method. As explained earlier, the performance goal at this stage will be more demanding. The required rate of true positives remains high (e.g., 95%), but fewer false positives (e.g., 20%) can be tolerated, such that d' (from Table 6.5) is now 2.48. For this second stage of the scan survey, the surveyor typically stops the probe over a suspect location for about 5 seconds before making a decision,

1) b_i = (150 cpm) × (5 sec) × (1 min/60 sec) = 12.5 counts

2) MDCR = (2.48) × (12.5) $^{1/2}$ / (5 sec) × (60 sec/1 min) = 105 cpm

MDCRsurveyor = 105 / (0.5) $^{1/2}$ = 149 cpm net above background

The greater of the calculated $MDCR_{surveyor}$ values is 185 cpm above background or approximately 335 cpm gross. This would be the value chosen for the $MDCR_{surveyor}$.

Calculations of Minimum Detectable Activities, Minimum Detectable Count Rates, and Scan Minimum Detectable Concentrations for projected Beta FSS Instrumentation can be found in the Table C-1 below:

Table C-1: Beta Surface Scan Detection Limits

Scan MDC calculations for Ludlum Detectors (Beta measurements)		
	Beta model 43-68	**Beta model 43-37**
R_B = Background Counting Rate[a], per min	150	750
T_{S+B} = Sample Counting Time (gross) (min)	1	1
T_B = Background Counting Time (min)	1	1
i=(the observation interval in sec)	1	1
ε =Efficiency of the instrument	0.2	0.2
P=Surveyor efficiency	0.5	0.5
Probe Area(cm^2)	126	582
$\mathbf{L_c}$ (critical level counts)	28.54	63.81
$\mathbf{L_d}$ (lower limit of detection)	59.95	130.35

MDA(minimum detectable Activity(dpm)	299.92	652.11
MDA(dpm/100 cm^2)	238	112
d' (Index of Sensitivity from table(6.5 MARSSIM)	1.38	1.38
b_i=Number of Back ground Counts in the interval	2.50	12.50
$S_i = d' \times \sqrt{b_i}$	2.2	4.9
MDCR(Minimum Detectable count Rate)=$S_i \times (60 \div) i$	131	293
Scan MDC[b]	**735**	**356**
DCGLs (dpm/100cm^2)	**1000**	**1000**
Note: a -assumed background counting rate . Calculations based on Strom & Stansbury (eqn 3-11 of NUREG 1507) b-Reference MARSSIM 6.7.2 Table 6.5 Equation-6.10		

General Information on Alpha Scan MDC

Scan MDCs for alpha emitters must be derived differently than scanning for beta and gamma emitters. *MARSSIM* contains formulas and probability concepts for alpha scans in Appendix J, which provides a complete derivation of the formulas used to determine the probability of observing a count when performing an alpha scan. Additional information on various material background, detector efficiencies, surface material effects, etc. may be found in NUREG-1507.

In general, when performing an alpha scan, once a count has been recorded and the surveyor stops, the surveyor should wait a sufficient period of time such that if the guideline level (or action level) of contamination is present, the probability of getting another count is at least 90%. For low background areas (alpha background of 0 to 3 cpm), it is assumed that a single count is sufficient to cause a surveyor to stop and investigate. For higher background areas or when using larger area detectors resulting in a higher background count rates such as the Ludlum Model 43-37 floor monitor (alpha background up to 10 cpm), the surveyor will usually need to get at least 2 counts while passing over the source area before stopping for further investigation.

For the purpose of determining alpha scan MDCs, the source activity, G in the following equations, is assumed to be slightly less than 20% of the alpha surface activity DCGL in Table 3-1, i.e., 100 dpm/100 cm^2.

The assumptions pertaining to scan speeds, background, efficiency, dwell times, etc. used in the evaluation of alpha scan MDCs (probability of detection) are provided in Table C-2. The probabilities of detection calculated using the equations below are also presented in Table C-2. These calculations indicate that the under the conditions presented in the assumptions, the design objective of 90% probability is achieved when scanning surfaces contaminated to 100 dpm/100 cm^2 when using the indicated detectors.

Table C-2: Alpha Surface Scan Assumptions

Model No.	Probe Area (cm^2)	Probe Width (cm)	α Efficiency (cpm /dpm)	α Bkgrd (cpm)	Scan Speed (cm/sec)	Pause Time (sec)	P(n>=1)	P(n>=2)
43-37	582	15	0.15*	10	6	2.5	NA	0.91
43-68	126	9	0.15*	3	1	7.3	0.90	NA

cm = centimeters cm^2 = square centimeters

cpm = counts per minute dpm = disintegrations per minute

sec = second cm/sec = centimeters per second

* Manufacturer's stated 4π alpha efficiencies for these detectors have a range of 15 to 20%. For this evaluation, 15% is chosen as a conservative approach.

Ludlum Model 43-37 Scan MDC

The Ludlum Model 43-37 gas proportional detector is a large area detector (active area of 582 cm^2) with a higher background count rate compared to smaller area detectors, such as the Ludlum Model 43-68. Using *MARSSIM* Equation J-7, the probability of two or more alpha counts during the scan survey of a surface is determined as follows:

$$P(n \geq 2) = 1 - P(n = 0) - P(n = 1)$$ (*MARSSIM* Equation J-7)

$$= 1 - \left(e^{-A}\right) \times (1 + A)$$

$$\text{for } A = \frac{(GE + B)t}{60}$$

Where:

$P(n \geq 2)$ = Probability of getting 2 or more counts during the time interval t

$P(n = 0)$ = Probability of not getting any counts during the time interval t

$P(n = 1)$ = Probability of getting 1 count during the time interval t

G = Source activity (100 dpm/100 cm^2)

E = Detector efficiency (4π)

B = Background count rate (cpm)

t = Dwell time over source (seconds)

Scans will be performed by moving the active area of the detector over the surface of interest at or below the given scan speed in Table C-2. If two or more counts occur over the indicated observation interval, a one-minute integrated or static measurement will be performed at that location prior to resuming the scan survey.

Ludlum Model 43-68 Scan MDC

If the Ludlum Model 43-68 gas proportional detector is used, then *MARSSIM* Equation J-5 and the assumptions listed in Table C-2, with a probability of at least one count occurring while surveying an area of contamination equal to the 100 dpm/100 cm^2 surface scan action level $P(n \geq 1)$, will be implemented instead of *MARSSIM* Equation J-7.

Using *MARSSIM* Equation J-5 and the assumptions listed in Table C-2 (scan speeds, background, efficiency, dwell times, etc), the probability that a single count is sufficient to cause a surveyor to stop and investigate further is derived as follows:

$$P(n \geq 1) = 1 - P(n = 0) = 1 - e^{-A} \qquad \text{(MARSSIM J-5)}$$

$$\text{for } A = \frac{GEd}{60v}$$

Where:

$P(n \geq 1)$ = Probability of getting 1 or more counts during the time interval t

$P(n = 0)$ = Probability of not getting any counts during the time

interval t

G = Source activity (100 dpm/100 cm^2)

E = Detector efficiency (4π)

d = Width of the detector in the direction of scan (cm)

v = Scan speed (cm/s)

Alpha scans will be performed using the Ludlum Model 43-68 detector by moving the active area of the detector over the surface of interest at the scan speed shown in Table C-2. Whenever a count is detected during the scan, the detector will be held in place over the location where the count was detected for the indicated pause time (approximately 7-8 seconds). If a second count is detected over this location during the pause time, a one minute integrated count will be performed.

Integrated Direct Surface Measurements and Smear Analysis

Integrated direct measurements (i.e., static measurements) of surface alpha and beta contamination will be performed to compare contaminant concentrations at discrete sampling locations to the appropriate action level. Smear samples will be collected at biased building surface locations, as appropriate, to quantify transferable surface alpha and beta contamination.

Integrated alpha and beta activity measurements will be performed using a Ludlum Model 43-68 gas proportional detector, or equivalent. Smears will be analyzed using a Ludlum Model 43-10-1 smear count detector attached to a Ludlum Model 2929 ratemeter, or equivalent. The static measurement and smear analysis MDC and assumptions used for each of the detectors are presented in Table C-3. The MDCs were determined using Equation 3-11 of *NUREG 1507*.

Table C-3. Static/Smear MDA Calculations

MDC calculations for Ludlum Detectors (Alpha/Beta static measurements and smears)				
	Alpha model 43-68 Static	**Alpha model 2929 Smear**	**Beta model 43-68 Static**	**Beta model 2929 Smear**
R_B = Background Counting Rate[a], per min	3	0.1	150	60
T_{S+B} = Sample Counting Time (gross) (min)	1	1	1	1
T_B = Background Counting Time (min)	1	1	1	1
ε =Efficiency of the instrument	0.2	0.37	0.2	0.26

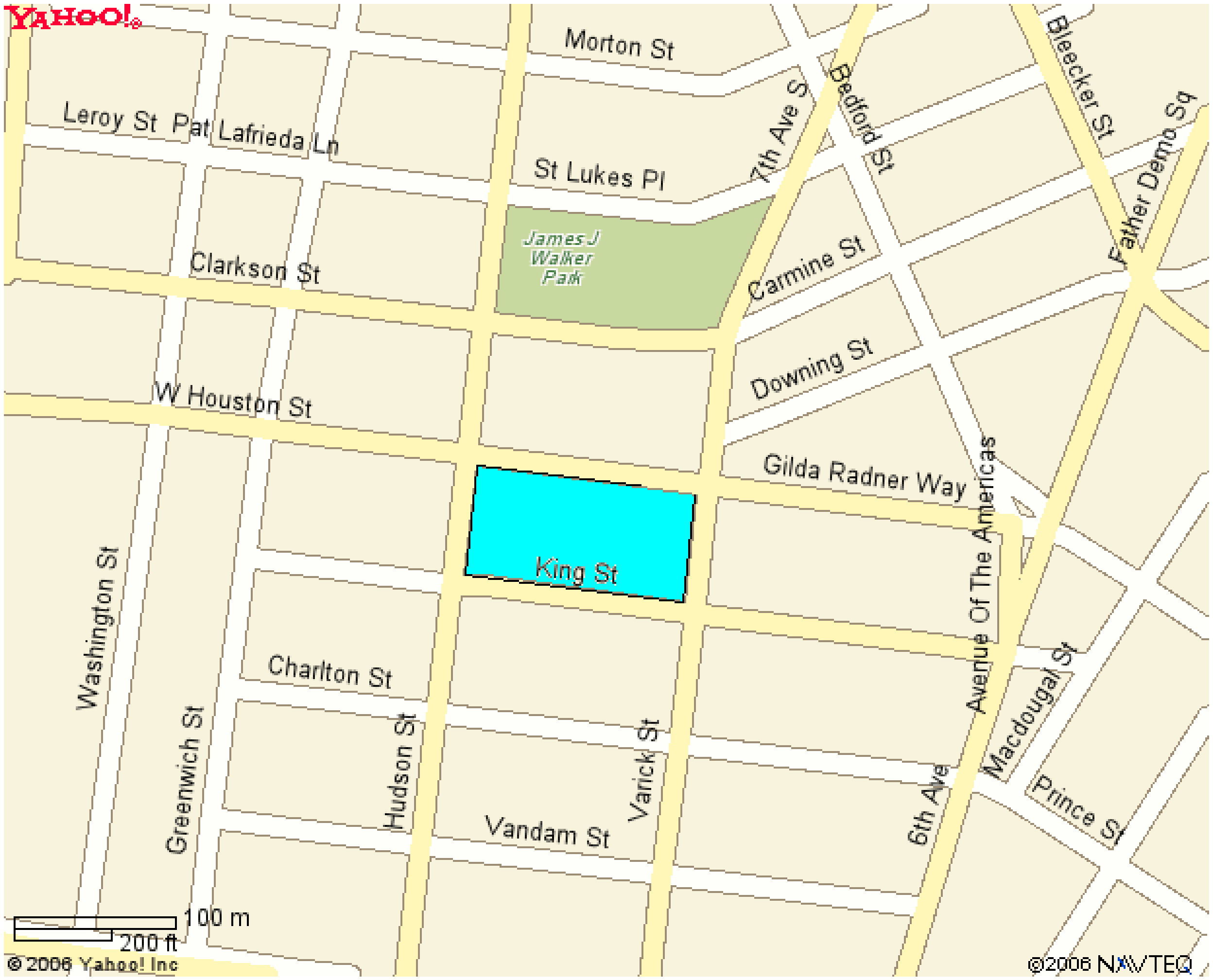
Probe Area(cm^2)	126	N/A	126	N/A
L_c (critical level counts)	4.04	0.74	28.54	18.05
L_d (lower limit of detection)	11.05	4.47	59.95	39.02
MDA(minimum detectable Activity(dpm)	55.29	12.08	299.92	150.15
MDA(dpm/100 cm^2)	**44**	**12**	**238**	**150**
DCGLs (dpm/100cm^2)	**500**	**20**	**1000**	**200**

Note:

a -assumed background counting rate

APPENDIX D

Site Maps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Avenue Of The Americas
Washington St
Greenwich St
Charlton St
Hudson St
Varick St
Macdougal St
6th Ave
Prince St
Vandam St
100 m
200 ft
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201 Varick Street

APPENDIX B

SITE SPECIFIC HEALTH AND SAFETY PLAN

__FINAL__

SITE SAFETY AND HEALTH PLAN

Environmental Measurements Laboratory
Department of Homeland Security
201 Varick Street
New York, New York

DHS 2006-001

Prepared For:

U.S. Army Sustainment Command
1 Rock Island Arsenal
Building 350, 5th Floor
Rock Island, IL 61299-6000

Prepared by:

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

CABRERA SERVICES, INC.
473 Silver Lane
East Hartford, CT 06118

October 2007

SITE SAFETY AND HEALTH PLAN
Final Status Survey
Environmental Measurements Laboratory
Department of Homeland Security
201 Varick Street
New York, New York

SITE SAFETY AND HEALTH PLAN APPROVALS

By their specific signature, the undersigned certify that this Site Safety and Health Plan is approved for use during the Final Status Survey activities at the Environmental Measurements Laboratory – Department of Homeland Security, New York.

______________________________ ______________
USASC Project Manager Date

______________________________ ______________
DHS EML Radiation Safety Officer Date

______________________________ ______________
DHS EML Safety Officer Date

SITE SAFETY AND HEALTH PLAN
Final Status Survey
Environmental Measurements Laboratory
Department of Homeland Security,
201 Varick Street
New York, New York

SITE SAFETY AND HEALTH PLAN APPROVALS

By their specific signature, the undersigned certify that this Site Safety and Health Plan is approved for use by Cabrera Services, Inc. (Cabrera) during the Final Status Survey activities at the Environmental Measurements Laboratory – Department of Homeland Security, New York, NY.

__________________________________ ______________
Cabrera Services – Vice President Date

__________________________________ ______________
Cabrera Services - Project Manager Date

__________________________________ ______________
CABRERA Services – Safety and Health Manager Date
Paul Schwartz, CIH, CSP

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LIST OF ACRONYMS AND ABBREVIATIONS

µR/hr	microRoentgen per hour
^{o}C	Degrees Centigrade
^{o}F	Degrees Fahrenheit
ACGIH	American Conference of Governmental Hygienists
BBP	Bloodborne Pathogen
BNL	Brookhaven National Laboratory
C-14	Carbon-14
CFR	Code of Federal Regulations
CHP	Certified Health Physicist
CIH	Certified Industrial Hygienist
cm^2	square centimeter
CPM	Counts per minute
CPR	Cardio-Pulmonary Resuscitation
CRZ	Contamination Reduction Zone
Cs-137	Cesium-137
CSP	Certified Safety Professional
CZ	Contamination Zone
DAC	Derived Air Concentration
dBA	Decibels A-weighed scale
DCGL	Derived Concentration Guideline Level
DHS	Department of Homeland Security
DOE	Department of Energy
DOT	U.S. Department of Transportation
$dpm/100cm^2$	disintegrations per minute per 100 centimeters squared
ECP	Exposure Control Plan
EML	Environmental Measurements Laboratory
FSS	Final Status Survey
GFCI	Ground Fault Circuit Interrupter
H-3	Hydrogen-3 (Tritium)
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEPA	High Efficiency Particulate Air
HSA	Historical Site Assessment
HVAC	Heating ,Ventilating, and Air Conditioning
IDW	Investigative Derived Waste

LSC	Liquid Scintillation Counting
m	meter
m^2	square meters
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MeV	mega electron volts
Mrem/yr	millirem per year
MSDS	Material Safety Data Sheet
Ni-63	Nickel 63
NRC	U.S. Nuclear Regulatory Commission
NYCDOH	New York City Department of Health
NVLAP	National Voluntary Laboratory Accreditation Program
PAPR	Powered Air Purifying Respirator
PCB	Polychlorinated Biphenyl
PE	Professional Engineer
PM	Project Manager
PPE	Personal Protective Equipment
Pu-238	Plutonium 238
Pu-239	Plutonium 239
OSHA	U.S. Occupational Safety and Health Administration
Ra-226	Radium 226
RAM	radioactive materials
RCRA	Resource Conservation Recovery Act
RCZ	Radiation Control Zone
ROC	Radionuclides of Concern
RSO	Radiation Safety Officer
RSP	Radiation Safety Program
RWP	Radiation Work Permit
SHM	Safety and Health Manager
SOP	Standard Operating Procedure
Sr-90	Strontium 90
SRSO	Site Radiation Safety Officer
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SZ	Support Zone
Tc-99	Technetium 99
TCLP	Toxicity Characteristic Leaching Procedure
TLD	Thermo luminescent Dosimeter
TM	Technical Manager

U-235	Uranium 235
VP	Vice President
WAC	Waste Acceptance Criteria
WBGT	Wet-Bulb Globe Temperature

1.0 INTRODUCTION

1.1 Purpose and Objectives

The purpose of this *Site Safety and Health Plan* (*SSHP*) is to establish general safety and radiation protection procedures for Cabrera Services, Inc. (CABRERA) personnel, contractors, and government personnel involved in site work at the Department of Homeland Security (DHS) Environmental Measurements Laboratory (EML, hereafter referred to as the "Site"). Work at the Site involves potential exposure to radiological, chemical, and physical hazards. . CABRERA is contracted through the U.S. Army Sustainment Command, located in Rock Island, IL.

This SSHP establishes the work practices necessary to help ensure the safety and health of personnel assigned to the Site, the local community, and the environment during Site activities. The objective of this SSHP is to anticipate, identify, evaluate, and control hazards that may be encountered during work at the Site. This document is a working document and is subject to change based on review and the implementation of additional tasks. Site activities will be performed in accordance with this SSHP, CABRERA's Radiation Safety Program (RSP) (CABRERA 2000a), U. S. Nuclear Regulatory Commission (NRC), Occupational Safety and Health Administration (OSHA), other applicable local and federal statutes and other applicable health and safety regulations. CABRERA Standard Operating Procedures (SOPs) that are referenced within this SSHP are radiological procedures from CABRERA's Radiation Safety Program (RSP). A copy of CABRERA's NRC radioactive materials license is provided as Appendix B. Health and Safety requirements applicable to this project are addressed in CABRERA's Health and Safety Manual. The levels of personal protection and procedures specified in this plan are based on the best information available from reference documents and current Site data. The recommendations represent the minimum health and safety requirements to be observed by personnel engaged in this project. Unforeseeable site conditions may warrant a reassessment of the recommended protection levels and controls. Revision to the SSHP must have prior approval by the CABRERA Corporate Safety and Health Manager (SHM) and Corporate Radiation Safety Officer (RSO).

1.2 Background Information

The EML facility was formerly operated by the Department of Energy (DOE) as an environmental radiochemistry laboratory, and now falls under the Department of Homeland Security. Currently, no handling of unsealed radioactive sources occurs within the facility. Upon completion of unrestricted release of the facility, EML intends to retain possession of sealed radioactive sources under NRC licensure.

EML is located in a GSA Building located in lower Manhattan, NY at 201 Varick Street. EML occupies the entire fifth floor of the facility, and small areas in the first floor and basement.

1.3 Summary of Recent Investigations

1.3.1 Brookhaven National Laboratory 2004 and 2005 Surveys

Several areas of radiological contamination are known to exist on the fifth floor of the site from historical surveys. In Lab 516, 15,000 dpm/100 cm^2 fixed beta-gamma contamination is

known to exist inside a cabinet. In Lab 518, 1560 dpm/100 cm^2 of fixed alpha contamination is known on bench tops. In Lab 526, 70,000 dpm/100 cm^2 of fixed beta-gamma and 6,000 dpm/100 cm^2 fixed alpha contamination, as well as 52 dpm/100^2 of removable alpha contamination, is known to exist in drawers, cabinets, and on floors, and bench tops (Brookhaven, 2005).

In the EML area of the building basement, Radium contamination is known to exist on the floor and walls. The removable contamination in this area was encapsulated by the Environmental & Waste Management Services Division of Brookhaven National Laboratory in June of 2004 (Brookhaven, 2004).

1.3.2 BNL Hazardous Material Survey

In addition to the Radiological surveys noted in section 1.3.1, BNL also surveyed sink traps for mercury and building surfaces for lead dust. Details regarding the non-radiological contaminants can be found in Section 3.3.2.

1.4 Summary of Tasks to be Performed

CABRERA's overall approach for this effort is to review previous findings and conduct site activities to characterize previously surveyed areas so that the EML can be prepared for the Final Status Survey that will lead to the release of the Building. The following is a brief summary of the activities to be conducted during these. Additional details of Site activities are provided in Section 3.1.

Task	Initial Level of Protection
• Mobilization and demobilization;	Level D
• Characterization survey;	Level D
• Remediation activities;	Modified Level D or Level C
• Decontamination of equipment;	Modified Level D or Level C
• Final Status Survey, and;	Level D or Modified Level D
• Management of investigation derived waste (IDW).	Modified Level D or Level C

All necessary precautions will be taken during performance of these activities to prevent cross contamination and dispersion of activity as well as to maintain health and safety of project personnel, laboratory personnel, and protection of the local community, and environment.

Following review and approval of the Final Status Survey Plan, a team of three radiation technicians, a site supervisor, and the Project Health Physicist will mobilize to the site to implement a characterization survey and limited decontamination of known impacted areas, as well as surveys of laboratory rooms believed to be releasable. The survey will be designed such that data collected will support release for unrestricted use for those areas with limited or no contamination. The survey will include direct measurements and sampling on elements of the floor drain system where applicable. For areas previously identified with removable contamination or for limited areas of fixed contamination, a limited decontamination effort (e.g., wipe down to remove removable contamination, limited scabbling of hard surfaces) will be undertaken to support decommissioning. These areas will be evaluated as Class I survey areas.

- Scabbling will be limited to a total area of 200 square feet and to a maximum of ½ inch deep.

1.5 General

All operations and personnel having the potential for exposure to Site hazards are subject to the requirements of this *SSHP*. Work shall not be performed in a manner that conflicts with the intent of, or the inherent safety, health or environmental precautions expressed in this plan. Personnel violating health and safety procedures will be give verbal and/or written warnings. Continued violations will result in further disciplinary action by the individual’s supervisor including dismissal from the site.

2.0 ORGANIZATION OF HEALTH AND SAFETY PERSONNEL

2.1 Vice President

The Vice President (VP), Mr. Len Johnson, is responsible for establishing and executing program administrative matters, program controls, program-related policy matters, and program levels of authority, responsibility, and communication. The VP is responsible for ensuring necessary project health and safety personnel have been assigned to the project team and that necessary health and safety documents, review and notification will be performed before the commencement of Site related activities.

2.2 Project Manager

The Project Manager (PM), Mr. Greg Hisel, CHP, is responsible for evaluating the appropriateness and adequacy of the technical services provided for the project, and for developing the technical approaches and level of effort required to address each task. He is also responsible for the day-to-day conduct of work, including integration of input from supporting disciplines, EML, and subcontractors. He will work closely with the Project Technical Manager (TM) during implementation of the field program. Specific responsibilities of this role include:

- Initiating project activities.
- Directing project planning activities.
- Ensuring that qualified technical personnel are assigned to various tasks, including subcontractors.
- Identifying and fulfilling equipment and other resource requirements.
- Monitoring project activities to ensure compliance with established scopes, schedules, and budgets.
- Ensuring overall technical quality and consistency of project activities and deliverables.

2.3 Corporate Safety and Health Manager

The SHM, Mr. Paul Schwartz, CIH, CSP, is responsible for the review and acceptance of all projects SSHPs. No project involving hazardous, toxic, or radioactive materials shall commence without his signed acceptance of the SSHP. Additionally, the SHM shall:

- Ensure that the SSHP complies with all Federal, State, and local health and safety requirements, modifying specific aspects of the SSHP as necessary to address field changes that may impact safety.
- Evaluate and authorize any changes to the SSHP.
- Implement and oversee CABRERA's corporate health and safety program.
- Ensure that the Site Safety and Health Officer (SSHO) is appropriately qualified and trained to implement the SSHP. Maintain communication with the SSHO to ensure proper implementation of the SSHP, and provide direction on any significant safety issues that arise in the field.
- Assist in the training of field personnel with respect to the identification and mitigation of site-specific hazards and the use of air monitoring instruments, personal

protective equipment (PPE), decontamination procedures, and emergency/spill response.

- Conduct periodic site health and safety inspections.

2.4 Corporate Radiation Safety Officer

The RSO, Mr. Hank Siegrist, CHP, PE, is responsible for the acceptance of the portion of this SSHP that addresses radioactive material and/or radiological contamination. Specifically, the RSO shall:

- Ensure that the SSHP complies with all Federal, State, and local requirements related to the handling and transportation of radioactive and/or radiologically contaminated materials.
- Implement and oversee CABRERA's RSP (CABRERA 2000a), which includes all issues involving licensed radioactive material.
- Ensure that the Site Radiation Safety Officer (SRSO) is appropriately qualified and trained to implement the portions of the SSHP related to radiation safety, and that communication is maintained with the SRSM to ensure proper implementation of the SSHP and provide direction on any significant radiation safety issues that arise in the field.
- Assist in the training of field personnel with respect to the identification and mitigation of site-specific radiation hazards and the use of radiation monitoring instruments, personal dosimetry, and contamination surveys.
- Conduct periodic site radiation safety inspections.

2.5 Project Technical Manager

The TM, Mr. Gregory Hisel, CHP, acts as the primary technical lead on the project. The TM is the project technical liaison to the VP and PM and serves as the SRSO for all field activities. The TM provides direct supervision of field staff ensuring that all personnel adhere to the requirements of this *SSHP* and oversees all data collection, manipulation, and reporting. The Site Safety and Health Officer (SSHO) will assume the duties of the TM in his absence. The TM shall have the following additional responsibilities:

- Assists the SHM in designing adequate implementation of the SSHP.
- Serve as onsite RSO.
- Coordinate with the PM and SHM in developing the SSHP for site-specific projects.
- Provide consultation to the PM on matters pertaining to radiation.
- Ensuring compliance with all applicable regulations concerning the handling and transportation of radioactive material.
- Provide radiation training to all onsite personnel who may be exposed to ionizing radiation.

2.6 Site Safety and Health Officer

The SSHO acts as the liaison between the TM and SHM. The SSHO will assume the duties of the TM in his absence and shall have the following additional responsibilities:

- Coordinate with the SHM and the TM for field implementation of the SSHP.

- Conduct the daily safety toolbox meeting.
- Providing consultation to the TM.
- Maintain communication with the SHM.
- Assisting TM in training of site personnel in the site-specific hazards, specifically in the areas of interpretation of air monitoring instruments/results, identification and remediation of hazards, personal protective equipment (PPE) levels, decontamination, and emergency/spill response.
- Conduct project health and safety inspections, as required.

2.7 Other Project Personnel

Each site person is ultimately responsible for his or her own health and safety while working on this project, taking all reasonable precautions to prevent injury to themselves and to their fellow employees and being alert to potentially harmful situations are primary responsibilities. Site personnel shall be responsible for:

- Performing only tasks that they can do safely and in which they have been trained.
- Notify the SSHO of special medical conditions (i.e., allergies, contact lenses, etc.).
- Notify the SSHO of prescription and/or non-prescription medication the worker may be taking that might cause drowsiness, anxiety or other unfavorable affects.
- Preventing spillage and splashing of materials to the greatest extent possible.
- Practicing good housekeeping by keeping the work area neat, clean, and orderly.
- Immediately reporting all injuries to the SSHO.
- Complying with the SSHP and all health and safety recommendations and precautions, properly using the PPE as determined by this SSHP and/or the SSHO.

2.8 Contact Information

Contact information for key CABRERA personnel is located in Appendix C.

3.0 HAZARD ASSESSMENT

Potential exposure to radiological contaminants is expected to be minimal. The protection required for hazardous material will often protect against radiological contaminants. All hazards will need to be evaluated prior to making a final determination of required levels of PPE. The hazards review should consider the level of contamination (hazardous and radiological), the environment in the work area, and the type of work being performed. The RSO, with concurrence of the SRSO and PM, will make final determination of radiological controls and levels of PPE prior to start of site preparation and survey activities. Since higher levels of PPE can create or increase the heat stress of site workers, the extent of protective clothing required should be limited to the minimum required to protect against potential hazards.

3.1 Tasks to be Performed

- Task 1. Mobilization: This task will include setting up the administrative work areas; mobilizing equipment; staging project personnel; and familiarizing project personnel with the site, work, and the requirements of the work.

- Task 2 Perform Radiation Survey Measurements:

3.1.1 Class 1

Floors, Lower Walls (< 2 meters [m]) and Fixtures

Perform a 100% beta scan survey of surfaces. Collect fixed-point measurements at systematic locations using a triangular grid pattern. Floor areas limited to 100 square meters (m^2), where practical. Collect additional fixed-point measurements at biased locations using scan described in 3.10.1 or professional judgment.

Upper Walls (> 2m) and Ceilings

Perform a minimum 25% scan survey on walls above 2m and 10% scan survey on accessible ceiling surfaces. Collect fixed-point measurements at biased locations using professional judgment.

3.1.2 Class 2

Floors, Lower Walls (< 2m and Fixtures

Perform a minimum 25% scan survey of surfaces. Collect fixed-point measurements at systematic locations using a triangular grid pattern. Floor area limit of 1,000 m^2 applied. Collect additional fixed-point measurements at biased locations using professional judgment.

Upper Walls and Ceilings

Perform a minimum 10% scan on walls above 2m and accessible ceiling surfaces. Collect fixed-point measurements at biased locations using scanning procedures described in Section 3.10.1 of the FSS Plan or professional judgment.

3.1.3 Class 3

All Surfaces and Fixtures

Perform a minimum 10% scan survey of all surfaces. Collect fixed-point measurements at biased locations using professional judgment. No floor area size limit enforced.

- Task 3 Perform Liquid Scintillation Analysis (may be required during future tasks, but not during the initial phase of this project): Liquid Scintillation Counting (LSC) involves the use of a desktop instrument where the radiolabeled analyte is uniformly distributed in a liquid chemical medium capable of converting the kinetic energy of nuclear emissions into light energy. The chemical is often referred to as a "cocktail" and is not particularly hazardous. A material safety data sheet (MSDS) for this material is located in Appendix D.
- Task 4. Decontamination of Equipment: This task consists of the decontamination and survey of any equipment that may have been contaminated as a result of the radiological investigation activities.
- Task 5. Management of IDW: This task consists of handling and packaging of all bulk IDW that is generated beyond collected samples. Anticipated IDW includes, used PPE, consumable sampling equipment, and decontamination fluids. Solid and liquid wastes will be packaged into separate drums for onsite storage and future disposition. All drums will be sealed, appropriately labeled, and staged in an approved holding area until shipment.
- Task 6. Demobilization: This task will include removing all temporary equipment from the Site, staging IDW drums, and returning the site to its original condition.

3.2 Activity Hazard Analyses

Appendix E addresses the principle steps, potential hazards, controls, equipment, inspection, and training requirements associated with each site-specific task. If surveys indicate actual radiological conditions are different than expected, then additional controls will be implemented. Inspection and training requirements are hereby included by reference from the CABRERA *Health and Safety Manual* (CABRERA 2005a). Health and safety equipment, such as monitoring instruments and PPE, are further discussed in Sections 4.5 and 8.0, respectively, of this *SSHP*.

3.3 Radiological and Chemical Hazards

3.3.1 Radiological Contaminants of Concern

Operational radiological safety surveys have been performed routinely during the use of the facility for radiochemistry. A comprehensive survey of the analytical laboratories was performed by Brookhaven National Laboratories, report dated October 3, 2005. Common good laboratory practices were used to remove and dispose of contamination as it was generated or discovered. Based on the historical information available, the following is a list of radionuclides with any significant likelihood of remaining at the sight. Radionuclides specifically denoted as being at the facility are listed. However, the potential exists for all other nuclides with Atomic Numbers up to 92 to have been historically present at the site in radioanalytic samples. Short half-life isotopes which are not likely to be present at the site in significant activity at the present time are not included in the list**.**

Table 3-1. Radionuclides of Concern

Nuclide	Name	Half-Life	Principal Emissions	Source of Radionuclide
Ni-63	Nickel-63	100.1 yr	0.067mega electron volts (MeV) beta	Radioanalytic Sample
Ra-226	Radium-226	1600 yr	4.785 MeV alpha 0.168 MeV beta 0.186 MeV gamma	Radioanalytic Sample
Cs-137	Cesium-137	30.17 yr	0.511 MeV beta 0.662 MeV gamma (from Ba-137m)	Radioanalytic Sample
Sr-90	Strontium-90	28.6 yr	0.196 MeV beta 0.935 MeV beta (from Y-90)	Radioanalytic Sample
Tc-99	Technetium-99	21.3E4 yr	0.293 MeV beta	Radioanalytic Sample
Th-232	Thorium 232	1.4E10 yr	4.010 MeV alpha (most abundant)	Radioanalytic Sample
U-235	Uranium-235	7.04E8 yr	4.396 MeV alpha (most abundant) 0.014 MeV beta (most abundant) 0.186 MeV gamma (most abundant)	Radioanalytic Sample
U-238	Uranium-238	4.47E9 yr	4.196 MeV alpha (most abundant) 0.029 MeV beta (most abundant)	Radioanalytic Sample
Pu-238	Plutonium-238	87.75 yr	5.499 MeV alpha (most abundant) 0.021 MeV beta (most abundant)	Radioanalytic Sample
Pu-239	Plutonium-239	2.41E4 yr	5.155 MeV alpha (most abundant) 0.029 MeV beta (most abundant)	Radioanalytic Sample

3.3.2 Non- Radiological Contaminants of Concern

As noted in section 1.3.2, BNL conducted a hazardous materials survey of EML (BNL, September 2005). Using a mercury vapor detector, sink traps were surveyed for the presence of mercury vapor. Because many of the traps contained water, it was believed that mercury vapor may have been suppressed resulting in false positive readings. Mercury vapor was detected within some of the drains but apparently there was nothing detectable in normal breathing zone areas. Lead dust wipe samples were collected and detectable lead was found in a number of samples.

Asbestos containing materials are also present in the Laboratory Building in the form of floor tiles and mastic. A qualified asbestos abatement contractor must be available if the floor tiles and mastic have to be removed in a way that could cause asbestos fibers to become airborne.

Project personnel will be made aware of the presence of the aforementioned non-radiological hazards. Personnel conducting characterization activities are unlikely to be exposed to any of these hazards. In the event remediation activities could disturb building materials identified as containing these potential hazards, controls and/or personal protective equipment will be used to prevent exposure and minimize the generation of airborne contamination.

3.4 Physical Hazard Identification

Physical hazards are a primary safety concern during this project. These hazards include those associated with the use of operation and use of power tools and lifting/transport machinery, use of hand tools, general lifting, slips, trips, and falls.

3.4.1 Hand Tools

Only tools that are in good condition shall be used. Defective tools and improper use of tools contribute to accidents. The following safe practices shall be observed when using hand tools:

- Use tools in the manner for which they were designed;
- Be sure of footing before using any tool;
- Do not use tools that have split handles, mushroom heads, worn jaws, or other defects;
- Do not use makeshift tools or other improper tools; and
- Use spark proof tools where there are explosive vapors, gases, or residue.

3.5 Material Handling

Proper lifting techniques will be used such as keeping straight back, lifting with legs; personnel will avoid twisting back, will use mechanical equipment, or get help from others.

3.6 Electrical Hazards

All portable electrical equipment used on project sites must be double insulated or grounded and connected through a ground fault circuit interrupter (GFCI). Conductive materials must be kept clear of energized power lines. Isolate equipment from energy sources. The following distances must be observed:

Table 3-2. Minimum Voltage-Safe Distances

Voltage	Distance
0 to 50 kV	10 feet
51 to 200 kV	15 feet
201 to 300 kV	20 feet
301 to 500 kV	25 feet
501 to 750 kV	35 feet
751 to 1,000 kV	45 feet

kilovolts=kV

Lockout/tagout procedures must be utilized in areas where contact with live electrical equipment is possible. Treat all de-energized electrical equipment as if it were energized until lockout/tagout and ground procedures (where appropriate) have been implemented (see HSM-004, Cabrera Services, Lockout/Tagout, 2002).

3.7 Fall Hazards

All work will be conducted under 29 CFR 1926 Sub Part M Fall Protection requirements. Some work may require personnel to work over six feet. Personnel shall utilize 100% fall protection whenever they are six feet or more above the next lower level with an unprotected side or edge. Use of body belts, even for positioning, is strictly prohibited. Only full body harnesses will be utilized (see HSM-012, Cabrera Services, Fall Protection, 2001).

3.7.1 Slips, Trips, Falls

Work areas shall be visually inspected. Slip, trip, and fall hazards shall be either removed or marked and barricaded. Sufficient illumination shall be maintained. Good housekeeping must be maintained at all times and any scrap materials, debris, and field equipment must be placed in locations that do not pose a tripping or egress hazard.

3.7.2 Elevated Work Platforms

Only authorized, trained personnel will be permitted to operate an elevating work platform. The equipment shall be inspected prior to use and records of such inspections must be maintained on site. Any equipment found to be deficient from the manufacturer's specifications must be taken out of service until it can be brought into operable condition.

3.8 Ladders

3.8.1 Loads

- Self-supporting (foldout) and non-self-supporting (leaning) portable ladders must be able to support at least four times the maximum intended load, except extra-heavy-duty metal or plastic ladders, which must be able to sustain 3.3 times the maximum intended load.

3.8.2 Angle

- Non-self-supporting ladders, which must lean against a wall or other support, are to be positioned at such an angle that the horizontal distance from the top support to the foot of the ladder is about 1/4 the working length of the ladder.

- In the case of job-made wooden ladders, that angle should equal about 1/8 the working length. This minimizes the strain of the load on ladder joints that may not be as strong as on commercially manufactured ladders.

3.8.3 Rungs

- Ladder rungs, cleats, or steps must be parallel, level, and uniformly spaced when the ladder is in position for use. Rungs must be spaced between 10 and 14 inches apart.

- For extension trestle ladders, the spacing must be 8-18 inches for the base, and 6-12 inches on the extension section.

- Rungs must be so shaped that an employee's foot cannot slide off, and must be skid-resistant.

3.8.4 Slipping

- Ladders are to be kept free of oil, grease, wet paint, and other slipping hazards.
- Wood ladders must not be coated with any opaque covering, except identification or warning labels on one face only of a side rail.

3.8.5 Other Requirements

- Foldout or stepladders must have a metal spreader or locking device to hold the front and back sections in an open position when in use.
- When two or more ladders are used to reach a work area, they must be offset with a landing or platform between the ladders.
- The area around the top and bottom of ladder must be kept clear.
- Ladders must not be tied or fastened together to provide longer sections, unless they are specifically designed for such use.
- Never use a ladder for any purpose other than the one for which it was designed.

3.9 Confined Spaces

A confined space is defined as a space large enough and so configured that an employee can bodily enter and perform assigned work, has limited means for entry and exit, and is not designed for human occupancy. Confined space work may pose hazards such as chemical exposures, flammable/explosive atmospheres, electrocution, oxygen deficiency, excessive heat, and other significant hazards created by the nature of the work space (i.e., entrapment). Only authorized, trained personnel shall participate in confined space entries. Supervisors, attendants, and entrants must have written documentation of training prior to performing permit-required confined space entries.

All confined spaces are initially considered permit required. Under certain conditions, a space may be reclassified as a non-permit space provided the SSHO approves the reclassification and the space meets the non-permit space criteria (see HSM-003, Cabrera Services, Confined Space Entry, 2003).

3.10 Use of Scabbler

Only authorized personnel will be permitted to operate the scabbler. Operators must be familiar with the equipment and have read the manufacturer's operating instructions prior to use. The equipment must be inspected and determined to be in safe operating condition and equipped with required guards. The following operating guidelines must be followed:

- Eye and hearing protection must be worn at all times when the machine is in use
- Appropriate PPE includes steel toe safety shoes, padded gloves, non-fogging safety goggles or face shield, and full-face respirator if necessary (see Section 8.0)
- Maintain safe operating distance from other personnel

3.10.1 Heat Stress

Since work will be performed in an indoor environment heat stress is not likely to be a problem. However, depending on work activity and use of PPE, heat stress should be considered and addressed. In the event the SSHO determines heat stress to be of concern, a training session on the signs and symptoms of heat stress will be conducted. Workers will be encouraged to observe themselves and others for signs of heat stress. In addition, experience has shown that the following work/rest regimen (see Table below) is appropriate for field workers performing various degrees of work while wearing Level D (no protective clothing). Values are given in degrees Celsius (°C) Wet Bulb Globe Temperature (WBGT).

Heat stress is the combination of both environmental and physical work factors that contribute to the total heat load imposed on the body. Environmental factors that contribute to heat stress include air temperature, radiant heat exchange, air movement, and humidity.

The body's response to heat stress is reflected in the degree of symptoms. When the stress is excessive for the exposed individual, a feeling of discomfort or distress may result and a heat-related disorder may ensue. The severity of the response will depend not only on the magnitude of the prevailing stress, but also on the age, physical fitness, degree of acclimatization, and dehydration of the worker.

Heat stress is a general term used to describe one or more of the following heat-related disabilities and illnesses:

Heat Cramps - a condition characterized by painful, intermittent spasms of the voluntary muscles following hard physical work in a hot environment. Cramps usually occur after heavy sweating and often begin at the end of a work shift.
Heat Exhaustion - a condition characterized by profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. The skin is cool and sometimes pale and clammy with sweat. Body temperature is normal or subnormal. Nausea, vomiting, and unconsciousness may occur.
Heat Stroke - a condition in which sweating is diminished or absent. The skin is hot, dry, and flushed. Increased body temperature, if uncontrolled, may lead to delirium, convulsions, coma, and even death. **Medical attention is needed immediately**.

Resting frequently in a cool area and consuming large quantities of fresh, potable water can prevent heat stress. Dilute electrolytic beverages, such as Gatorade®, may be used as a secondary source of fluid replacement. If heat exhaustion symptoms are observed, the person will be required to rest in a shaded area and consume liquids. If symptoms are widespread or observed frequently, an appropriate work/rest period will be instituted. This will involve limiting the work/rest regimen so that after one minute of rest, a person's heart rate does not exceed 110 beats per minute.

If the heart rate is higher than 110 beats per minute after 1 minute of rest, the next work period will be shortened by 33%, while the length of the rest period stays the same. Resting heart rates will be established prior to the start of onsite activities when ambient temperatures exceed 70ºF and workers are wearing impervious clothing or when temperatures exceed 85ºF. A suggested work-rest regimen is outlined in Table 3-3, and definitions of the various categories of work demand are presented in Table 3-4.

If symptoms of heat stroke are observed, the victim will be cooled immediately and emergency medical services will be called. Workers will not hesitate to seek medical attention if heat stroke is suspected. One or more of the following additional mitigative measures may also be implemented:

- Provide a cool environment in the work vicinity.
- Use ice vests while in PPE to provide cooling to the worker.
- Reschedule work for cooler times of the day (night or early morning).

Table 3-3: Screening Criteria for Heat Stress Exposure

Work Demand	ACCLIMATIZED EMPLOYEES				NON-ACCLIMATIZED EMPLOYEES			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
100% Work	85.1°F 29.5°C	82.1°F 27.8°F	78.8°F 26°C	NO WORK	81.5°F 27.5°C	77°F 25°C	72.5°F 22.5°C	NO WORK
75% Work 25% Rest	86.9°F 30.5°C	83.3°F 28.5°C	81.5°F 27.5°C	NO WORK	84.2°F 29°C	79.7°F 26.5°C	76.1°F 24.5°C	NO WORK
50% Work 50% Rest	88.7°F 31.5°C	85.1°F 29.5°C	83.3°F 28.5°C	81.5°F 27.5°C	86°F 30°C	82.4°F 28°C	79.7°F 26.5°C	77°F 25°C
25% Work 75% Rest	90.5°F 32.5°C	87.8°F 31°C	86°F 30°C	85.1°F 29.5°C	87.8°F 31°C	84.2°F 29°C	82.4°F 28°C	79.7°F 26.5°C

WGBT values expressed in °F and °C
Source: American Conference of Governmental Industrial Hygienists (ACGIH 2000)

Table 3-4: Work Demand Activities

Categories	Example Activities
Resting	Sitting quietly
	Sitting with moderate arm movement
Light	Sitting with moderate arm movement
	Standing with light work at machine or bench while using arms
	Using table saw
	Standing with light or moderate work at machine or bench and some walking
Moderate	Scrubbing in a standing position
	Walking about with moderate lifting or pushing
	Walking on level at 6 Km/hr (3.7 m/hr) carrying 3 Kg (6.6 lbs.) weight load
Heavy	Carpenter sawing by hand
	Shoveling dry sand
	Heavy assembly work on a non-continuous basis
	Intermittent heavy lifting with pushing or pulling (e.g., pick and shovel work)
Very Heavy	Shoveling wet sand

(ACGIH 2000)

4.0 RADIATION SAFETY PROGRAM

The CABRERA RSP (CABRERA 2000a) will be implemented to protect worker health and safety during remedial support activities. The RSO ensures that contamination control activities are effective, samples and areas are not cross-contaminated, workers and the environment are protected, and that activities comply with radiological procedures in the RSP. It also ensures that worker doses are maintained as low as reasonably achievable (ALARA) in accordance with CABRERA SOP *AP-005: ALARA* (CABRERA 2000b). This will require methods to identify and prevent the release of potentially contaminated items from radiologically controlled areas. Methods and programs used to protect the workers, Site visitors and the environment are discussed in the following sections.

4.1 Radiation Work Permits

The Radiation Work Permit (RWP) serves as a tool in protecting workers from the radiation hazards per CABRERA SOP, AP-012, *Radiation Work Permits* (CABRERA 2000c). In this permit, the levels of PPE will be detailed per CABRERA SOP, AP-010, *Personal Protective Equipment* (CABRERA 2000d), as well as the levels of radioactive materials expected and other pertinent information.

4.2 Radiation Surveys and Monitoring

4.2.1 Survey Methods

Contamination surveys, which include removable contamination (i.e., wipe) and total radioactivity (i.e., direct measurement) surveys on equipment and other potentially contaminated items originating from radiological control areas, will be preformed per CABRERA SOP, OP-001, *Radiological Surveys* (CABRERA 2005b).

4.2.2 Survey Documentation

Original copies of field data, field records, analytical data, training records, and other project-specific documentation will be retained in the CABRERA East Hartford Office in accordance with CABRERA SOP, AP-001, *Record Retention* (CABRERA 2000e).

4.3 Applicable Regulatory Criteria and Release Limits

Regulatory authority for release of the site has not yet been finalized as of the writing of this report.

The NRC screening values represent surface concentrations of individual radionuclides that would be deemed in compliance with the 25 millirem/year unrestricted release dose limit in 10 CFR 20.1402 (NRC, 2003b).

Personnel contamination limits listed in Table 4-1 will be implemented for FSS efforts.

Table 4-1. Radioactive Material and Personnel Contamination Limits

Agency / Reference	Alpha Total ($dpm/100cm^2$)	Alpha Removable ($dpm/100cm^2$)	Beta/Gamma Total ($dpm/100cm^2$)	Beta/Gamma Removable ($dpm/100cm^2$)
NYCDOH §175.03 - Release of Materials or Facilities	2,500 (Max) 500 (Avg)[1]	100	0.2 mR/hr[2]	1,000
Skin, Personal Clothing	20	ND[3]	0.1	ND[3]
NRC 10 CFR 20.1402	Total dose to the public after decommissioning of not more than 25 mrem/yr			

Notes: 1. Averaged over 1 m^2 3. ND = Not Detected
2. Measured at 1 cm from the surface

4.4 Decontamination

4.4.1 Equipment Contamination Surveys

Contamination surveys will be accomplished using direct frisk and loose contamination (smear) survey methods. The direct frisking method is performed using calibrated and daily source checked instrumentation capable of detecting alpha and beta-gamma radiations. The loose contamination survey method employs a contamination collection smear that removes loose contamination over approximately 100 cm^2 surface area of potentially contaminated surfaces. The smear samples, in turn, are analyzed in a calibrated field laboratory instrument. Equipment contamination surveys will be performed in compliance with CABRERA, OP-001, Radiological Surveys, rev. 1.

4.4.2 Contamination Controls

Contamination controls provided during sample collection activities will include physical barriers such as rope boundaries along with standard ingress/egress points. Equipment and tools potentially contaminated by sample collection activities will be controlled until release criteria have been met.

4.4.3 Survey Forms

Survey forms will be used to record the results of fixed/loose contamination surveys associated with equipment and tools used during sample collection activities.

Completed survey forms will be forwarded to the SRPO or field supervision (PM, TM, or RSO) for data validation.

4.4.4 Equipment Decontamination Protocols

Sample collection equipment will be decontaminated prior to deployment to minimize cross-contamination. Decontamination procedures can be found in CABRERA, OP-018, Decontamination of Equipment and Tools, rev. 0 and will meet the criteria presented in section 4.3.

4.4.5 Applicability of Surveys

At a minimum, direct and loose surveys will be performed under the following conditions.

- All sampling equipment in an RCZ will be surveyed prior to leaving the site.
- All material brought into a RCZ will be surveyed prior to being removed from the zone or bagged and disposed of as Investigative Derived Waste (IDW).
- To ensure that samples sent to off-site laboratory do not have surface contamination in excess of allowable limits, sample containers will be surveyed prior to placement in containers for shipment to off-site laboratories, and the exterior of sample containers will be surveyed prior to shipment to off-site laboratories.

Additional surveys will be performed at the direction of the RSO.

4.5 Personal Monitoring

4.5.1 External Radiation Dosimetry

CABRERA will issue a TLD to each of the site personnel to provide a permanent record of the individual's occupational radiation exposure. These TLDs will be supplied and evaluated by an approved vendor participating in the National Voluntary Laboratory Accreditation Program (NVLAP). Personnel assigned to the project will be issued a TLD to be worn at all times on the project site, and shall immediately notify the SRSO in the event of misplacement or loss.

4.5.2 Internal Dose Monitoring

The contamination levels are not expected to cause any internal dose that would necessitate internal dose assessment. Therefore, no internal dose monitoring is required.

4.5.3 Air Monitoring Plan

Even though relatively low radioactivity are expected to be encountered during this effort, it will be the responsibility of the SRSO, in consultation with the RSO, to determine whether to implement air monitoring to measure and document airborne radioactivity in accordance with *CABRERA SOP OP-002: Air Sampling and Analysis.* Air monitoring will be performed in areas where there is a potential for airborne contaminants, including cutting, grinding, scabbling, and related activities. Personnel air sampling will be conducted to document the workers exposure, and perimeter air monitoring will be conducted to document ambient conditions during the evaluation process.

5.0 PROJECT SITE CONTROLS

Survey and sample collection activities performed in radiological posted areas shall be performed using radiation work permits as per CABRERA SOP, AP-012, *Radiation Work Permits* (CABRERA 2000c). Posted radiologically controlled areas shall be controlled through the use of CZs, Contamination Reduction Zones, and Support Zones, as described below.

5.1 General Site Access

General access to the Site is controlled through facility's on-site security.

5.2 Radiologically Controlled Areas

Access to potentially radiologically controlled areas is controlled via EML's normal control of radiation areas. Access control of areas under investigation/decontamination will be controlled through the use of caution/radiological tape or rope.

5.2.1 Contamination Zone

A CZ shall be designated and delineated for areas that have the possibility of exposing contaminated material to personnel or the surrounding environment. As such, they may be considered potentially contaminated areas. Gross equipment decontamination area(s) shall require visible delineation and posting as a CZ.

5.2.2 Contamination Reduction Zone

Contamination Reduction Zones (CRZs) shall be established between CZs and any non-contaminated areas. Personnel and equipment that exit a CZ shall do so through the CRZ. Equipment decontamination may be performed in a CZ, but personnel and final equipment decontamination shall be located in the CRZ. The CRZ shall contain the equipment necessary for personnel decontamination, and may be equipped with designated "step-off areas" if decontamination procedures warrant. Site areas surrounding CZs shall be administered as CRZs.

5.2.3 Radiologically Controlled Area Entry and Exit

When exiting a CZ, personnel and equipment must pass through the CRZ. Potentially contaminated PPE shall be removed in the CRZ. Decontamination shall be performed prior to exiting the CRZ if contamination is detected above the limits in section 4.3.

5.3 Support Zones

Support Zones (SZs) are uncontrolled "clean" areas throughout the Site. SZs encompass both the overall support infrastructure (i.e., Site office, restrooms, etc.) as well as smaller, task-specific SZs that may be established adjacent to CRZs. The latter may consist of break areas, equipment and PPE staging areas, and engineering control support centers. PPE shall not normally be required in exterior areas of a SZ.

If personnel are performing work in PPE in a CZ, a minimum of one person will be in the SZ at all times. This person will have access to communications with the TM and SSHO (e.g., cellular phone or two-way radio).

5.4 Site Postings

Site postings shall delineate the project work areas, and at a minimum, the site control boundary shall be posted, *Caution Authorized Personnel Only*. Radiological postings shall be

in accordance with 10 CFR 20.1902 (NRC 2005b).

5.5 Asbestos Abatement

All asbestos abatement work, including but not necessarily limited to elements described below, shall be performed by a licensed asbestos abatement subcontractor. The asbestos abatement contractor must conduct a site visit in order to be awarded a contract.

- submit all State and Federal permits;
- submit to CABRERA a work plan for approval prior to performing the work describing how the asbestos abatement work will be accomplished;
- submit to CABRERA prior to performing the work all training certificates and proof of medical clearances;
- submit all waste shipment manifests in accordance with applicable Federal, State, and local regulations. A final copy of the manifest documenting disposal shall be submitted to CABRERA; and
- submit to CABRERA all personal air sample analytical results at the completion of the project or a Negative Exposure Assessment for the work procedures used to complete the work (i.e. removal of asbestos-containing materials).

6.0 TRAINING

This section contains a discussion of the training requirements for personnel performing work on this project.

6.1 Basic OSHA Training

All field workers shall have 24- or 40-hour HAZWOPER training in accordance with 29 CFR 1910.120 (OSHA 2005a), and at least three days of documented field experience under the direct supervision of a trained experienced supervisor. Onsite management personnel (field supervisor) must have an additional 8 hours of specialized supervisory training. All workers must have an annual refresher (8 hours) if initial training is over l year old. Copies of training certificates should be readily available for review. Where there is potential exposure to contaminants with specific OSHA training requirement such as asbestos, lead, or arsenic, documentation of training shall be required.

6.2 Site-Specific Health and Safety Training

Site-specific health and safety training, as required by applicable sections of 29 CFR 1910.120 and 1926.65 (OSHA 2005a), shall be completed prior to field activities for all project personnel and site visitors. The designated SSHO will review the SSHP, work plan, and other associated responsibilities with other field team members and afford them the opportunity to ask any questions. A record of this training will be maintained by the SSHO. The TM shall review the work plan with the project team and assign specific responsibilities, ensuring that all project personnel understand the importance of adhering to the health and safety requirements presented in this SSHP during project implementation. The form provided in Appendix A will be used to acknowledge receipt of this training and signed by all project field personnel.

6.3 Radiation Worker Training

All field personnel assigned to this project must complete the CABRERA site-specific radiation worker training or equivalent as determined by the RSO and administered by the TM. A score of 80% must be achieved for successful completion of the course.

6.4 Hearing Conservation Training

Powered equipment generally will produce sound levels greater than 85 DeciBels Adjusted (dBA). Hearing protection shall be required where exposure may occur for several hours during the day. For individuals with documented threshold shifts, use of hearing protection is mandatory whenever powered equipment or other devices are used which produce sound levels over 85 dBA.

6.5 Respiratory Protection Training

In accordance with 29 CFR 1910.134 (OSHA 2005b), all Site personnel required to use respiratory protection devices shall receive equipment-specific training. This training covers the use, limitations, inspection, maintenance, and cleaning of respiratory protection devices required under this *SSHP*. Unless air monitoring results indicate the need for respiratory protection, it will not be required. Optional use of respiratory protection shall be at the discretion of the TM in consultation with the SHM/RSO. The SSHO shall ensure that all affected personnel are medically cleared, appropriately trained, and fit-tested to use a respirator.

6.6 First Aid and CPR Training

At least one employee will be certified in First Aid and cardiopulmonary resuscitation (CPR). The training shall be equivalent to that provided by the American Red Cross. This individual will be onsite at all times during which project activities are in progress.

6.7 Blood Borne Pathogen Training

Any person who has received first aid and/or CPR, and who may need to provide emergency service to an injured/unconscious co-worker shall have received awareness level training in controlling exposures to Blood Borne Pathogens (BBPs). This training shall consist of the following:

- Review of the (BBP) standards;
- Requirements of the Exposure Control Plan (ECP);
- Description of the risks of exposure and how BBP are transmitted;
- Methods of protection against exposure and procedures for decontamination; and
- Post-exposure procedures.

6.8 Hazard Communication

This SSHP discusses the methods used to comply with the OSHA Hazard Communication Standard (HCS) 29 CFR 1910.1200 (OSHA 2005c). In order to comply with this CFR, the following shall apply to all commercial products containing hazardous substances brought onsite:

- Any hazardous materials brought onsite shall comply with the requirements of the CABRERA Hazard Communication Program (CABRERA 2002). This program shall be made available to all site personnel.
- All containers not supplied with adequate hazard labeling shall have a hazard communication label affixed to the container displaying the health and physical hazards of the material.
- Employees working with hazardous substances shall be trained in accordance with the requirements of 29 CFR 1910.1200.
- An inventory of all hazardous substances used onsite will be maintained.
- Personnel, including contractors, using hazardous substances shall be informed of the hazards and the location of appropriate MSDS.

6.9 Asbestos Awareness

CABRERA employees will not be involved in any asbestos abatement activities. Asbestos abatement is the responsibility of a licensed asbestos abatement contractor. However, CABRERA employees must be aware of the hazards associated with asbestos exposure and procedures necessary to ensure their safety. An asbestos awareness training session will be required for any CABRERA employee who may have to work in proximity to asbestos abatement activities or may have to enter asbestos abatement controlled areas (no abatement activities will be permitted while CABRERA employees are performing radiation surveys in asbestos abatement area).

7.0 MEDICAL SURVEILLANCE

The purpose of the medical surveillance program is to ensure suitable job placement of employees, to monitor potential health effects of hazards encountered in the work place, and to maintain and promote good health through preventative measures.

7.1 Medical Support Functions

In compliance with 29 CFR l910.120 (f) (OSHA 2005a), medical surveillance is required for all personnel who will be involved in Site activities. The TM or designee will ensure that project personnel are medically cleared for the anticipated duties. Documents that should be made available are the employee’s most recent medical clearance and respirator clearance forms. The purpose of the medical surveillance program is to ensure suitable job placement of employees, to monitor potential health effects of hazards encountered in the work place, and to maintain and promote good health through preventative measures. All personnel assigned to work on the site, shall provide documentation to the SSHO demonstrating compliance with the medical surveillance requirements of 29 CFR 1910.120.

8.0 PERSONAL PROTECTIVE EQUIPMENT

In accordance with 29 CFR l910, Subpart I (OSHA 2005d) all PPE will be provided, used and maintained in a sanitary and reliable condition. All PPE will be of construction, design, and material to provide employees protection against known or anticipated hazards. PPE will be selected which properly and appropriately fits the employee. All personnel shall be provided with training on the selection, use, and limitations of PPE in accordance with the standard. Any concerns regarding the use of appropriate PPE will be brought to the attention of the SHM. The SSHO is responsible for ensuring that necessary PPE is available onsite.

All personnel performing operations onsite shall be required to use the appropriate level of protection. The SSHO will make the final determination for PPE levels based on encountered Site conditions and activities.

8.1 Construction Attire

Construction attire shall be worn as directed by the SSHO at all times at this Site. Construction attire consists of:

- Coveralls or sleeved shirts (minimum 4-inch long) and long pants, unless otherwise directed by the SSHO.
- Safety boots with steel toes.
- Hardhat.
- Safety glasses with attached side shields.
- Leather work gloves.
- Hearing protection worn during equipment operations, if necessary.

8.2 Level D Protection

Level D protection shall be required for all work activities within the controlled areas for chemical or radiological contamination. It is not anticipated that there will be any airborne contaminates, but to ensure that the level of protection is appropriate, air monitoring will be performed as directed by the RSO of SSHO to evaluate the need for upgrading PPE. Level D protection is as follows and may include modifications as deemed necessary by the SSHO:

- Construction Attire (see Section 8.1)
- Chemical-resistant coveralls such as Tyvek©.
- Outer nitrile gloves at a minimum for all hazardous or potentially hazardous material handling activities. Inner latex surgical gloves are recommended where practical.
- Rubber overboots or equal.

8.3 Level C Protection

Level C protection shall be worn when activities are being performed that could generate airborne contamination or when air-monitoring results show levels that exceed those specified in Section 4.5.3. Level C protection consists of Level D attire with the addition of:

- Full-face powered air-purifying respirator (PAPR) equipped with high efficiency particulate air (HEPA) P-100 canisters or cartridges.

9.0 RADIOACTIVE WASTE MANAGEMENT PROGRAM

9.1 General Waste Management

Waste may be classified as non-investigative waste or investigation derived waste (IDW). Non-investigative waste, such as litter and household garbage, will be collected on an as-needed basis to maintain each site in a clean and orderly manner. Acceptable interim containers will be sealed boxes or plastic garbage bags.

9.2 Handling of Investigation Derived Waste

9.2.1 Packaging of IDW Materials

IDW will be properly containerized at the site. Depending on the constituents of concern special marking may be required. Acceptable containers will be sealed, U.S. Department of Transportation (DOT)-approved 7A-certified steel 55-gallon drums with lids. Other types of containers (e.g., B-25 boxes) may be necessary depending on the extent of remediation necessary. Each container will be properly labeled with site identification, matrix, constituents of concern, and other pertinent information for handling.

9.2.2 Waste Profiling

The waste will be properly characterized in accordance with all applicable regulations and waste acceptance criteria (WAC) of the disposal facility.

Prior to shipment of material, waste characterization is required by the volume reduction/disposal facility for proper acceptance. If the characterization is known based on previously identified waste streams, then additional sampling may not be necessary. Waste characterization typically includes the following:

- Evaluate Radiological Characteristics
    - Isotopes
    - Activity Concentration
    - Weighted Average per Container
- Laboratory Certification Information
- Generator Signature

9.2.3 Material Loading and Off-Site Transport

- Waste transportation and disposal are not included in this SSHP.

9.2.4 IDW Disposal

- IDW transportation and disposal are not included in this SSHP.

9.2.5 Solid Radioactive Waste Estimate

Not known at this time.

9.2.6 Liquid Radioactive Waste

Not known at this time.

10.0 GENERAL SITE SAFETY PROCEDURES

10.1 General

Hazards due to normal site activities can be reduced by using common sense and by following safe practices. The following practices are expressly forbidden:

- Running and horseplay;
- Smoking, eating, drinking, applying cosmetics, or chewing gum or tobacco within any potentially contaminated area;
- Ignition of flammable materials in the work zone without the proper Hot-Work Permit. Equipment will be bonded, grounded, and explosion resistant, as appropriate; and
- Performance of tasks in the restricted area individually (i.e. working alone).

Hazard assessment is a continuous process; personnel must be aware of their surroundings and constantly aware of the chemical and physical hazards that are or may potentially be present. The number of personnel in the SZ or CZ shall be the minimum number necessary to perform work tasks in a safe and efficient manner. The use of the Buddy System is mandatory for CZ work. Team members will be familiar with the physical characteristics of each site including site access and the location of communication devices and safety equipment.

10.2 Sanitation

Project sanitation needs shall be addressed by way of on-site toilets in the SZ. Fresh water shall be brought in for personnel consumption.

10.3 Buddy System

All work activities shall be accomplished utilizing the buddy system. No one will be allowed to enter the work zones alone. Personnel shall keep in visual and/or radio contact with each other at all times.

10.4 First Aid

A 16-unit first aid kit shall be maintained at the Site, along with an eye wash station capable of providing 15 minutes of eye flushing. All injuries shall be reported immediately to the SSHO. Any employee who becomes ill resulting from possible exposure to site hazards shall notify the SSHO or TM, who will make immediate arrangements for medical consultation.

10.5 Daily Safety Meetings

The SSHO shall conduct daily safety meetings, with the assistance of the TM, to review the day's work plan, associated activities, and any anticipated hazards. Names and topics will be documented and maintained on file. This daily orientation shall be required for all individuals scheduled to work that day. Copies of daily safety tailgate forms will be made available to EML safety and project staff as requested. An example daily safety meeting form is contained in Appendix F.

11.0 EMERGENCY RESPONSE PROCEDURES AND EQUIPMENT

The purpose of this section is to address potential emergency situations and to provide guidelines for emergency response procedures. If, during the performance of this project, the presence of potentially hazardous conditions is evident in a particular area, personnel shall leave the area and immediately notify the appropriate emergency response personnel.

11.1 Emergency Recognition and Prevention

The types of potential emergencies that may occur on this project include:

- Physical injuries to site personnel such as sprains, broken bones, severe lacerations;
- Exposure to site contaminants or hazardous materials; and
- Electrical fires.

11.2 Emergency Equipment

To facilitate timely emergency response, the following emergency equipment shall be available and maintained in a location known and accessible to all personnel onsite:

- 16-unit First Aid kit,
- Eye wash, and
- 2-way radios and/or cellular telephones.

11.3 Emergency Procedures

All site personnel shall review the provided emergency notification numbers. Emergency plans and evacuation procedures shall be reviewed with all personnel prior to commencement of Site activities.

11.4 First Aid and Medical Treatment Procedures

In the event of an emergency, personnel who have been trained and certified in First Aid may administer general onsite treatment. If medical treatment is required, the SSHO or other personnel familiar with the incident and site contaminants must accompany the victim to the hospital. General treatment procedures include:

- Remove the injured or exposed person(s) from immediate danger.
- Assess the nature and extent of the injury.
- Report any accident to the SSHO immediately.
- Render first aid and decontaminate affected personnel, if necessary.
- Call an ambulance for transport to local hospital immediately.
- Evacuate other personnel onsite to a safe place if necessary, until the SSHO determines that it is safe for work to resume.

11.5 Emergency Alert Procedures

If conditions in or around the work area pose imminent danger during the performance of this project, personnel shall leave the area and immediately notify the appropriate emergency response personnel. Emergency response numbers are provided in Appendix C and shall be posted at each site telephone. All project personnel shall review the emergency notification numbers, as well as the emergency plans and evacuation procedures prior to commencement

of site activities. This list, along with a street map showing the routes to local hospitals and directions (Appendix C) shall be provided in the onsite copy of this *SSHP*.

12.0 RECORDKEEPING

Each employee working onsite is responsible for providing the following record keeping information. These records will be maintained at the CABRERA East Hartford Office and become part of the project file.

- Signed Statement of SSHP Acknowledgment (See Appendix A for sample form).
- Personnel training certificates for:
  - 24-hr or 40-hr HAZWOPER training,
  - Current 8-hr HAZWOPER refresher,
  - CABRERA Radworker training,
  - First Aid/CPR training (if applicable), and
  - BBP Training (if applicable).
- Medical approval forms for site work and respirator clearance.

The following documents will also be incorporated into the project file:

- Accident Investigation Reports - In case of an accident or employee injury onsite, a written accident report will be completed and forwarded to the SSHO within 48 hours.
- Revisions to the SSHP - The SSHO, in consultation with the SHM, will document recommended changes to the SSHP. Revisions approved by the SHM and the VP will become part of the SSHP and will be distributed to all essential personnel.

13.0 REFERENCES

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APPENDIX A: STATEMENT OF ACKNOWLEDGEMENT

STATEMENT OF ACKNOWLEDGEMENT

SITE SAFETY AND HEALTH PLAN
for
Environmental Measurements Laboratory
201 Varick Street
New York, NY

1.0 INTRODUCTION .... __________

2.0 ORGANIZATION OF HEALTH AND SAFETY PERSONNEL........... __________

3.0 HAZARD ASSESSMENT .... __________

4.0 RADIATION SAFETY PROGRAM .... __________

5.0 PROJECT SITE CONTROLS.. __________

6.0 TRAINING... __________

7.0 MEDICAL SURVEILLANCE.. __________

8.0 PERSONAL PROTECTIVE EQUIPMENT... __________

9.0 RADIOACTIVE WASTE MANAGEMENT PROGRAM .... __________

10.0 GENERAL SITE SAFETY PROCEDURES.. __________

11.0 EMERGENCY RESPONSE PROCEDURES AND EQUIPMENT __________

12.0 RECORDKEEPING.. __________

13.0 REFERENCES .... __________

I have read the "Site Safety and Health Plan for the “Environmental Measurements Laboratory Characterization and Final Status Survey” outlined above and understand the material presented.

PRINTED NAME: ____

SIGNATURE: ____

DATE: ___________________

APPENDIX B: COPIES OF APPLICABLE RADIOACTIVE MATERIALS LICENSES

Cabrera Services, Inc. NRC Decommissioning License

(Copy not included in Draft)

APPENDIX C: EMERGENCY INFORMATION

Site Contacts and Emergency Telephone Numbers

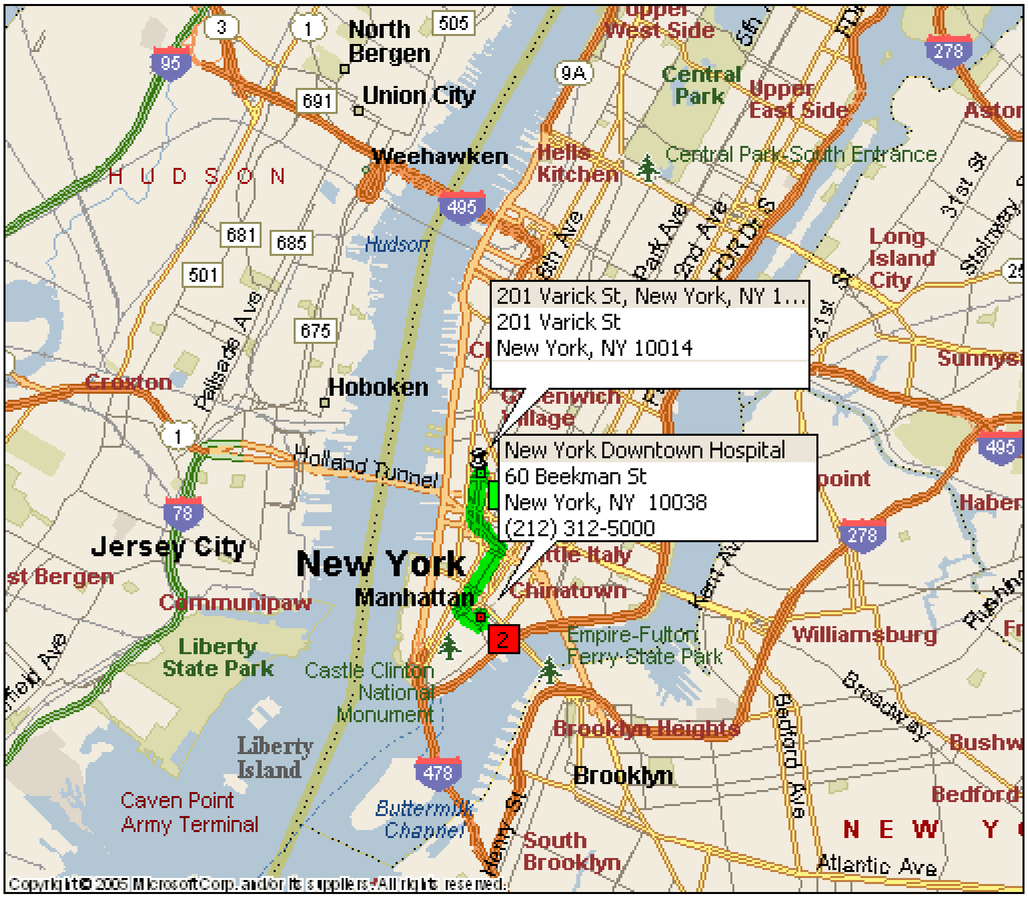
Map and Route to Local Hospital

Directions to Local Hospital

SITE CONTACTS & EMERGENCY TELEPHONE NUMBERS			
EML Local Emergency Assistance Services (Oncall 24-Hours a Day)			
EMERGENCY TYPE	**AGENCY**	**EMERGENCY NUMBER**	**SECONDARY NUMBER**
Fire	Fire Department	911	-
Spill	Fire Department	911	-
Injury		911	
Security		911	
CABRERA Personnel			
TITLE	**NAME**	**OFFICE NUMBER**	**CELL NUMBER**
Vice President	Len Johnson	(860) 569-0095	
Project Manager	Greg Hisel, CHP	(845) 956-0095	(518) 755-7465
TM	Greg Hisel, CHP	(845) 956-0095	(914) 489-6128
Corporate RSO	Hank Siegrist, CHP	(860) 569-0095	(860) 416-0196
Corporate HSO	Paul Schwartz, CIH, CSP	(860) 569-0095	(860) 463-8595
SSHO	Michele Driscol		(973) 985-9525
Personnel with First Aid/CPR Training	Greg Bright	-	(781) 264-4445
	Michele Driscol	-	(973) 985-9525

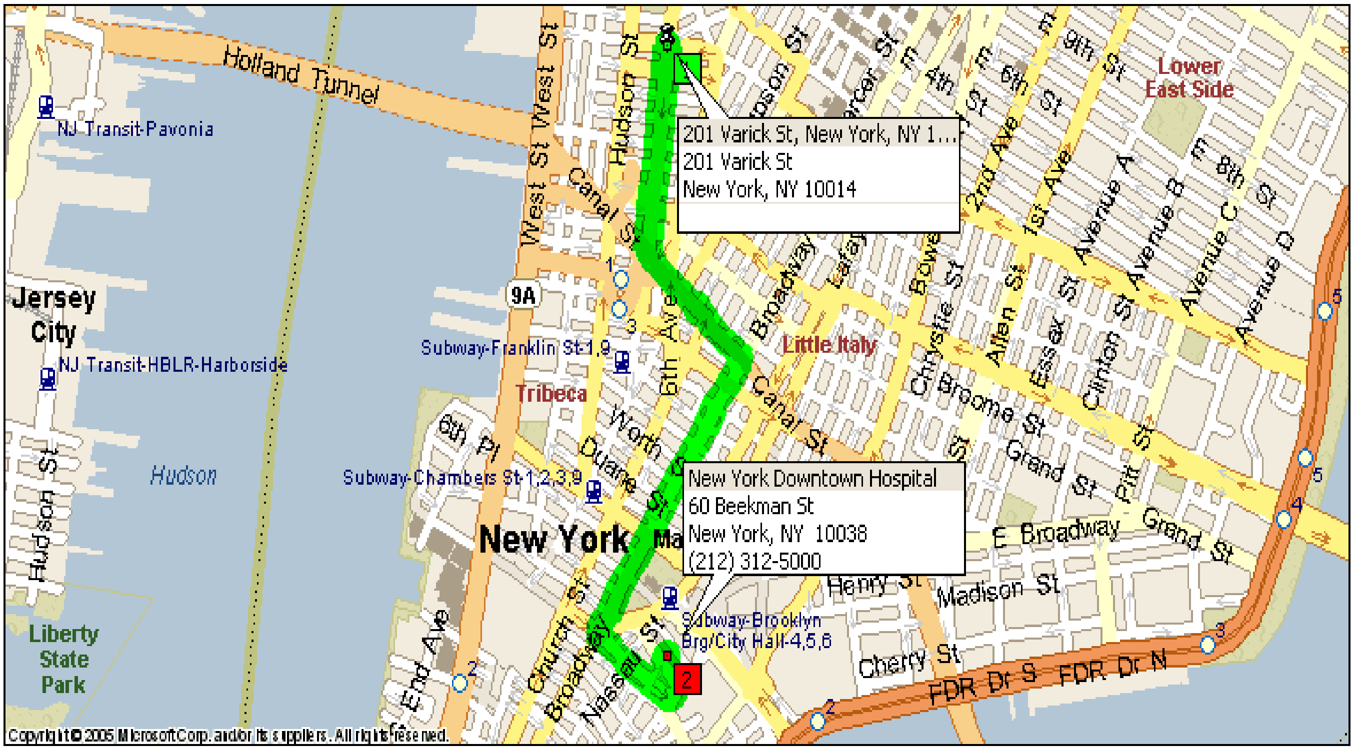
MAP OF EML SITE IN RELATION TO NYU DOWNTOWN HOSPITAL

Figure 13-1



DIRECTIONS FROM EML TO NYU DOWNTOWN HOSPITAL

Figure 13-2



	Directions	Miles
	Depart 201 Varick St, New York, NY	**0.4**
	Bear LEFT (South-East) onto Canal St	**0.3**
	Turn RIGHT (South-West) onto Broadway	**0.7**
	Turn LEFT (South-East) onto Ann St	**0.2**
	Turn LEFT (North-East) onto Gold St, then immediately turn LEFT (North-West) onto Beekman St	**0.1**
	Turn RIGHT (North) onto Local road(s	**0.0**

APPENDIX D: CHEMICAL INFORMATION

TBD

APPENDIX E: ACTIVITY HAZARD ANALYSES

Task: Mobilization/Demobilization

Task	Hazards	Hazard Control
Mobilization, site preparations, establishing sample locations, demobilization.	*Physical Hazards*: Slip, trips, falls, tools, terrain, or vegetation; uneven walking surfaces.	The work area shall be visually inspected. Personnel shall enter muddy areas cautiously. Slip, trip, and fall hazards shall be either removed or marked and barricaded. Sufficient illumination shall be maintained. Site personnel shall conduct initial walkovers in groups of two at a minimum.
	Inclement Weather, Heat/Cold Stress.	Workers shall be briefed and cognizant of heat and cold stress symptoms. Fluids shall be available to workers. Work rest periods shall be established according to the ACGIH and the National Institute for Occupational Safety and Health (NIOSH) guidelines.
	Traffic.	Work areas shall be clearly barricaded and appropriate signs shall be displayed. Traffic shall be rerouted as necessary. Personnel working near roadways or directing traffic shall wear high visibility vests.
	Strains and sprains from manually lifting and moving.	Proper lifting techniques shall be used such as keeping back straight and lifting with legs. Personnel shall avoid twisting their back, shall use mechanical equipment, or get help from others. The work area shall be visually inspected.
	Fire.	Flammable liquids shall be stored in safety containers and flammable storage cabinets. Properly rated fire extinguishers shall be placed in onsite vehicles, within the contamination reduction zone, and within office trailer.
	Hands or fingers caught between objects; abrasions and lacerations.	Personnel shall be made aware of the hazard and asked to carefully coordinate the handling and placement of heavy objects. Materials and objects being handled shall be inspected for rough or sharp edges, and appropriate precautions shall be taken to avoid contact.
	Moving mechanical parts from heavy equipment operations.	Personnel shall wear work gloves and avoid placing hands between objects.
		Personnel shall be made aware of the hazard and shall coordinate carefully during handling equipment operations. Guards shall be kept in place during operation. A safe distance shall be maintained from moving mechanical parts.
	Hand tools, manual and power.	Tools shall be inspected prior to use. Damaged tools shall be tagged out-of-service until repair can be performed by a qualified person. Tools shall be used properly and for their intended purpose.
	Foot Injury.	Safety shoes/boots meeting ANSI specifications are required. Muddy areas must be entered with care as buried objects may pose tripping and/or puncture hazards.

Task: Mobilization/Demobilization (continued)

Task	Hazards	Hazard Control
Mobilization, site preparations, establishing sample locations, demobilization.	Housekeeping.	Materials shall be stored to prevent intrusion into the work areas. Work areas shall be kept organized and, if present ice, snow, and mud shall be cleared from steps to reduce slip hazards.
	Striking and being struck by operating equipment, loads, falling objects, and pinch points.	Workers shall stay out of the swing area of all equipment and from under loads. No personnel shall ride on the equipment unless seats are provided. Workers exposed to traffic hazards shall wear traffic/reflector vests.
	Electric Hazards.	Generators shall be grounded unless self-grounded. Extension cords shall be properly rated for intended use.
		Prior to any intrusive activity, authorities shall be contacted for permits.
		Elevated parts of machinery, ladders, and antennas shall be kept at least 10 ft from overhead electric lines.
		Qualified electricians shall make all electrical installations. A lockout/tagout program shall be implemented (CABRERA 2005a).
	Radiation Hazards.	Personnel shall be briefed on area radiation levels. When required, personnel shall wear appropriate dosimetry; personnel and equipment shall be checked for contamination.
	Chemical Hazards: No chemical contaminants are anticipated.	No intrusive activities will be allowed during this activity; therefore, the risk level of exposure to site contaminants during this activity is low. Level D PPE shall be worn to prevent dermal contact
	Biological Hazards: Poisonous plants, insects, snakes.	Personnel shall review recognition of poisonous plants, insects, or snakes typical of this area and use appropriate measures as required. Personnel shall adhere to CABRERA Blood Borne Pathogens Exposure Control Program (CABRERA 2005a).

Task: Perform Radiation Survey Measurements

Task	Hazards	Hazard Control
Surveying the site with radiation detection equipment.	*Physical Hazards*: Slip, trips, falls, tools, terrain, or vegetation; uneven walking surfaces.	The work area shall be visually inspected. Personnel shall enter clean spills immediately. Slip, trip, and fall hazards shall be either removed or marked and barricaded. Sufficient illumination shall be maintained. Site personnel shall conduct initial walkovers in groups of two at a minimum.
	Heat/Cold Stress.	Workers shall be briefed and cognizant of heat and cold stress symptoms. Fluids shall be available to workers. Work rest periods shall be established according to the ACGIH and the NIOSH guidelines.
	Foot Injury.	Safety shoes/boots meeting ANSI specifications are required. Muddy areas must be entered with care as buried objects may pose tripping and/or puncture hazards.
	Housekeeping.	Materials shall be stored to prevent intrusion into the work areas. Work areas shall be kept organized and, if present ice, snow, and mud shall be cleared from steps to reduce slip hazards.
	Ergonomic injury.	Personnel shall use the backpack to distribute weight evenly. Personnel shall take breaks, as necessary. Personnel shall apply proper lifting techniques, or get help when lifting heavy equipment of supplies.
	Radiological Hazards.	Level D protection shall be required for all work activities within the controlled areas for radiological contamination. Airborne contaminants are not expected, but air monitoring shall be performed to evaluate the need for upgrading PPE. Level C protection shall be worn when air-monitoring results show levels that exceed 10% of Derived Air Concentration (DAC) for alpha and beta emitting radionuclides. The additional Level C protection shall include a full-face PAPR equipped with HEPA P-100 canisters or cartridges.
	Chemical Hazards:.	Personnel will be made aware of locations that contain asbestos, lead, or mercury and what measures must be taken to avoid disturbance of the material.

Task: Collecting Samples from Interior Structures

Task	Hazards	Hazard Control
Collection of surface and structural samples from the building.	*Physical Hazards*: Slip, trips, falls, tools, terrain, or vegetation; uneven walking surfaces.	The work area shall be visually inspected. Personnel shall enter clean spills immediately. Slip, trip, and fall hazards shall be either removed or marked and barricaded. Sufficient illumination shall be maintained. Site personnel shall conduct initial walkovers in groups of two at a minimum.
	Chemical Hazards—Possible lead in paint	Metal surfaces may have been painted with lead-based paint. No cutting, sanding, or grinding of painted surfaces until determination of paint is made
	Heat/Cold Stress.	Workers shall be briefed and cognizant of heat and cold stress symptoms. Fluids shall be available to workers. Work rest periods shall be established according to the ACGIH and the NIOSH guidelines.
	Traffic.	Work areas shall be clearly barricaded and appropriate signs shall be displayed. Personal traffic shall be rerouted as necessary and kept out of controlled areas. .
	Working at elevations	If it becomes necessary to sample or inspect areas above ground or floor level, fall protection must be employed anytime work is performed at elevations greater than six feet.
	Electric Hazards.	Generators will be grounded unless self-grounded. Extension cords will be properly rated for intended use. Qualified electricians will make all electrical installations. A lockout/tagout program will be used for equipment maintenance.
	Housekeeping.	Materials shall be stored to prevent intrusion into the work areas. Work areas shall be kept organized and, if present ice, snow, and mud shall be cleared from steps to reduce slip hazards.
	Strains and sprains from manually lifting and moving.	Proper lifting techniques will be used such as keeping straight back, lifting with legs; personnel will avoid twisting back, will use mechanical equipment, or get help from others
	Radiological Hazards.	Level D protection shall be required for all work activities within the controlled areas for radiological contamination. Airborne contaminants are not expected, but air monitoring shall be performed to evaluate the need for upgrading PPE. Level C protection shall be worn when air-monitoring results show levels that exceed those specified in Section 4.5.3. The additional Level C protection shall include a full-face PAPR equipped with HEPA P-100 canisters or cartridges.
	Hands or fingers caught between objects; abrasions and lacerations. Puncture wounds from stepping on sharp objects	Personnel shall be made aware of the hazard and asked to coordinate carefully the handling and placement of heavy objects. Materials and objects being handled will be inspected for rough or sharp edges, and appropriate precautions shall be taken to avoid contact. Personnel shall wear work gloves and avoid placing hands between objects. Appropriate footwear shall be worn.

Task	Hazards	Hazard Control
Scabbling Structural Members or metal plate surfaces	***Chemical Hazards***—Possible lead in paint	Metal surfaces may have been painted with lead-based paint. No cutting, sanding, or grinding of painted surfaces until determination of paint is made.
	Physical Hazards—Slip, trips, falls, tools, terrain, or vegetation; uneven walking surfaces; weather hazards, such as ice, snow, and poor visibility.	The work area shall be visually inspected. Slip, trip, and fall hazards shall be either removed or marked and barricaded. Sufficient illumination shall be maintained.
	Radiation Hazards -	Personnel trained in accordance to site radiation protection requirements.
	Working at elevations	If it becomes necessary to scabble areas above ground or floor level, fall protection must be employed anytime work is performed at elevations greater than six feet.
	Noise	Use of hearing protection by operators and personnel in the vicinity is required during this procedure. Sound levels from this operation will likely exceed 90 dBA in proximate locations of this operation..
	Inclement Weather, Heat/Cold Stress.	Workers shall be briefed and cognizant of heat and cold stress symptoms. Fluids will be available to workers. Work rest periods will be established according to ACGIH and NIOSH guidelines.
	Electric Hazards.	Generators will be grounded unless self-grounded. Extension cords will be properly rated for intended use. Prior to any intrusive activity, authorities will be contacted for permits. Elevated parts of machinery, ladders, and antennas will be kept at least 10 ft from overhead electric lines. Qualified electricians will make all electrical installations. A lockout/tagout program will be used for equipment maintenance.
	Vibration	If excessive vibration occurs, use of work gloves designed to absorb vibration will be provided.
	Housekeeping	Materials will be stored to prevent intrusion into the work areas. Work areas will be kept organized and ice, snow, and mud will be cleared from steps to reduce slip hazards.

Task: Decontamination of Equipment

Task	Hazards	Hazard Control
Decontamination of materials and equipment.	*Physical Hazards*: Slip, trips, falls, tools, terrain, or vegetation; uneven walking surfaces.	The work area shall be visually inspected. Personnel shall enter muddy areas cautiously. Slip, trip, and fall hazards shall be either removed or marked and barricaded. Sufficient illumination shall be maintained. Site personnel shall conduct initial walkovers in groups of two at a minimum.
	Inclement Weather, Heat/Cold Stress.	Workers shall be briefed and cognizant of heat and cold stress symptoms. Fluids shall be available to workers. Work rest periods shall be established according to the ACGIH and the NIOSH guidelines.
	Moving mechanical parts from heavy equipment operations.	Personnel shall be made aware of the hazard and shall coordinate carefully during equipment handling operations. Guards shall be kept in place during operation. A safe distance shall be maintained from moving mechanical parts. Appropriate PPE shall be used.
	Strains and sprains from manually lifting and moving.	Proper lifting techniques shall be used such as keeping back straight and lifting with legs. Personnel shall avoid twisting their back, shall use mechanical equipment, or get help from others. The work area shall be visually inspected.
	Noise during the operation of heavy equipment.	A hearing conservation program (CABRERA 2005a) shall be established. High noise areas shall be identified. Hearing protection shall be provided as appropriate.
	Hands or fingers caught between objects; abrasions and lacerations.	Personnel shall be made aware of the hazard and shall carefully coordinate the handling and placement of heavy objects. Materials and objects being handled shall be inspected for rough or sharp edges, and appropriate precautions shall be taken to avoid contact. Personnel shall wear work gloves and avoid placing hands between objects.
	Pressure washing equipment.	Personnel shall be informed of the hazards associated with the operation of pressure washers, including: water under pressure and steam. Personnel shall wear appropriate PPE, including splash protection.
	Fire.	Flammable liquids shall be stored in safety containers. Propane cylinders shall be stored in secured areas outside. Properly rated fire extinguishers shall be placed near fuel storage areas, within site vehicles and the site trailer.
	Housekeeping.	Materials shall be stored to prevent intrusion into the work areas. Work areas shall be kept organized and, if present ice, snow, and mud shall be cleared from steps to reduce slip hazards.

Task: Decontamination of Equipment (continued)

Task	Hazards	Hazard Control
Decontamination of materials and equipment.	*Radiation Hazards*: Potential contact with, ingestion of, or inhalation of radioactive particulates during decontamination activities.	Scrubbing, power washing, or spraying off equipment may result in transfer of radioactive material onto workers' hands, or may generate airborne contamination. Workers shall wear personal monitoring dosimetry. Workers shall use methods that are least likely to disperse contamination and will wear PPE as necessary.
	Chemical Hazards: No chemical contaminants are anticipated.	No action necessary.

Task: Management of IDW

Task	Hazards	Hazard Control
Management of IDW.	*Physical Hazards*: Slip, trips, falls, tools, terrain, or vegetation; uneven walking surfaces.	The work area shall be visually inspected. Personnel shall enter muddy areas cautiously. Slip, trip, and fall hazards shall be either removed or marked and barricaded. Sufficient illumination shall be maintained. Site personnel shall conduct initial walkovers in groups of two at a minimum.
	Inclement Weather, Heat/Cold Stress.	Workers shall be briefed and cognizant of heat and cold stress symptoms. Fluids shall be available to workers. Work rest periods shall be established according to the ACGIH and the NIOSH guidelines.
	Moving mechanical parts from heavy equipment operations.	Personnel shall be made aware of the hazard and shall coordinate carefully during equipment handling operations. Guards shall be kept in place during operation. A safe distance shall be maintained from moving mechanical parts.
		Appropriate PPE shall be used.
	Strains and sprains from manually lifting and moving.	Proper lifting techniques shall be used such as keeping back straight and lifting with legs. Personnel shall avoid twisting their back, shall use mechanical equipment, or get help from others. The work area shall be visually inspected.
	Hands or fingers caught between objects; abrasions and lacerations.	Personnel shall be made aware of the hazard and shall carefully coordinate the handling and placement of heavy objects. Materials and objects being handled shall be inspected for rough or sharp edges, and appropriate precautions shall be taken to avoid contact.
		Personnel shall wear work gloves and avoid placing hands between objects.
	Housekeeping.	Materials shall be stored to prevent intrusion into the work areas. Work areas shall be kept organized and, if present ice, snow, and mud shall be cleared from steps to reduce slip hazards.
	Radiation Hazards: Initial steps of the process involve the handling of exposed soil borings and decon water could present opportunity for direct exposure or transfer of contamination.	Initial PPE assigned for sampling activities will include coveralls, boot covers, gloves, and dosimetry. Sealed drums may be handled in construction attire with dosimetry. IDW drums will have liners installed prior to use. IDW containers leaving the CZ will be surveyed to ensure radiological contamination levels do not exceed those in Table 4-1.
	Chemical Hazards: No chemical contaminants are anticipated.	No action necessary.

APPENDIX F: DAILY SAFETY MEETING FORM

CABRERA SERVICES
RADIOLOGICAL • ENVIRONMENTAL • REMEDIATION

Daily Safety Toolbox Meeting	
Project Name:	Project Number:
Location:	Date/Time:
General Scope of Work:	

Emergency Telephone Numbers		
Police:	Fire:	Ambulance:
Other (UXO, Facility, etc.):		
Name:	Phone #:	
Name:	Phone #:	
Name:	Phone #:	
Name:	Phone #:	

Day's Work Tasks	
Task 1:	Task 2:
Task 3:	Task 4:
Task 5:	Task 6:
Training Requirements:	

Safety and Health Information					
Job Safety Analysis Completed for this Work?			Yes		No
RWP Permit:		Yes		No	RWP #______________
Confined Space Permit:		Yes		No	#___________________
Radiation Hazards:					
Chemical Hazards (including marking tape, decon agents, etc.):					
Physical Hazards:					
Work Control Methods (JHA, Work Plan, monitoring, etc.):					
PPE:					
Special Equipment (Generators, ISOCS, Backhoes, etc.):					
Types of Communication:					
Special Topics:					

Safety and Health Information (continued)			
Lessons Learned from Previous Day:			
Questions and Feedback from Attendees:			
Meeting Conducted By	**Printed Name**	**Signature**	**Company**
CABRERA Field Lead			
Radiological Lead			
Safety and Health Rep			

Meeting Attendees

Print Name	Signature	Company

Signature indicates that the employee understands the content of the briefing, has been given the opportunity to ask questions, provide feedback or raise concerns, and has completed the specified training requirements.

2/14/2002

APPENDIX C

SURVEY RESULTS AND FORMS

Scan Information Sheet

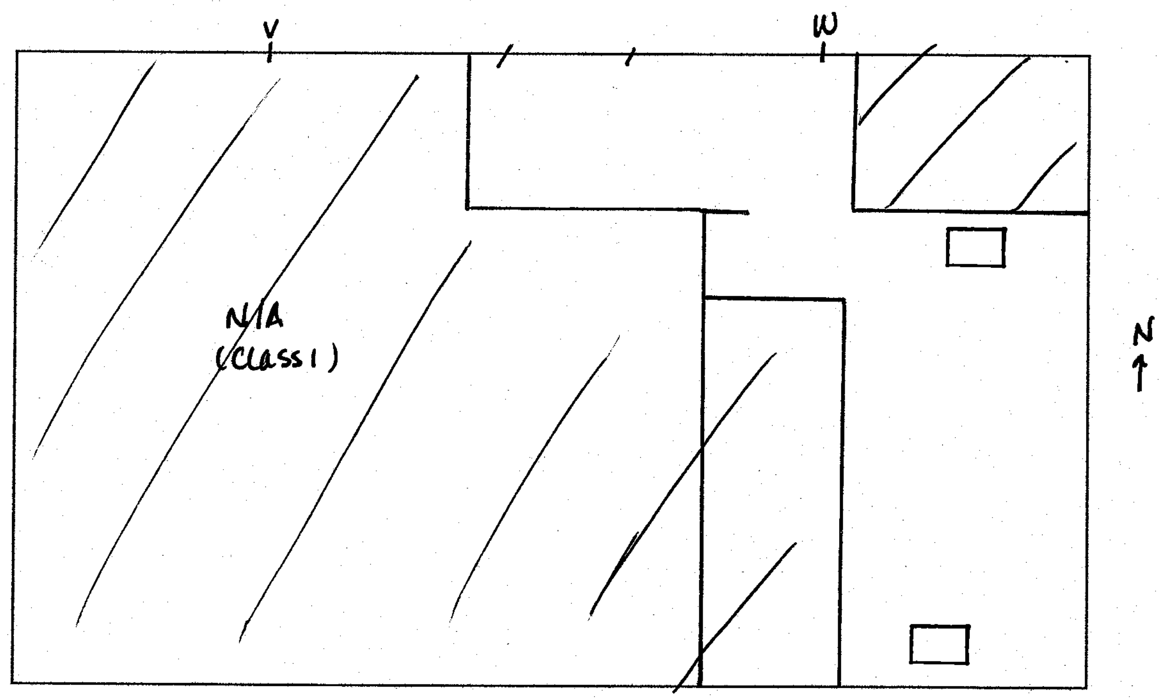
SU/Room: 5-R3/554W

Class: 3

Tech Init.: PR, GB

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm

- Private office area, kept locked
- Floor VAT, walls PCB



Notes: Floor Survey (43-37/2360, #184938)
α-survey: ≤ bkgd.
βavg: 400 cpm
βmax: 500 cpm
γ-survey: ≤ bkgd. (44-3/2221, #163673)

Wall Survey (43-37/2360, #193675)
α-survey: ≤ bkgd.
βavg: 500 cpm
βmax: 600 cpm

Tech Signature: [signature]

Date: 3/15/07

Scan Information Sheet

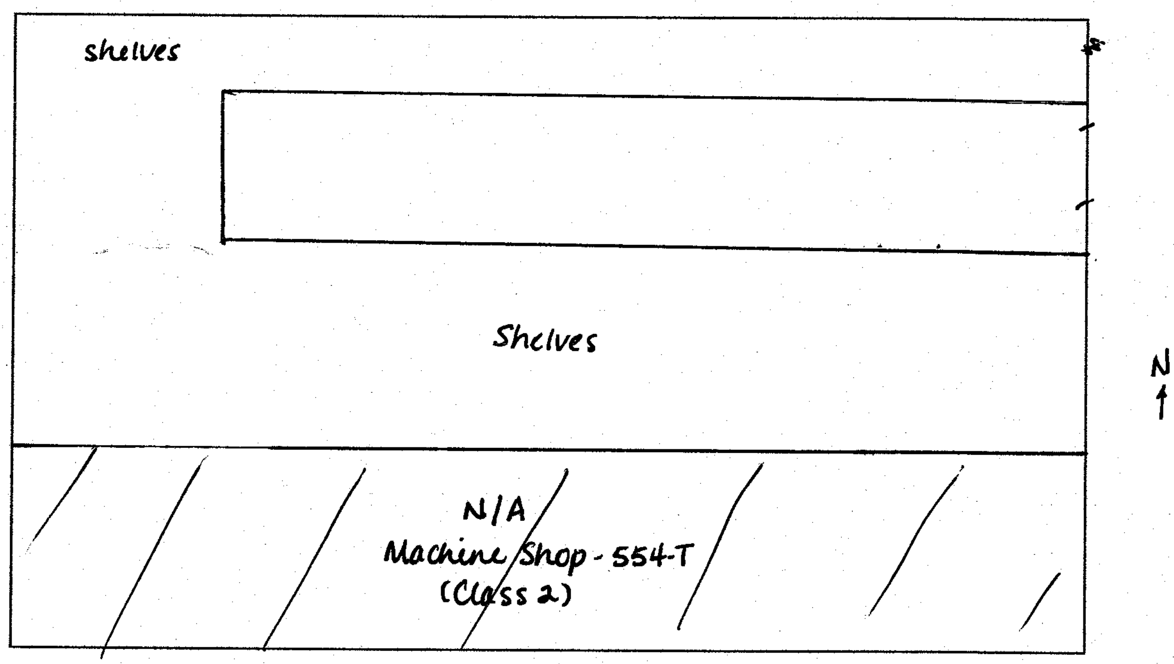
SU/Room: 5-R3/554-U

Class: 3

Tech Init.: PR, GB

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm

- Machine Shop anteroom.
- Floor VAT, walls PCB.



Notes: Floor Survey (43-37/2360, # ~~184938~~ 193675) γ-survey: ≤ bkgd (44-3/2221, # 163673)
α-survey: ≤ bkgd βavg: 400 cpm βmax: 450 cpm
Wall Survey (43-37/2360, # 193675
α-survey: ≤ bkgd. βavg: 400 cpm βmax: 450

Tech Signature: [signature]

Date: 3/15/07

Scan Information Sheet

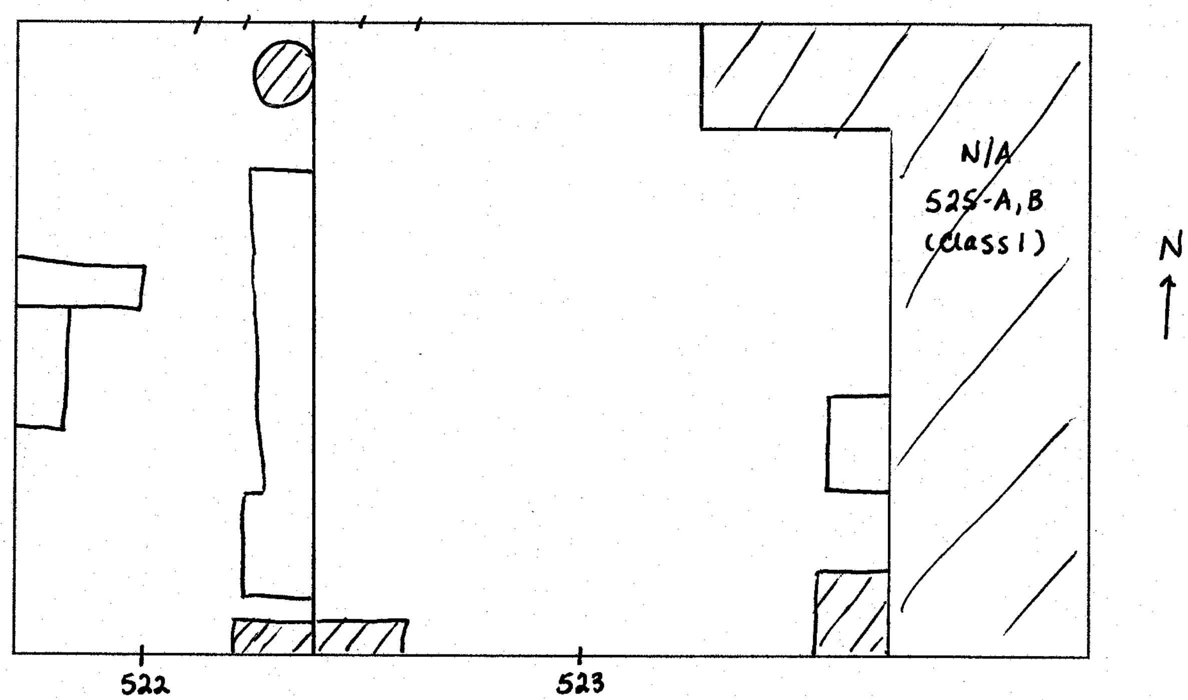
SU/Room: 5-R3/522-523

Class: 3

Tech Init.: PR, GB, MD

(Redrawn to exclude 525A-B)

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm



Notes: Floor Survey: (43-37/2360, #184938) γ-survey: ≤ bkgd. (~~43-3~~ 44-3/2221, #163673)
α-survey: ≤ bkgd. βavg: 500 cpm βmax: 600 cpm

Wall Survey: (43-37/2360, #193675) α-survey: ≤ bkgd. βavg: 400 cpm βmax: 550 cpm } 522

(43-68/2224, #161781) α-survey: ≤ bkgd. βavg: 210 cpm βmax: 250 cpm } 523

Tech Signature: [signature]

Date: 3/7/07
3/9/07

Scan Information Sheet

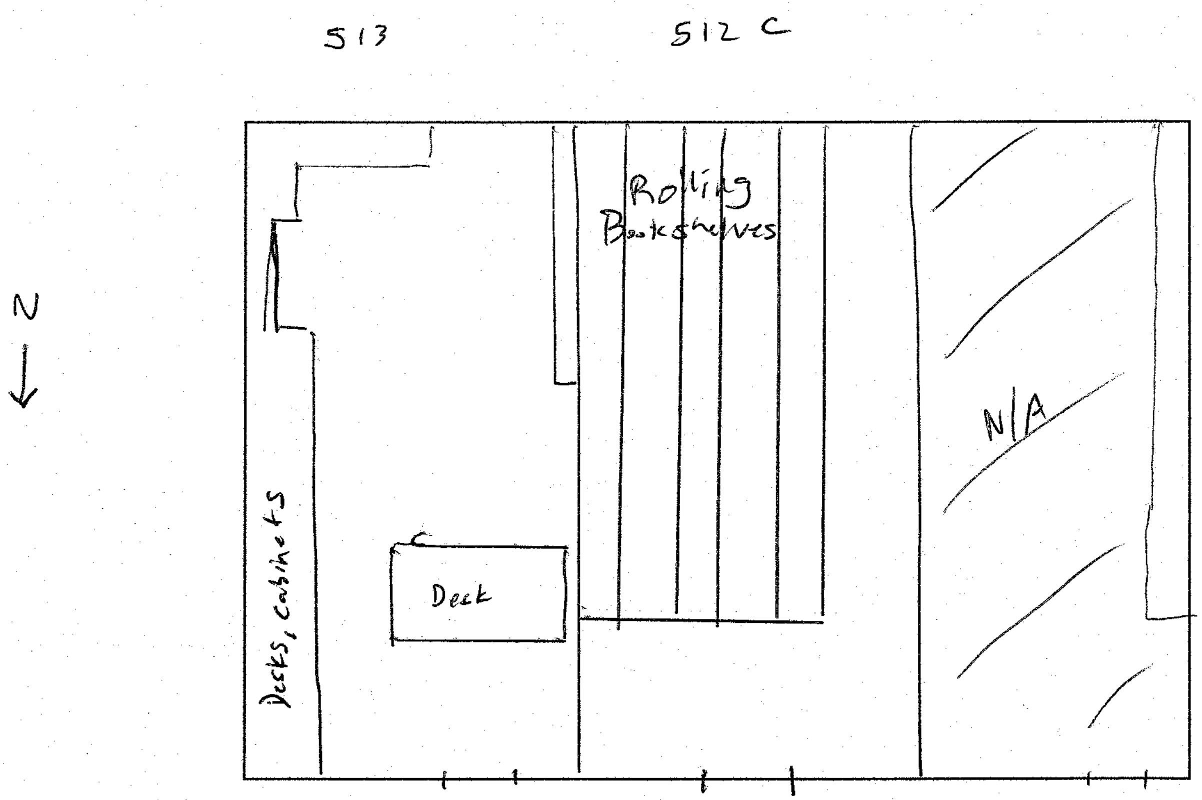
SU/Room: 5-R3 / 513, 512C

Class: 3

Tech Init.: GB

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm

- Library Area / Reading Room, private office.
- Floor carpet, walls PCB.



Notes: Floor is carpet. Floor survey performed with 43-37/2360 #184938
α survey ≤ background, beta average = 450 cpm, beta max = 550 cpm
Wall survey performed with 43-37/2360 # 193675
α survey ≤ background, beta average = 400 cpm, beta max = 600 cpm

γ-survey: ≤ bkgd. (~~43-3~~ 44-3/2221, #163673)

Tech Signature: [signature]

Date: 3/7/07

Scan Information Sheet

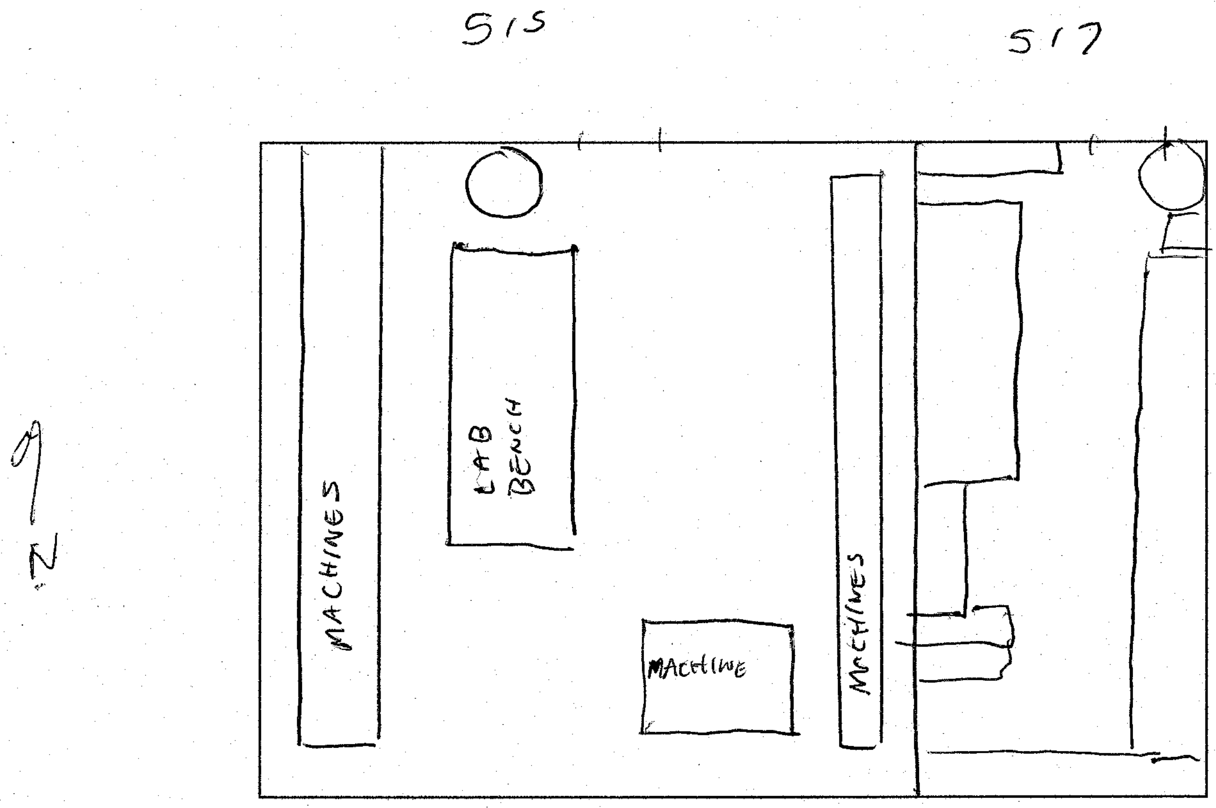
SU/Room: 5-R3/515, 517

Class: 3

Tech Init.: GB

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm

- Lab Areas.
- Floor VAT, Walls PCB.



Notes: Floor survey → 43-37/2360 #184938 | γ-survey: ≤ bkgd. (~~43-3~~ 44-3 /2221, #163673) PB 3/7/07

α Survey ≤ bkgd | β ave - 500 cpm, β max - 600 cpm

Wall survey → 43-37/2360 # 183625

α Survey ≤ bkgd | Walls, machines β ave - 400 cpm, β max - 500 cpm } lab counter | β ave - 200 cpm, β max - 300 cpm } remainder

Tech Signature: [signature] Date: 3/7/07

Scan Information Sheet

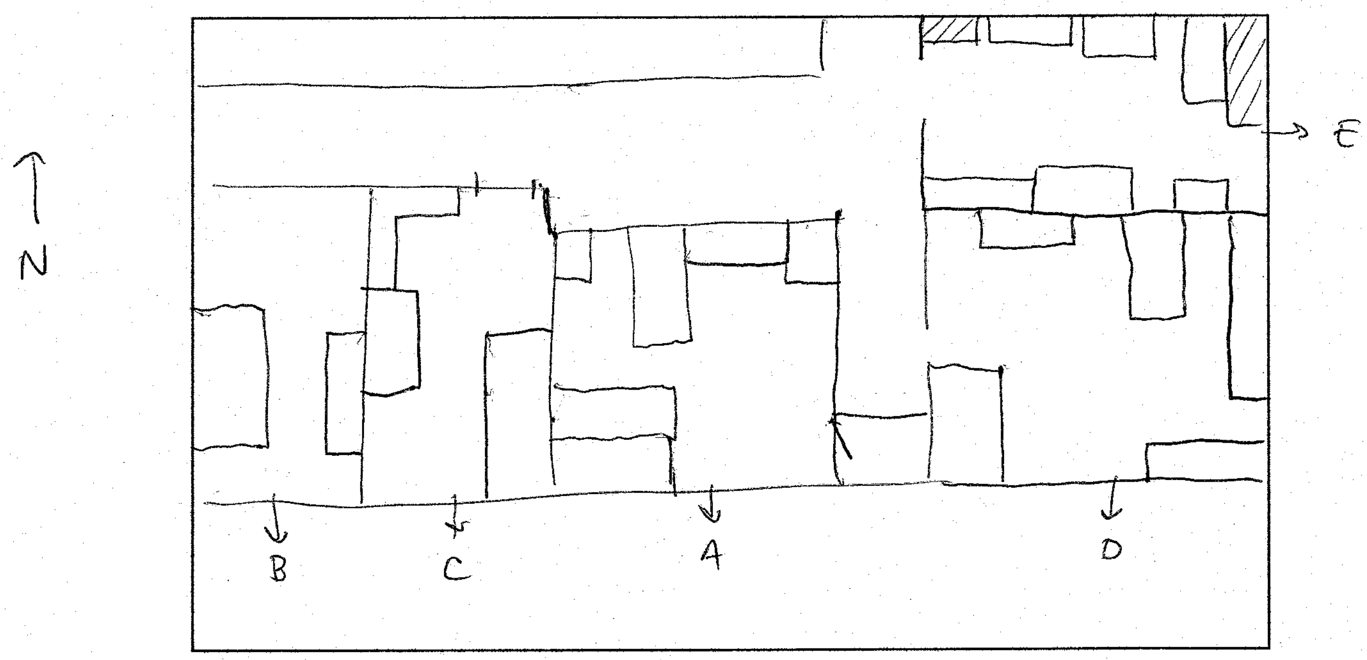
SU/Room: 5-R3/528 A-E and hallway

Class: 3

Tech Init.: [signature initials]

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm

- Offices
- Floor VAT, walls PCB.



Notes: Floor survey · 43-37/2360 #184938

α survey · ≤ Bkgd   β ave - 500 cpm   β max 600 cpm

Wall survey → 43-37/2360 # 193675

α Survey ≤ Bkgd   β ave 400 cpm   β max 550 cpm

γ-survey : ≤ bkgd. (~~43-3~~/2221, #163673) 44-3 PR 3/7/07

Tech Signature: [signature]

Date: 3/7/07

Scan Information Sheet

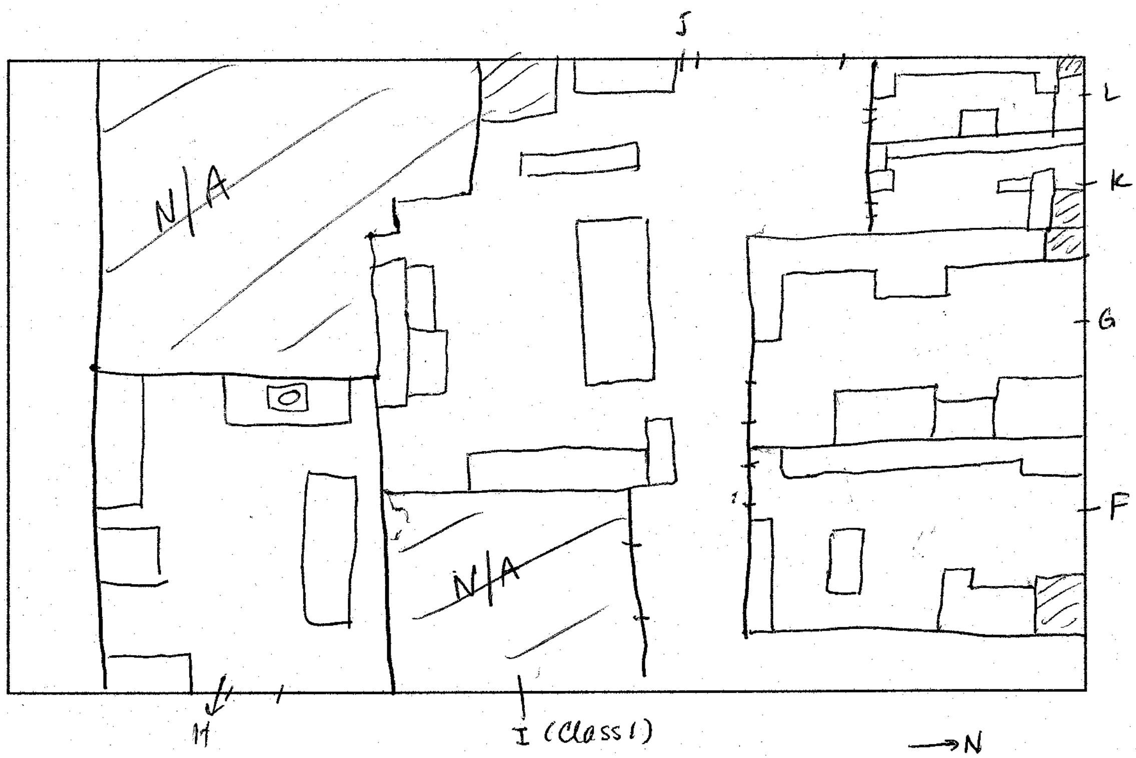
SU/Room: 5-R3/528#L

Class: 3

Tech Init.: GB

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm

- Offices, breakroom, hallway
- Floors VAT, walls PCB.



Notes: Floor survey - 43-37/2360 #184938
α survey - ≤ bkgd
βave - 450 cpm
βmax - 600 cpm

γ- survey : ≤ bkgd
(~~43-3~~/2221, #163673)
44-3

Wall survey - 43-37/2360 #193675
α survey: ≤ bkgd
βavg: 450 cpm
βmax: 550 cpm

Tech Signature: [signature]

Date: 3/7/07

Scan Information Sheet

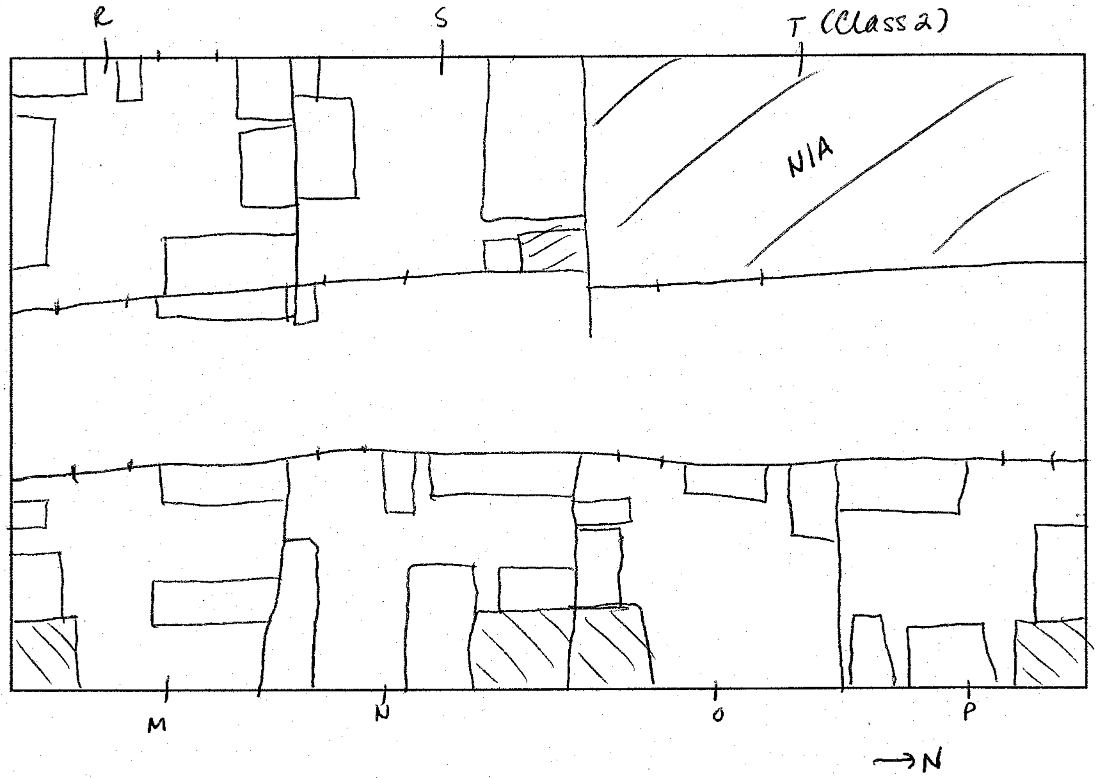
SU/Room: 5-R3/528M-P, R-S

Class: 3

Tech Init.: [signature]

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm

- Offices, hallway
- Floors VAT, walls PCB



Notes: Floor survey - 43-37/2360 #184938

α survey: ≤ Bkgd (see side note) β_{avg}: 500 cpm β_{max}: 550 cpm Note: Exception to floor α survey Rm 528M α ≤ release criteria

Wall Survey - 43-37/2360 # 193675

α survey: ≤ bkgd β_{avg}: 450 cpm β_{max}: 600 cpm

γ-survey: ≤ bkgd. (~~43-3~~ 44-3 /2221, #163673) DR 3/7/07

Tech Signature: [signature]

Date: 3/7/07

Scan Information Sheet

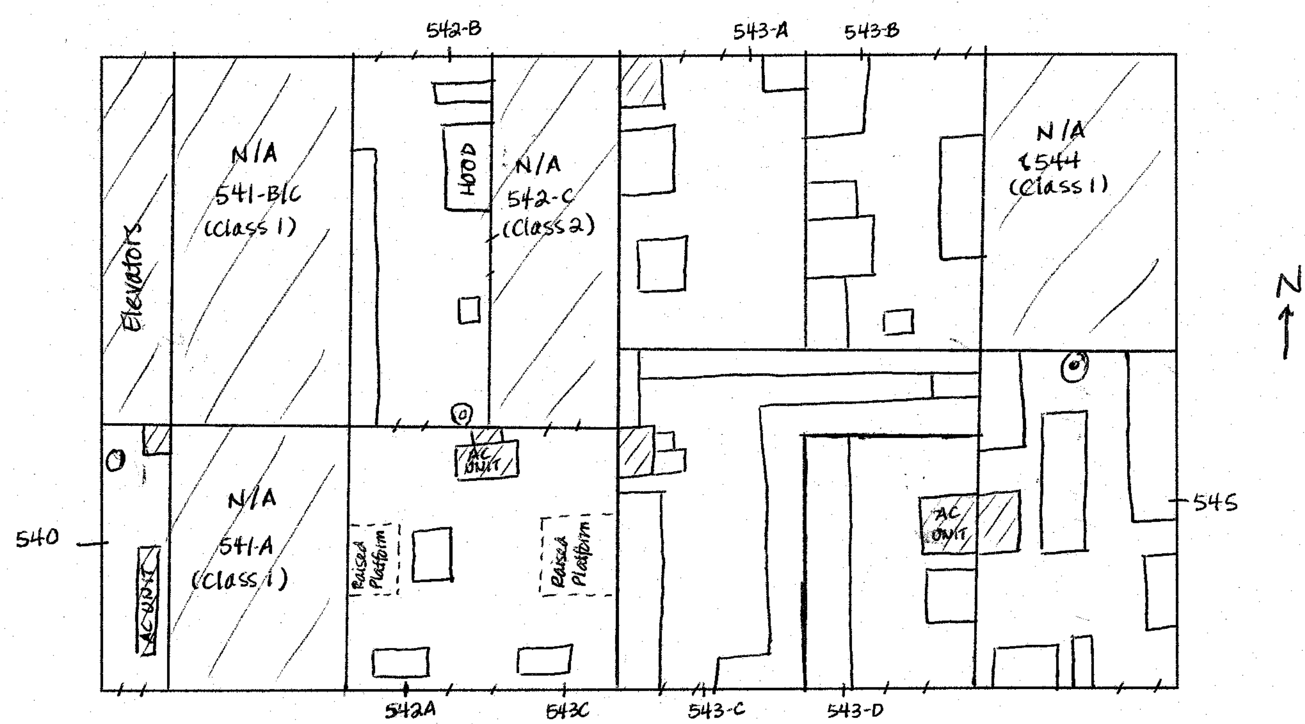
SU/Room: 5-R3/542-A/B, 543-A-D, 545, 540

Class: 3

Tech Init.: PR, GB

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm

-Offices, lab areas, computer lab, storage
-Floors VAT, walls PCB



Notes: Floor Survey (43-37/2360, #184938) γ-survey (~~43-3~~ 44-3 PR 3/8/07 /2221, #163673)
α-survey: ≤ bkgd βavg: 400-450 cpm βmax: 600 cpm ≤ bkgd
Wall Survey (43-68/2224, #161781)
α-survey: ≤ bkgd βavg: 200 cpm βmax: 250 cpm

Tech Signature: [signature] Date: 3/8/07

Scan Information Sheet

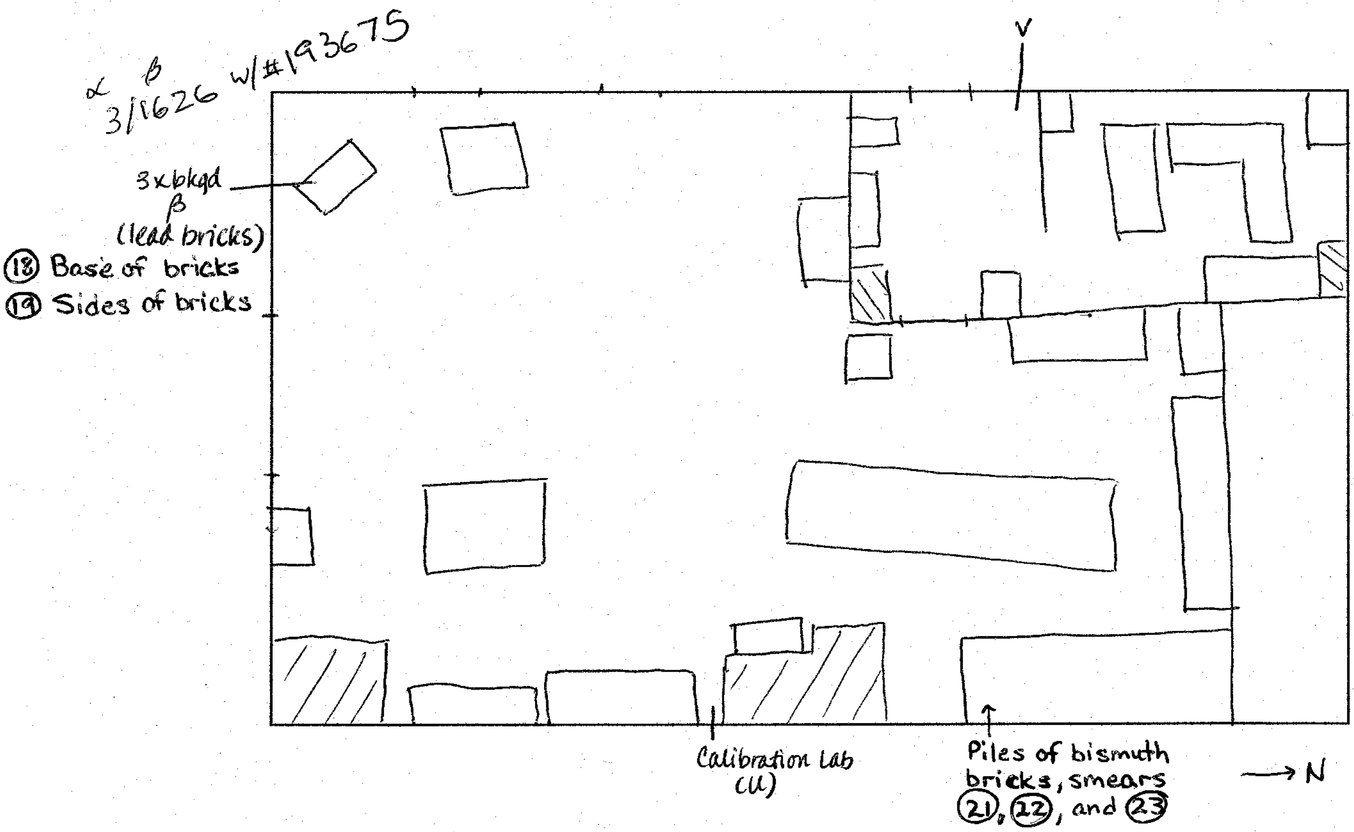
SU/Room: 5-R3/528 U-V

Class: 3

Tech Init.: GB

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm

- Calibration Laboratory
- Floor VAT, walls PCB



Notes: Floor survey - 43-37/2360 #184938 γ-survey: ≤ bkgd (~~43-3~~ 44-3 DR 3/7/07 2221, #163673)

α survey: ≤ Bkgd β avg: 500 cpm β max: ~~1600~~ GB 3/7/07 700 cpm

Wall survey - 43-37/2360 #193675

α survey: ≤ bkgd β avg: 500 cpm β max ~~1600~~ DR 3/7/07 550 cpm (not including hot spot)

Tech Signature: [signature]

Date: 3/7/07

Scan Information Sheet

SU/Room: 5-R3/ 546 (5AC-3)

Class: 3

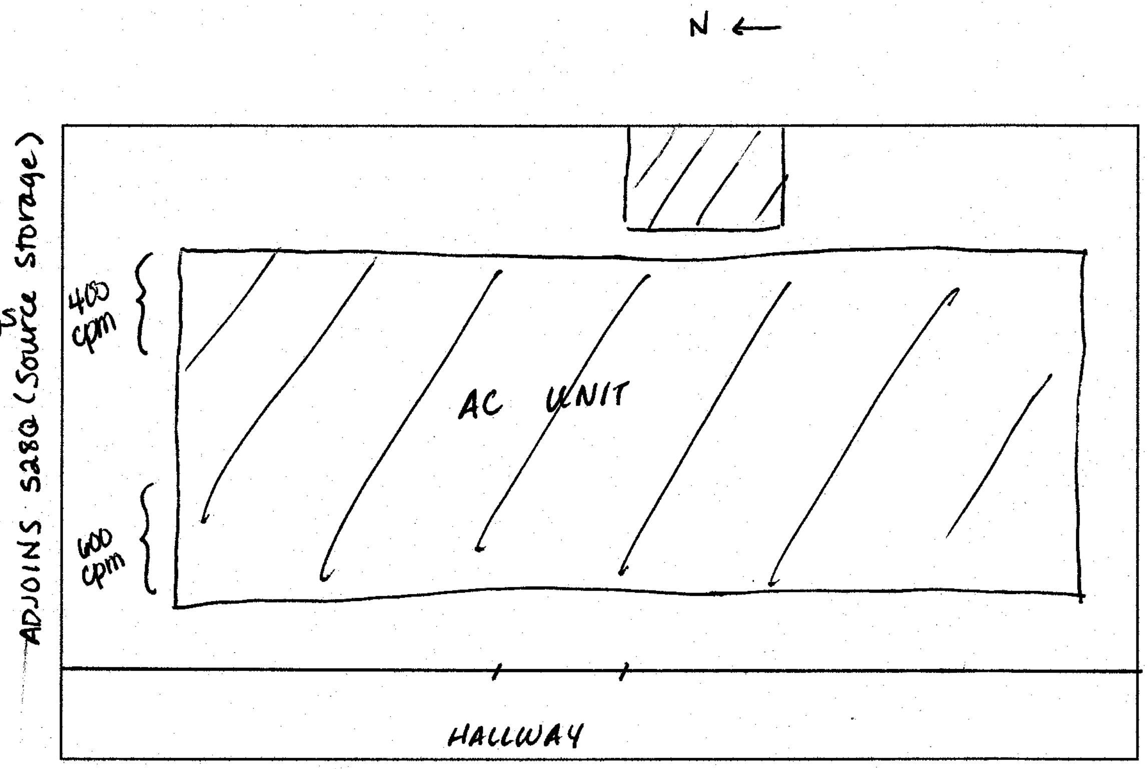
Tech Init.: PR, GB

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm

- Machine/electrical room

walls - painted concrete cinderblock
floors - painted concrete

After removal, wall readings same as all other areas



Notes: Floor survey (43-68/~~2360~~ 2224, #~~184~~ 161781) γ-survey (~~43-3~~ 44-3/2221, #163673) ≤ bkgd. except for N wall, slightly higher

α-survey: ≤ bkgd   βavg: 600 cpm, βmax: 600 cpm } N wall/floor   150 cpm, 250 cpm } All other areas

Wall survey (SAA)

α-survey: ≤ bkgd.   βavg: 600 cpm, βmax: 600 cpm } N wall/floor   200 cpm, 250 cpm } All other areas

200 (avg), 200 ~~bkg~~ (max) } AC unit

Tech Signature: [signature]   Date: 3/9/07

Scan Information Sheet

SU/Room: 5-R3/547-547A, 548, 549, 550

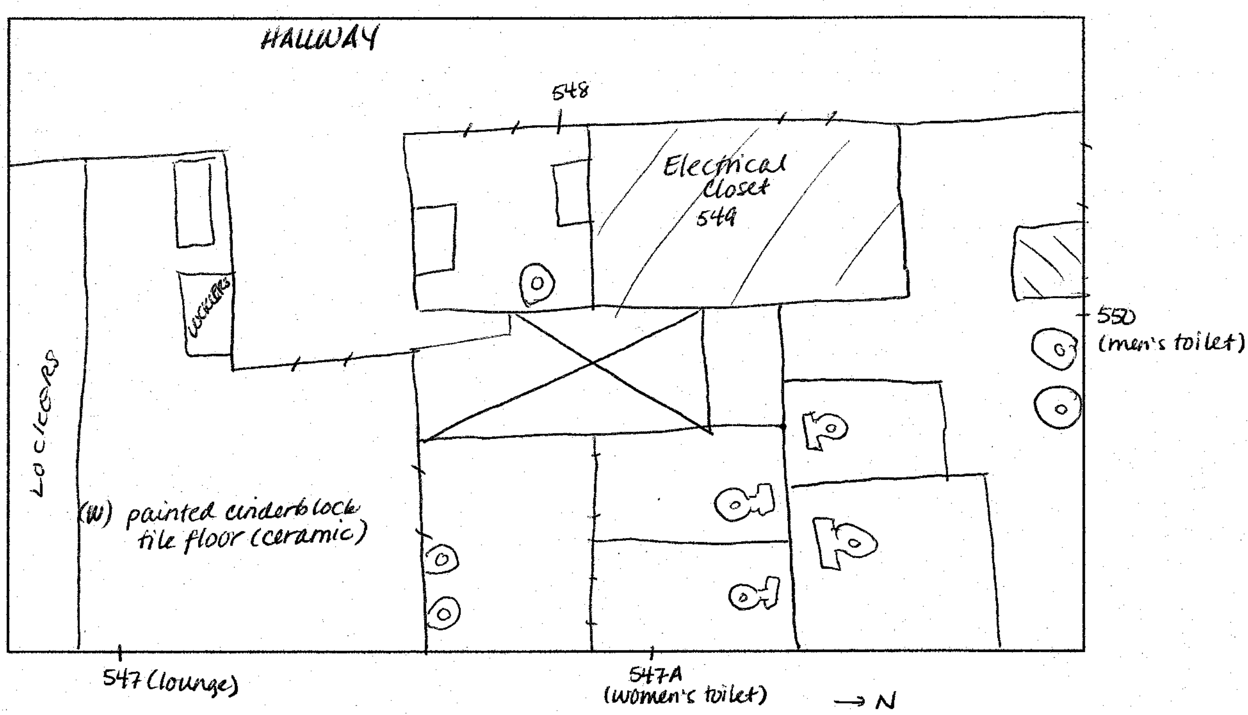
Class: 3

Tech Init.: PR, GB

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm

- East restrooms, janitor's closet.
- Both bathrooms made of similar material, which shows a slightly higher than average background (ceramic).

(o) = sink
(o) = toilet



Notes: Floor survey (43-37/2360, #161781)

α-survey: ≤ release criteria; β_{avg}: 1000 cpm, β_{max}: 1500 cpm {L.R. 1000, 547A 1400} M.R. 550

γ-survey (44-3/2221, #163673) ≤ release criteria

Wall survey (43-68/2224, #161781)

α-survey: ≤ bkgd. β_{avg}: 400 cpm, β_{max}: 500 cpm

Tech Signature: [signature]

Date: 3/8/07

Scan Information Sheet

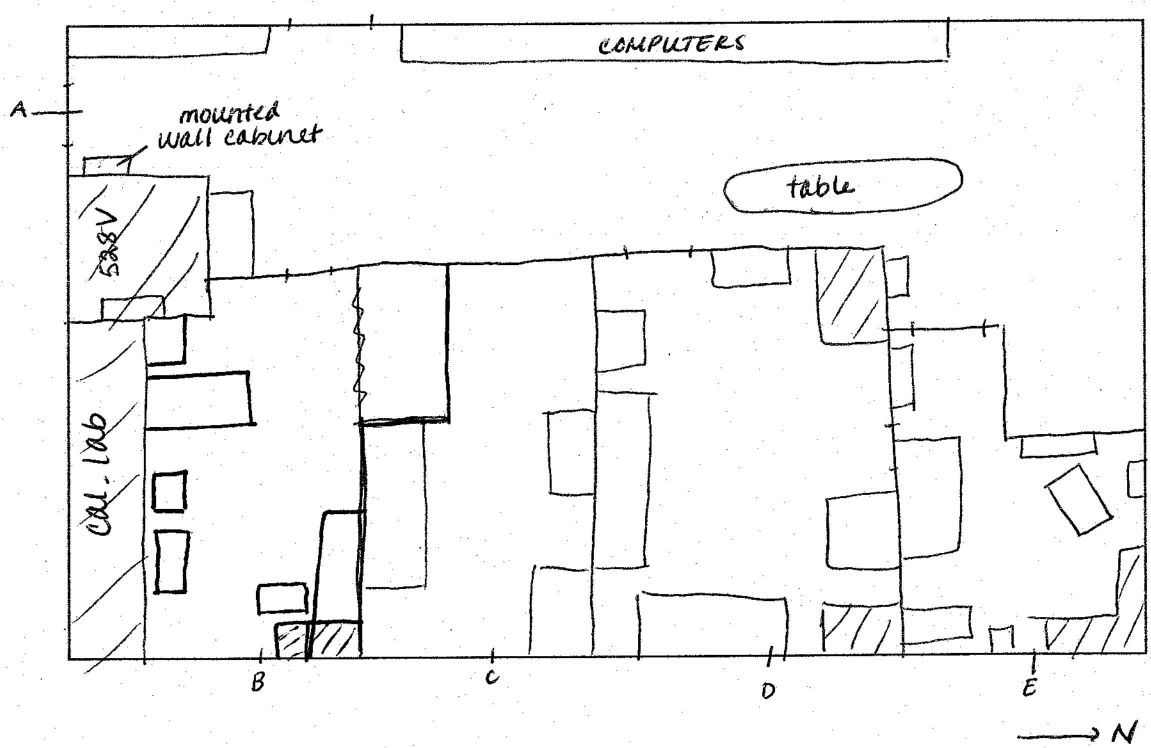
SU/Room: 5-R3/551A-E

Class: 3

Tech Init.: CB

Note:
1. On map: draw dimensions and characters
2. Record scan data for different surfaces
3. Mark all areas > Action Level (include sample ID)
4. Record avg and max observed cpm

- Offices, hallways/gathering space.
- Floors VAT, walls PCB
- 551B used regularly for experiments that include use of rad sources (sealed).
- Mounted wall cabinet near ~~N~~ SW entrance once contained displays of rad instruments/items (now empty). It was scanned and shows background levels.



Notes: Floor Survey - 43-37/2360 # 184938
α-survey: ≤ Bkgd
β avg: 500 cpm
β max: 600 cpm
γ-survey (~~43-3~~ 44-3/2221, # 163673)
≤ bkgd.

Wall Survey - 43-37/2360 # 193675
α-survey: ≤ Bkgd
β avg: 500 cpm
β max: 600 cpm

For 551B: (43-68/2224, # 161781)
β avg: 150 cpm
β max: 200 cpm

Tech Signature: [signature]

Date: 3/7/07
3/9/07