APPENDIX A

FINAL STATUS SURVEY PLAN
NATICK SSC

FINAL STATUS SURVEY PLAN

Natick Soldier Center – Research Development and Engineering Command at
Soldier Systems Center,
Natick, MA

USA Project 2005-030

Prepared for:

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

Prepared by:

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

473 Silver Lane
East Hartford, CT 06118

November 2006

TABLE OF CONTENTS

LIST OF TABLES ..... **iii**

LIST OF APPENDICES ..... **iii**

ACRONYMS AND ABBREVIATIONS ..... **iv**

1.0 INTRODUCTION **1**

1.1 OBJECTIVE 1
1.2 SITE BACKGROUND 2
1.3 RADIONUCLIDES OF CONCERN 3

2.0 DATA QUALITY OBJECTIVES **4**

2.1 STEP 1: STATE THE PROBLEM 4
2.2 STEP 2: IDENTIFY THE DECISION 4
2.2.1 Principal Study Question *4*
2.2.2 Decision Statements *4*
2.3 STEP 3: IDENTIFY INPUTS TO THE DECISION 4
2.4 STEP 4: DEFINE THE STUDY BOUNDARIES 5
2.5 STEP 5: STATE THE DECISION RULES 5
2.5.1 Surface Radioactivity Scan Surveys *5*
2.5.2 Residual Radioactivity *5*
2.6 STEP 6: DEFINE ACCEPTABLE DECISION ERRORS 5

3.0 SURVEY DESIGN AND METHODOLOGY **7**

3.1 DETERMINE IMPACTED AND NON-IMPACTED AREAS 7
3.2 AREA CLASSIFICATION BASED ON CONTAMINATION POTENTIAL 7
3.3 STATISTICAL TESTS 7
3.3.1 Sign Test *7*
3.3.2 Application of Sign Test for Multiple Surfaces *8*
3.3.3 Performing the Sign Test *8*
3.4 ELEVATED MEASUREMENT COMPARISON 9
3.5 SURVEY UNIT BREAKDOWN 9
3.6 SURVEY UNIT COVERAGE 10
3.7 RELEASE CRITERIA 11
3.7.1 Surface Contamination DCGLs *11*
3.8 SAMPLING GRID LAYOUT 11
3.8.1 Relative Shift *11*
3.8.2 Number of Sampling Points *12*
3.8.3 SU Grid Spacing *13*
3.9 BACKGROUND SURVEY AREAS 14
3.10 SURVEY METHODS AND INSTRUMENTATION 14
3.10.1 Surface Beta Radioactivity Scans *14*
3.10.2 Fixed-Point Measurements *16*

3.10.3 Smear Sample Collection and Analysis *16*

4.0 SURVEY QUALITY ASSURANCE / QUALITY CONTROL (QA/QC) 18

4.1.1 General *18*
4.1.2 Instrument Calibration *18*
4.1.3 Daily QC Checks *18*
4.1.4 Analytical Support Services *18*

5.0 REFERENCES 20

LIST OF TABLES

Table 1-1. Radionuclides of Concern 3

Table 3-1. Surface Activity DCGLs for Natick SSC Final Status Survey 11

Table 3-2. Summary of MARSSIM Design Parameters for the Site FSS 12

Table 3-3. FSS Detector Probe Characteristics 14

LIST OF APPENDICES

APPENDIX A: Survey Unit Sampling and Analysis Matrix

APPENDIX B: Maps of Impacted Areas with MARSSIM Classifications

APPENDIX C: Calculation of Minimum Detectable Concentrations

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
AJMC	U.S. Army Joint Munitions Command
ARIEM	Army Research Institute for Environmental Medicine
^{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
dpm	disintegrations per minute
$dpm/100cm^2$	disintegrations per minute per 100 centimeters squared
DQO	Data Quality Objective
EMC	Elevated Measurement Comparison
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
NSC	Natick Soldier Center

QA	Quality Assurance
QC	Quality Control
RAM	radioactive materials
RDECOM	Research and Development Engineering Command
ROC	Radionuclide of Concern
SBCCOM	U.S. Army Soldier, Biological and Chemical Command
SOP	Standard Operating Procedure
SOR	Sum of the Ratios (equivalent to the sum of the fractions)
SSC	Soldier Systems Center
SU	Survey Unit
WRS	Wilcoxon Rank Sum (statistical test)

1.0 INTRODUCTION

Cabrera Services, Inc. (CABRERA) is under contract to the U.S. Army Joint Munitions Command (AJMC), formerly known as the U.S. Army Field Support Command, to complete project tasks in accordance with CABRERA project proposal number 05-076 Rev. 4, dated 14 April, 2006 (AJMC Project Number *USA 2005-030)*. The AFSC requires the preparation and implementation of a Final Status Survey Plan (FSSP) to address the radiological status of the Research Building (also known as Building 3), the Health Clinic Building (also known as Building 30), and the Low Level Radiation Storage Area (also known as Building 89) located at the Natick Solider Center (NSC) - Research and Development Engineering Command (RDECOM) at Soldier Systems Center (SSC) in Natick, Massachusetts. The NSC is the U.S. Nuclear Regulatory Commission (NRC) materials license holder, has responsibility for these structures, and plans to decommission them for license termination purposes. The project plans consist of the FSSP herein and a project Site Specific Health and Safety Plan. Data collected from this FSSP will be used to develop a Final Status Survey Report for use by AFSC in obtaining unrestricted release of NRC licensed areas, in accordance with NRC regulations and guidance

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

FSS activities, involving work with radioactive materials, will be performed in accordance with CABRERA's Radiation Protection Program, but will be regulated under NSC's NRC materials license.

1.1 Objective

The objective of this Final Status Survey (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 are less than the limits for unrestricted release.

1.2 Site Background

The SSC is a 76-acre facility located in Natick, Massachusetts. The SSC occupies a peninsula on the eastern shore of Lake Cochituate state park and recreational area and is bordered on the north and west by a residential area. The Army purchased the site in 1949 from the Metropolitan District Commission. At the time of purchase, the property was primarily used as a forested recreational area. The Army built the SSC in 1954 and has since used the area for industrial, laboratory, and storage activities for research and development in the areas of food science, aeromechanical, clothing, material, and equipment engineering. During its operation, the Army used a variety of substances including radioactive material and the volatile organic compounds (VOCs) tetrachloroethene, trichloroethene, carbon disulfide, benzene, chloroform, and acetone; "standard laboratory chemicals;" mineral spirits/turpentine; paints; inks; lubricants; gasoline; tetraethyl lead, a gasoline additive; pesticides; and metal dusts. Radioactive materials were used for food irradiation, tracer studies and clothing absorption tests, respectively.

The SSC also operated a medical waste incinerator. The incinerator was used to destroy about 1500 pounds of pathological wastes in CY 2000. Since 1973 the facility has operated a Jarvis model 150 pathological waste incinerator in Building 42 (Army Research Institute of Environmental Medicine (ARIEM)). This was replaced with a similar unit in 1990 in the same building. The unit is permitted to burn up to 876,000 pounds per year of pathological waste. Another research animal waste incinerator began operation in 1973 in Building 30 and was retired in 1992. That unit also burned scintillation solvent waste that was contaminated with radioactive materials from various radiological procedures and tests.

The facility has a long history of radioactive material use. Early Atomic Energy Commission (AEC) licensing records indicate radioactive material use as early as 1955. Radioactive material work involved primarily radioisotopes commonly used for biological research and related sealed sources that support materials research such as detection, calibration, and irradiation.

The facility is a U.S. Army facility that is mainly a research and development facility. The radioactive material and uses have dramatically reduced over the last 10 years. The reduction in program scope has been archived by numerous license amendments documenting the reduction in the number, type and quantities of radioactive material. Over the past 5 to 10 years the number of authorized use locations within the facility have also been reduced. Current levels of activity consist of a small number of bioscience laboratories with Army Research Institute for Environmental Medicine (ARIEM) located in Building 42 under a separate NRC license. Present day use is limited to Building 42 where microcurie (mCi) level experiments using I-125 are conducted. Radiation safety programmatic activities within Building 30 (Health Clinic) ceased with NRC's separate license authorization issued to ARIEM in 2004 and Building 89 is no longer used for radioactive waste storage.

A Historical Radiological Assessment (HRA) was conducted by CABRERA (CABRERA,

2004). The results of this assessment for the Research and Health Clinic Buildings identify two potential radiological contaminants of concern as listed in Section 1.3.

1.3 Radionuclides of Concern

From the review of records of licensing, inventory, operations, and radiological safety in the HRA, it was evident that any significant contamination identified through routine operational Radiological Safety Surveys (RSS) was decontaminated at that time. Common good laboratory practices were used to remove and dispose of contamination as it was generated or discovered. With the use of radioactive material phasing out in the 1970's the only radionuclides that had half-lives long enough to still be present at significant levels today are tritium (^{3}H) and Carbon-14 (^{14}C).

Table 1-1. Radionuclides of Concern

Nuclide	Name	Half-Life	Principal Emissions	Source of Radionuclide
H-3	Hydrogen-3 (tritium)	12.3 yr	0.019 mega electron volts (MeV) beta	Radioisotope research
C-14	Carbon-14	5730 yr	0.156 MeV beta (Research)	Radioisotope research

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 research 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 radionuclides of concern (ROC) in the building exceed applicable levels for unrestricted release?

2.2.2 Decision Statements

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 laboratories 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 RAM 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 (liquid scintillation counter results)
- Exposure rate surveys

2.4 Step 4: Define the Study Boundaries

The populations of interest are the concentrations of research radioisotopes on building surfaces and fixtures. The area of interest is horizontally and vertically limited to impacted areas located inside the buildings 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.

2.5.2 Residual Radioactivity

If residual radioactivity is found in a small discrete area, in addition to residual radioactivity distributed relatively uniformly across the survey unit, the unity rule, also called the Sum of the Ratios (SOR), will be used to ensure that the total dose is within the decommissioning guidance (NRC, 2000). When multiple contaminants are present within a SU, site radiological conditions are evaluated using the SOR and a DCGL of SOR = 1.0. The SOR is calculated as follows:

$$SOR = \frac{(C_1)}{(DCGL_1)} + \frac{(C_2)}{(DCGL_2)} + \frac{(C_3)}{(DCGL_3)} + \ldots$$

Where: $C_{1,2,3..}$ = Concentration of Radionuclides

$DCGL_{1,2,3..}$ = DCGL for that Radionuclide

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 and a HRA 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 were 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 Building 89; Building 3, Rooms 131, 133, 134, 135, 136, 214, 307, 309; Building 30, Rooms 101, 103, 108, and the roof over Room 108, as described in Appendix A.

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 Section 3.8.

Representative background values to be used in the paired observations will be collected in unimpacted areas of the buildings on similar building materials. 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.

3.4 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. Surveys of Class 1 areas are beyond the scope of this FSS effort.

3.5 Survey Unit Breakdown

After the HRA, the impacted areas were assigned six SUs designations based on the classification and physical location of each area.

- 3-1W Building 3, First Floor West, Rooms 131, 133, 134, 135, 136
- 2-3W Building 3, Second Floor West, Room 214
- 3-3E Building 3, Third Floor East, Rooms 307, 309
- 30-1 Building 30, Rooms 101, 103, 108
- 30-roof Building 30, Roof over Room 108
- 89-1 Building 89, all

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..

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.

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 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.

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.

NOTE: All SUs are initially classified as Class 3.

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, or an evaluation will need to be performed to ensure that the prospective dose due to residual radioactivity is not to exceed 25 millirem per year (mrem/yr).

Table 3-1. Surface Activity DCGLs for Natick SSC 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			
NRC NUREG 1757, Vol. 1 Building Surface Screening Values	N/A	N/A	H-3: 1.2 E+08 C-14: 3.6 E+06	10% of Total
Chosen DCGL For Natick SSC	***N/A***	***N/A***	***3,600,000***	***360,000***

Notes:
a. Averaged over 1 m^2
b. Measured at 1 centimeter (cm) from the surface
c. Screening values assumes removable surface contamination of 0.1%
d. Screening values derived using NUREG/CR-5512 Vol.3; Table 5.19 P_{crit} = 0.90 for building surfaces

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	Static Measurement[1] (cpm)	Tritium Smear Test (dpm/100 cm^2)
σ	30,240[2,3]	108,000[2]
DCGL	100,800[3]	360,000
LGBR	50,400	180,000
Relative Shift (Δ/σ)	1.67	1.67
Pr (from MARSSIM Tbl. 5.1)	0.95	0.95
N	14	14
N (including 20% overage)[4]	*17*	*17*

Notes:

1. Static counts to be performed with Ludlum 43-68 proportional detector. Count time = 30 sec.
2. Sigma values for static measurements and tritium smear tests were set at 0.3 times the DCGL to account for potential added variability (see Section 3.3.2)
3. 100,800 counts per minute (cpm) is equivalent to the beta DCGL of 3,600,000 disintegrations per minute per 100 centimeters squared (dpm/100 cm^2) assuming 2.8 % C-14 efficiency for the Ludlum 43-68 probe.
4. 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 static measurements and the tritium smear analysis 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 43-37 Floor Monitor (239-1F)	Smooth floor surfaces	Gas Proportional	Alpha, Beta	582
Ludlum 44-110 Gas Proportional Tritium Detector	Direct Static Measurements Only – no scans	Gas Proportional	Low Energy Beta	100
Ludlum Model 19, Ludlum 44-2 (or equivalent)	Gamma radiation scans and counts	Micro-R Exposure Rate (1-inch by 1-inch Sodium Iodide [NaI])	Gamma	N/A
LSC	Removable beta contamination measureements	Liquid scintillation	beta	N/A

3.10.1 Surface Beta Radioactivity Scans

Applicability:

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

Instrumentation:

The following detectors, which will have the ability to detect C-14 and higher-energy beta particles, 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

In addition, Ludlum 44-110 windowless gas-proportional detectors will be used for direct static measurements of H-3.

Scan measurement sensitivities are presented in Appendix C.

Technique:

The surfaces will be scanned for C-14 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.

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 30 second static measurement at the location ("biased count") for beta/alpha;
- A 30 second static measurement with a fixed tritium detector; and
- A "biased" smear sample to be analyzed (LSC) for potential nuclides of interest.

Data Recording:

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.

3.10.2 Fixed-Point Measurements

Applicability:

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/random, gridded survey or as biased measurements to investigate elevated scan readings.

Instrumentation:

Ludlum 43-68s and 44-110s, or equivalent, will be used to perform and document fixed-point measurements.

Technique:

Fixed-point measurements should be at least 1/2-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 1/2-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 radioactive material 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.

Normally smears should be analyzed via gross alpha/beta and tritium counting in an alpha/beta liquid scintillation counter. If very sensitive alpha/beta analysis is needed, the smears would have to be counted in an alpha/beta gas proportional counter before being analyzed in a Liquid Scintillation Counting (LSC) for ^{3}H and ^{14}C.

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.

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 FFS 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 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

LSC wipe samples will be sent to an acceptable contract laboratory for analysis. The

contract laboratory will be required to maintain an approved QA Program and current Materials License to possess radioactive material.

5.0 REFERENCES

(CABRERA, 2004) *Historical Radiological Assessment, U.S. Army Soldiers System Center, Natick, MA.* Cabrera Services, Inc. February 2004.

(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.

(NRC, 2000) NUREG 1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, U.S. Nuclear Regulatory Commission, August 2000.

(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 of 10CFR20, "*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**	**GPC Beta Scan**	**GPC Static beta count**	**Remov-able Contam. (Smears)**
3-1W	Building 3, First Floor West – Rooms 131, 133, 134, 135, 136	3	c	17 d	17 e (+biased)
3-2W	Building 3, Second Floor West – Room 214	3	c	17 d	17 e (+biased)
3-3E	Building 3, Third Floor East – Rooms 307, 309	3	c	17 d	17 e (+biased)
30-1	Building 30, Ground Floor– Rooms 101, 103, 108	3	c	17 d	17 e (+biased)
30-roof	Building 30, Roof over Room 108	3	c	17 d	17 e (+biased)
89-1	Building 89	3	cc	17 d	17 e (+biased)

TABLE NOTES

a Perform 100% 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.

cc Perform localized scan surveys on incinerator stack sides and in general area on roof around stack.

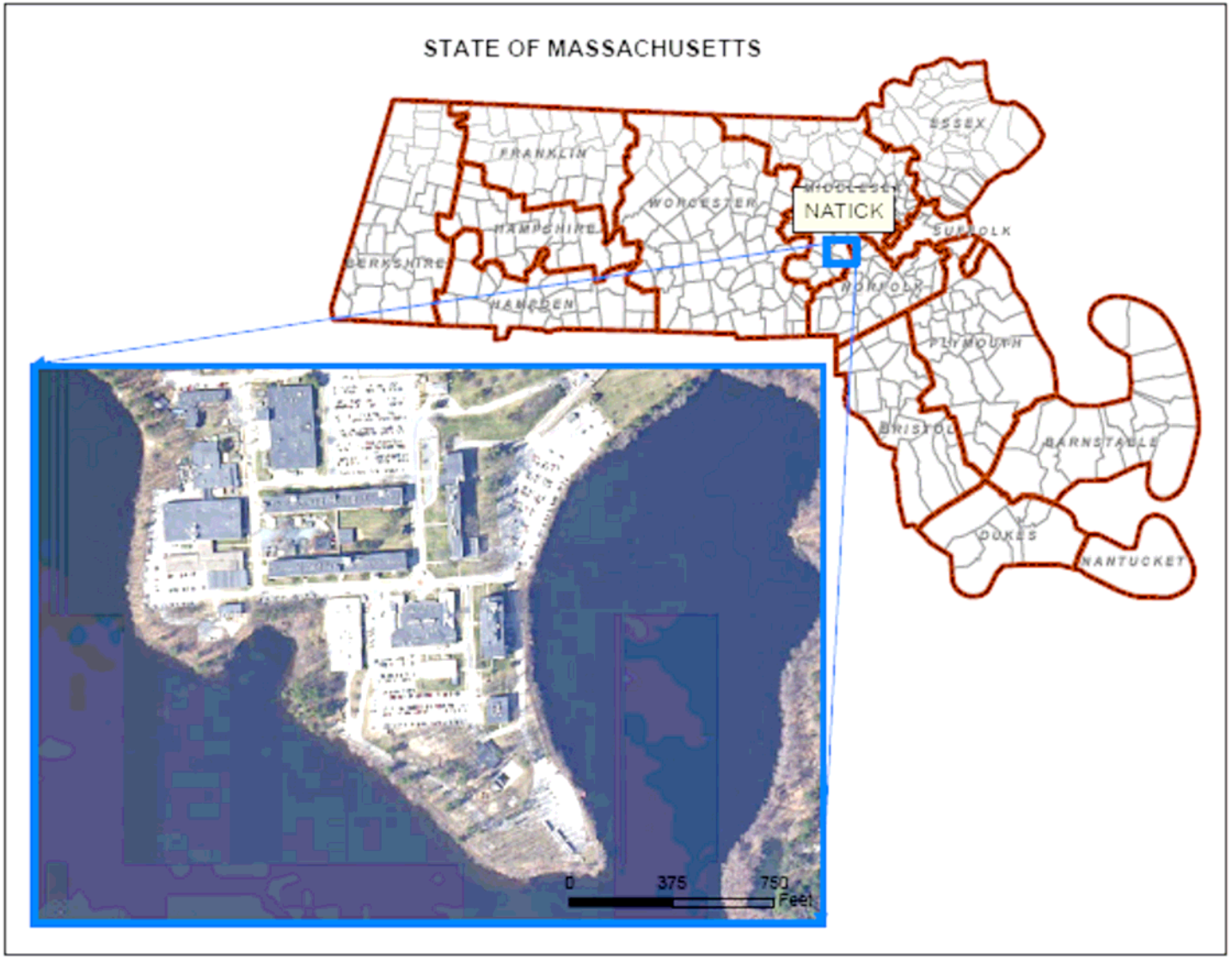
d Fixed, static-count measurements will be performed at systematic or random locations (depending upon SU classification) in the quantities listed in the table with an alpha/beta sensitive instrument and a tritium sensitive instrument (indoors only). A minimum of (1) measurement per room should be performed per physical room, with locations added if systematic/random grid pattern excludes area. NOTE: Fixed tritium counts will not be made on outdoor surfaces.

e Smears for removable contamination will be performed at systematic or random locations (depending upon SU classification) in the quantities listed in the table. An additional biased smear will be performed at the location of the highest scan survey result.

APPENDIX B

Maps of Survey Units with MARSSIM Classifications

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



Legend

County Boundaries

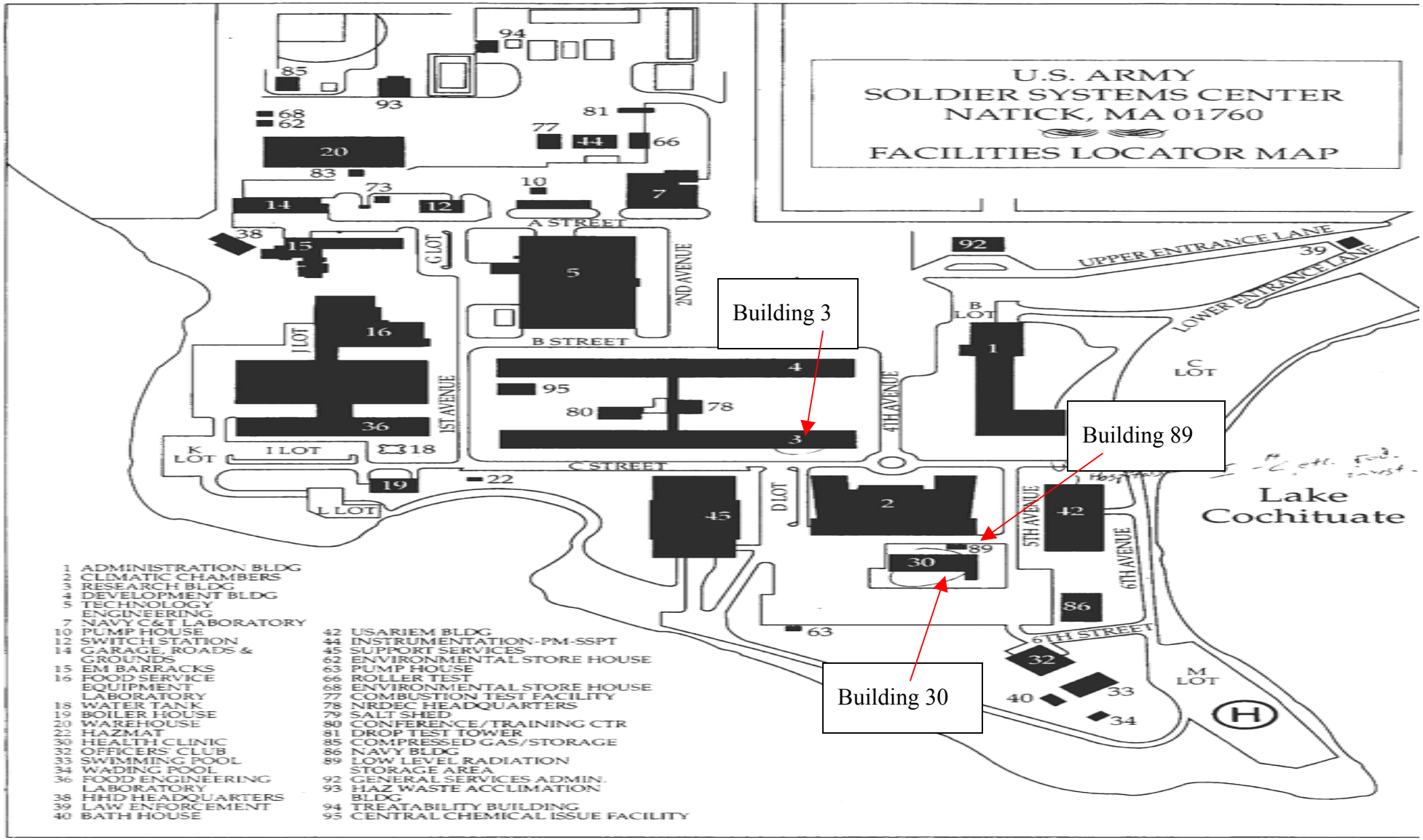
Town Boundaries

Location Map

Natick Army Laboratory
Natick, Massachusetts

CABRERA SERVICES

20
15
5
16
4
36
95
80
78
1
19
45
1
2
42
86
32
33
34
Legend
Building 3
Building 30
Building 89
Site Buildings
0 75 150 300
Feet
Location Map
Natick Army Laboratory
Natick, Massachusetts
CABRERA SERVICES


U.S. ARMY
SOLDIER SYSTEMS CENTER
NATICK, MA 01760
FACILITIES LOCATOR MAP
Building 3
Building 89
Building 30
Lake Cochituate
A STREET
B STREET
C STREET
1ST AVENUE
2ND AVENUE
4TH AVENUE
5TH AVENUE
6TH AVENUE
6TH STREET
UPPER ENTRANCE LANE
LOWER ENTRANCE LANE
G LOT
I LOT
K LOT
L LOT
D LOT
B LOT
C LOT
M LOT
1 ADMINISTRATION BLDG
2 CLIMATIC CHAMBERS
3 RESEARCH BLDG
4 DEVELOPMENT BLDG
5 TECHNOLOGY ENGINEERING
7 NAVY C&T LABORATORY
10 PUMP HOUSE
12 SWITCH STATION
14 GARAGE, ROADS & GROUNDS
15 EM BARRACKS
16 FOOD SERVICE EQUIPMENT LABORATORY
18 WATER TANK
19 BOILER HOUSE
20 WAREHOUSE
22 HAZMAT
30 HEALTH CLINIC
32 OFFICERS' CLUB
33 SWIMMING POOL
34 WADING POOL
36 FOOD ENGINEERING LABORATORY
38 HHD HEADQUARTERS
39 LAW ENFORCEMENT
40 BATH HOUSE
42 USARIEM BLDG
44 INSTRUMENTATION-PM-SSPT
45 SUPPORT SERVICES
62 ENVIRONMENTAL STORE HOUSE
63 PUMP HOUSE
66 ROLLER TEST
68 ENVIRONMENTAL STORE HOUSE
77 COMBUSTION TEST FACILITY
78 NRDEC HEADQUARTERS
79 SALT SHED
80 CONFERENCE/TRAINING CTR
81 DROP TEST TOWER
85 COMPRESSED GAS/STORAGE
86 NAVY BLDG
89 LOW LEVEL RADIATION STORAGE AREA
92 GENERAL SERVICES ADMIN.
93 HAZ WASTE ACCLIMATION BLDG
94 TREATABILITY BUILDING
95 CENTRAL CHEMICAL ISSUE FACILITY

Legend

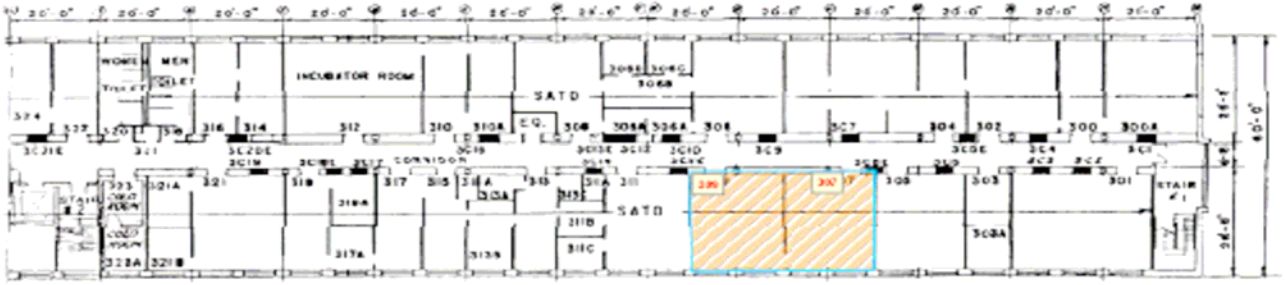
Potentially Impacted Rooms

1 inch= 15FT

FLOOR PLAN - BLDG. 30

POTENTIALLY IMPACTED ROOMS
HEALTH CLINIC, NATICK, MA

CABRERA SERVICES



Legend

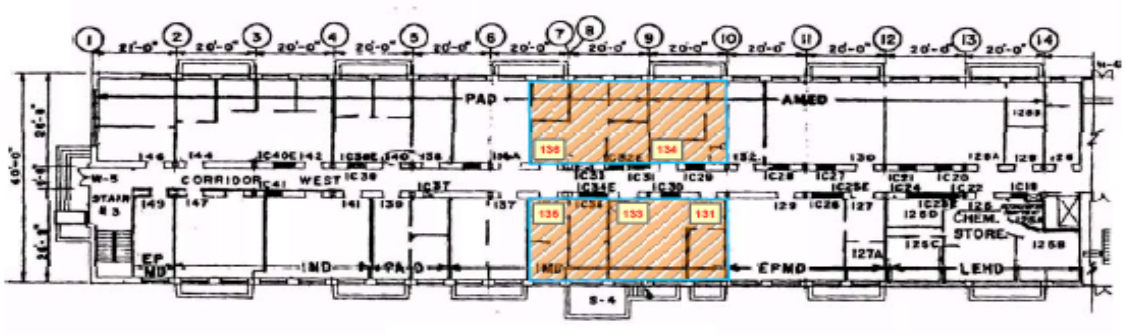
Potentially Impacted Rooms

1 inch = 40 FT

THIRD FLOOR EAST -BLDG. 3

POTENTIALLY IMPACTED ROOMS
RESEARCH BUILDING, NATICK, MA

CABRERA SERVICES



Legend

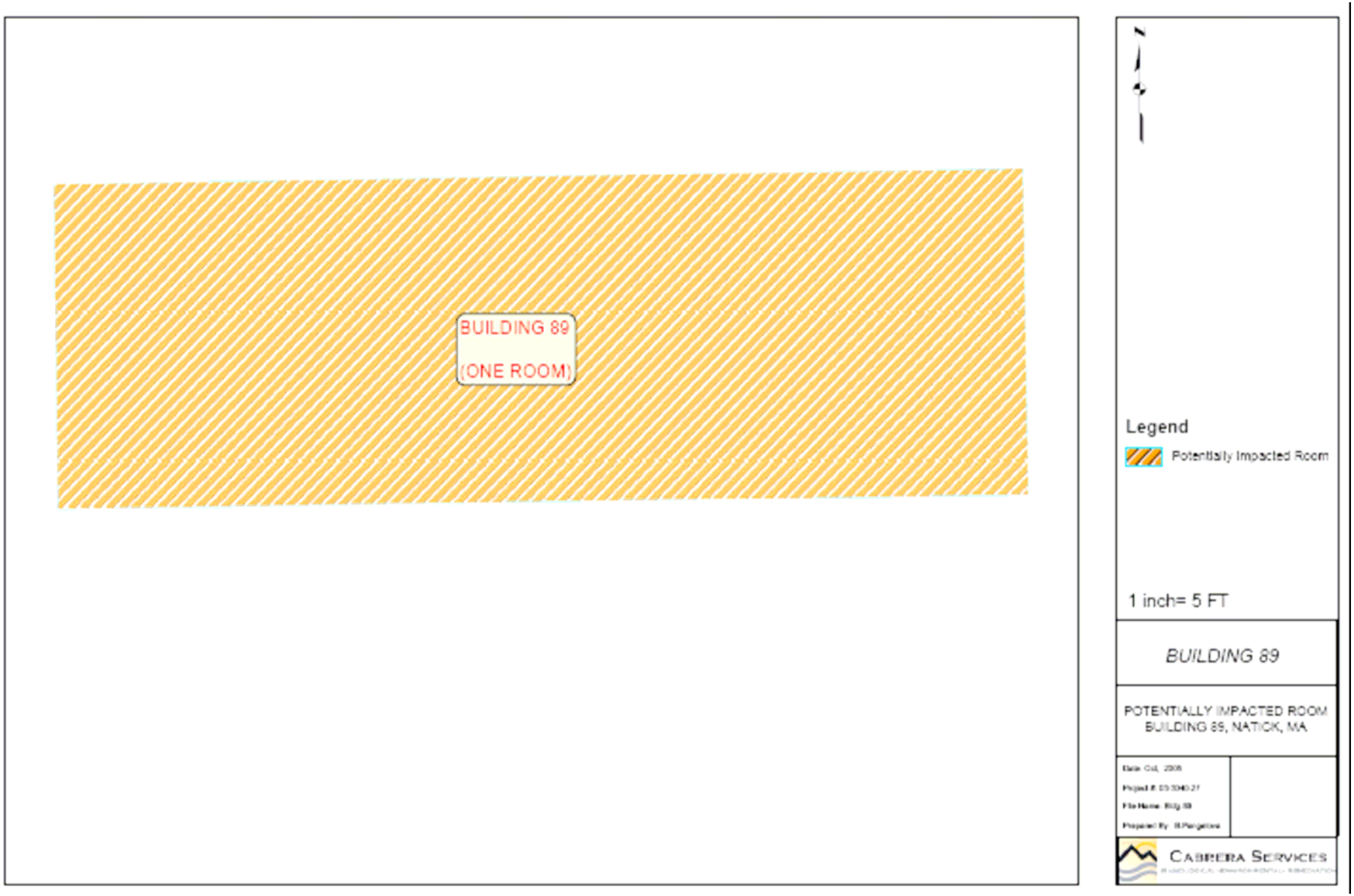
Potentially Impacted Rooms

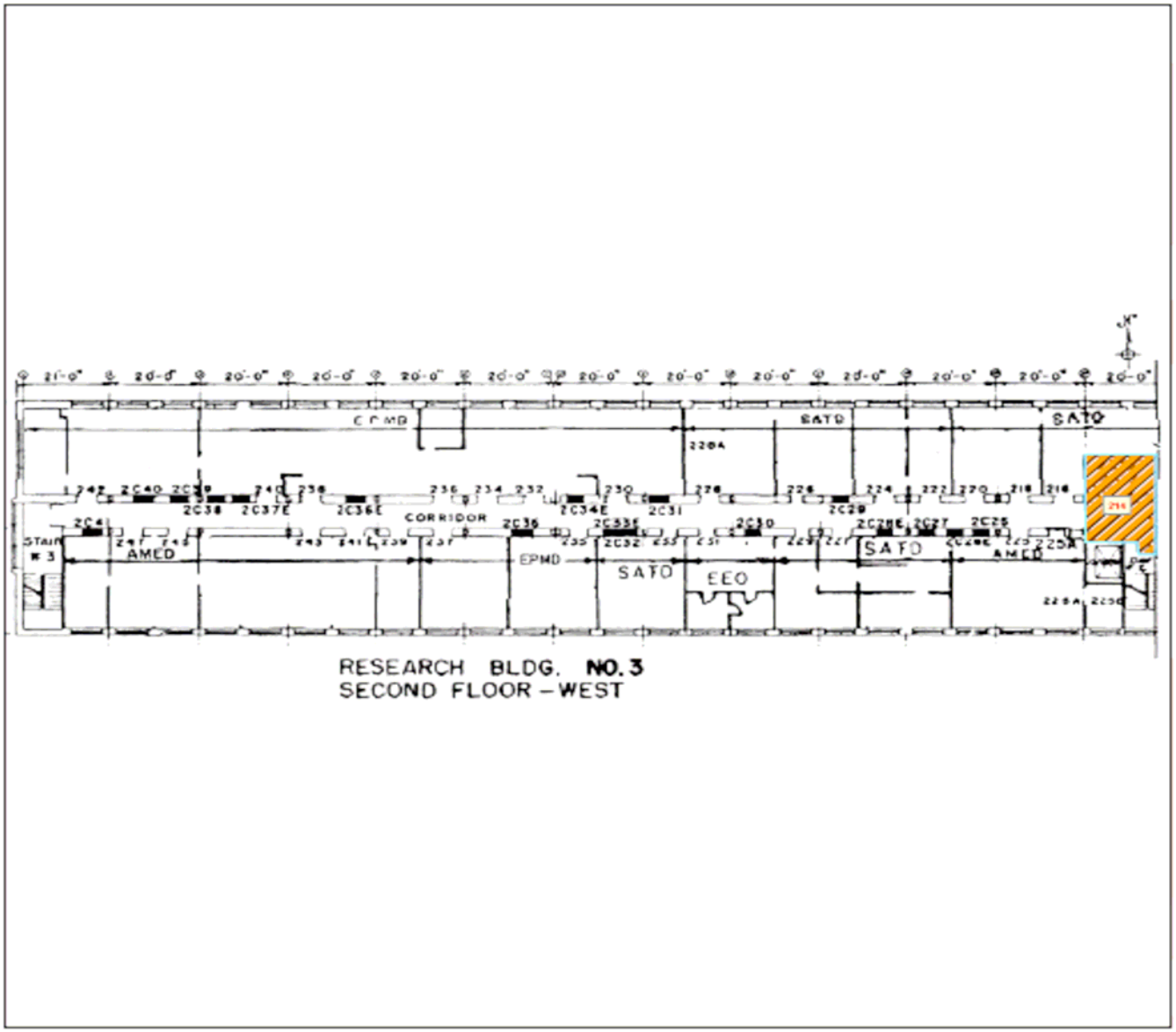
FIRST FLOOR WEST -BLDG. 3

POTENTIALLY IMPACTED ROOMS
RESEARCH BUILDING, NATICK, MA

Date: Oct, 2006
Project #: 03-3040.27
File Name: Bldg. 3_1W
Prepared By: B.Pangelova

CABRERA SERVICES
RADIOLOGICAL - ENVIRONMENTAL - REMEDIATION


BUILDING 89
(ONE ROOM)
Legend
Potentially Impacted Room
1 inch= 5 FT
BUILDING 89
POTENTIALLY IMPACTED ROOM
BUILDING 89, NATICK, MA
CABRERA SERVICES



Legend

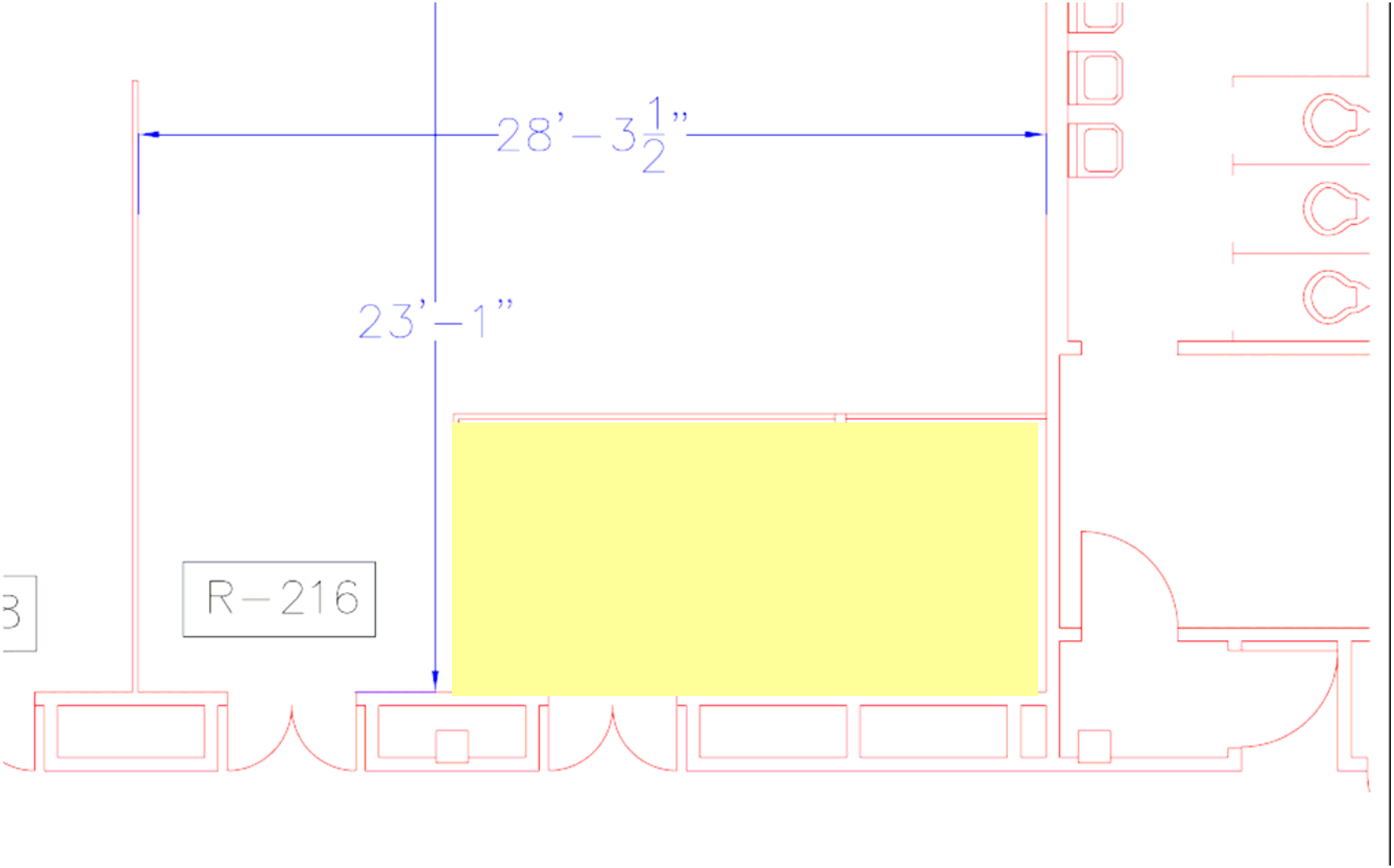
Potentially Impacted Rooms

1 inch = 40 FT

SECOND FLOOR EAST -BLDG. 3

POTENTIALLY IMPACTED ROOMS
RESEARCH BUILDING, NATICK, MA

CABRERA SERVICES



RESEARCH BUILDING 3, SECOND FLOOR

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 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 is the value chosen for the $MDCR_{surveyor}$.

Scanning Minimum Detectable Concentration

Having determined an estimate of the minimum instrument count rate detected by a real observer in the field, the count rate must be translated to the units of dpm/100cm^2, corresponding to the units of the derived concentration guideline limit (DCGL). For a scanning survey performed with a gas flow proportional detector, the greater of the $MDCR_{surveyor}$ values calculated in the previous section is 185 cpm above background or approximately 335 cpm gross. The scan MDC can be calculated using Equation 6-2 of NUREG-1507:

$$\text{Scan MDC} = \text{MDCR}/\{(E_i)\,(E_s)\,(\text{probe size}/100\ \text{cm}^2)\}$$

Where:

MDCR = minimum detectable count rate
E_i = instrument efficiency (assumed 2.8% for C-14, or 0.028 cpm per dpm)
E_s = surface efficiency (assumed 0.703, based on finished concrete, NUREG-1507, Table 5.4)
Probe size for the detector is 126 cm^2
Note that the surveyor efficiency has been previously used (above), and need not be included in this calculation.

Using the above equation, the Scan MDC is 8,447 dpm/100 cm^2.

Calculations of Minimum Detectable Activities, Minimum Detectable Count Rates, and Scan Minimum Detectable Concentrations for projected FSS Instrumentation can be

found in the Table below:

Table C-1. Static and Scan MDC Calculations

Scan MDC calculations for Ludlum Detectors(Beta measurements)				
	H-3 model (44-110)	**C-14 model(2929)**	**C-14 model (239-1F)**	**C-14 model(43-68)**
R_B = Background Counting Rate[a], per min	400	80	600	150
T_{S+B} = Sample Counting Time (gross) (min)	0.5	1	0.5	0.5
T_B = Background Counting Time (min)	1	1	1	1
i=(the observation interval in sec)	1	1	1	1
ε =Efficiency of the instrument	0.25	0.08	0.028	0.028
P=Surveyor efficiency	0.5	0.5	0.5	0.5
Probe Area(cm^2)	126	20.3	582	126
L_c (critical level counts)	46.60	20.84	57.07	28.54
L_d (lower limit of detection)	96.00	44.59	116.90	59.95
MDA(minimum detectable Activity(dpm)	479.88	557.69	5199.39	2706.84
MDA(dpm/100 cm^2)	381	2747	893	2148
d' (Index of Sensitivity from table(6.5 MARSSIM)	1.38	1.38	1.38	1.38
b_i=Number of Back ground Counts in the interval	6.67	1.33	10.00	2.50
$S_i=d'\times\sqrt{b_i}$	3.6	1.6	4.4	2.2
MDCR(Minimum Detectable count Rate)=$S_i\times(60\div)i$	214	96	262	131
Scan MDC[b]	N/A	N/A	2272	5248
DCGLs (dpm/100cm^2)	1.2×10^8	3.6×10^6	3.6×10^6	3.6×10^6

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

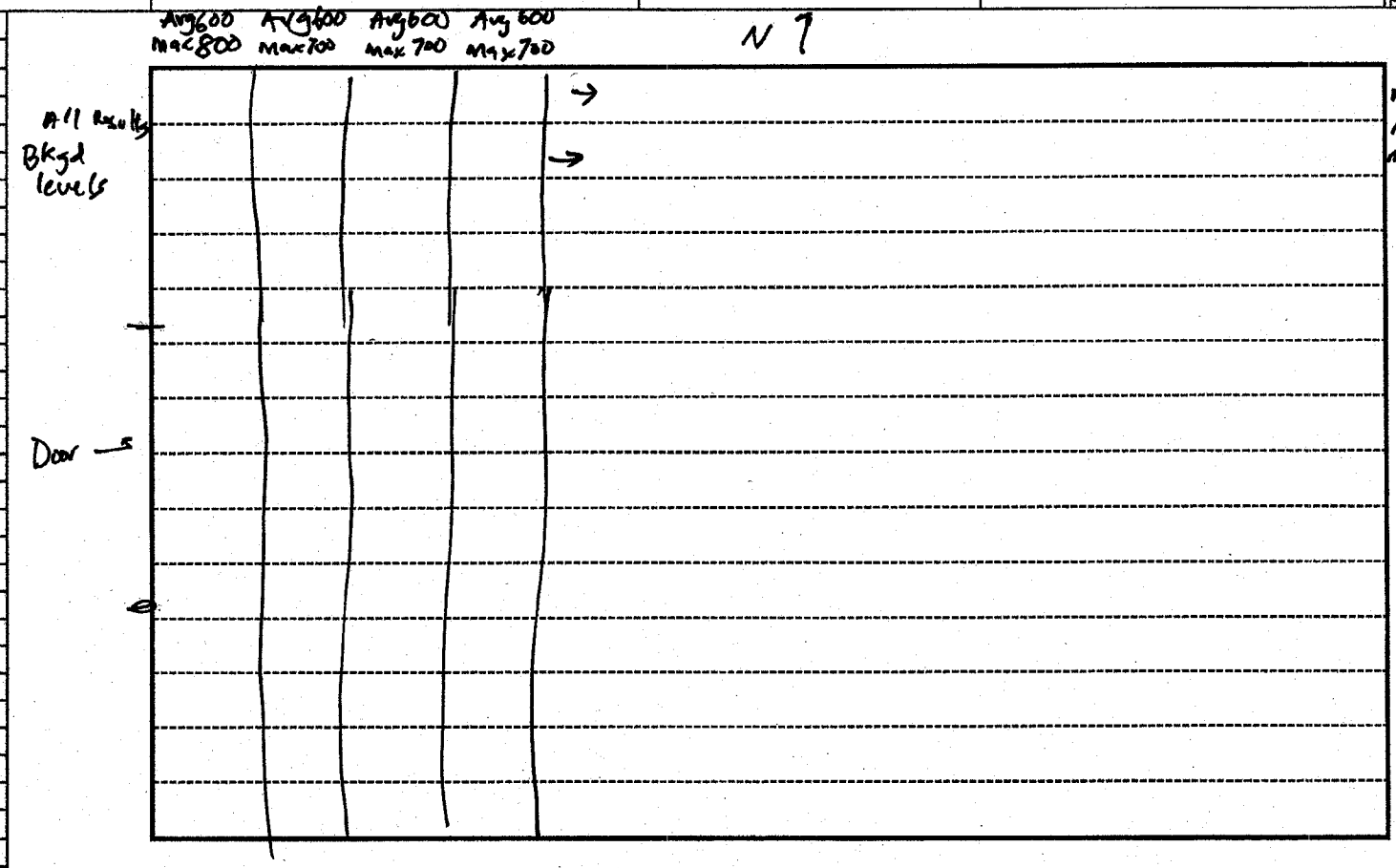
APPENDIX B

SURVEY RESULTS AND FORMS

OP-001-02 RADIOLOGICAL SURVEY SHEET (rev 1)

Location: Bldg 89 Floorscan Site: Natick SSC	RWP#	Survey #	Survey Type: Scan/Static/Smear	pg. __ of __

Smear Results CPM/100cm^2					
No.	α	β	No.	α	β
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		
Comments					



Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
GB	12/11/06	43-37						
		2360						
Reviewed By:	Date:							

Key			
⬭	Smear	*-*	Boundary
□	Dose Rate mrem/hr	■	A/S Location
*	Direct Reading CPM/100 cm^2		
△	Grab Sample		

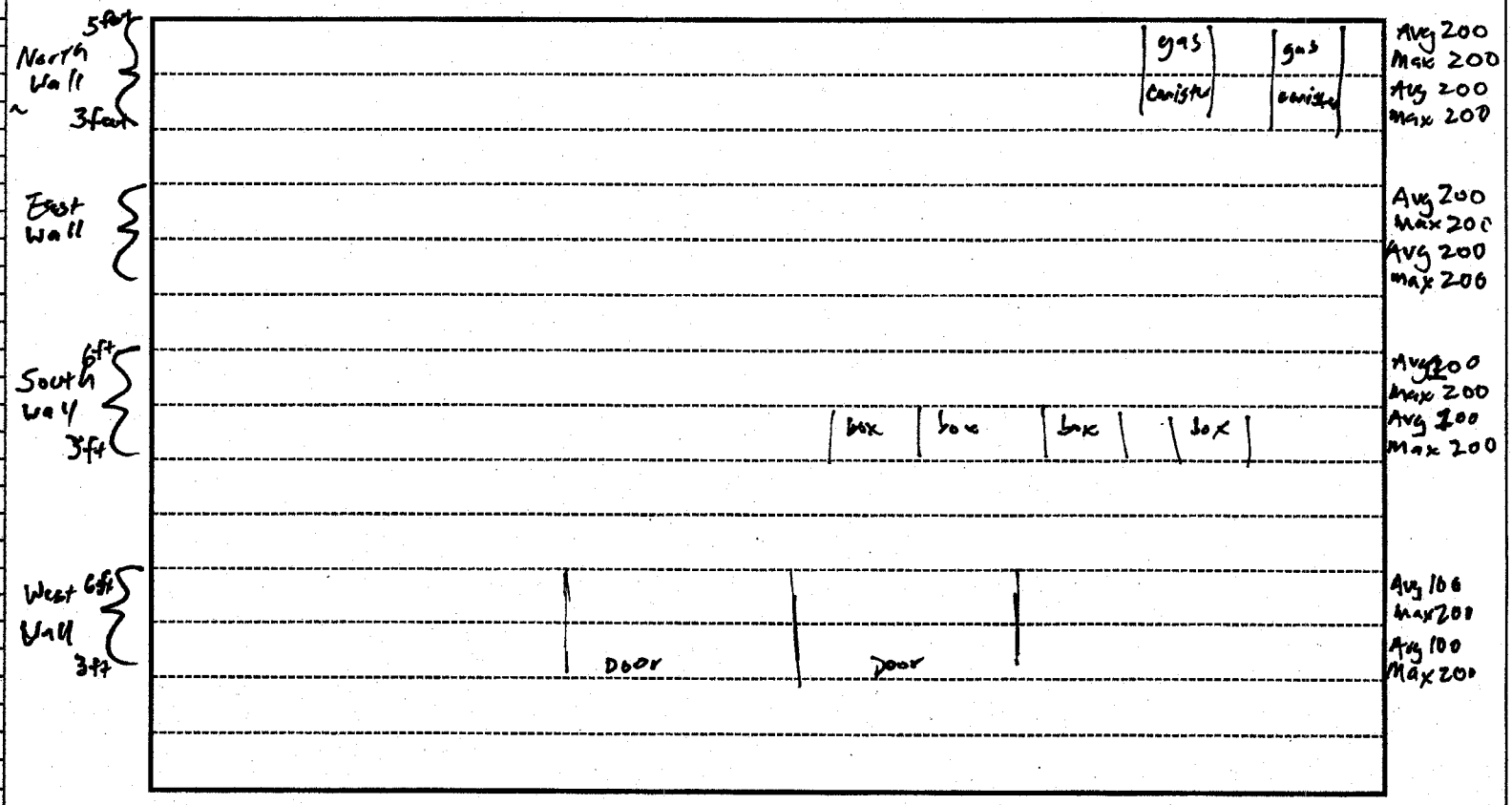
OP-001-02 RADIOLOGICAL SURVEY SHEET (rev 1)

Location: 31 dec 89 North Wall East Wall South Wall West Wall Site: Natick SSC	RWP#	Survey #	Survey Type: Scan/Static/Smear	pg.__of__

Smear Results
CPM/100cm^2

No.	α	β	No.	α	β
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments



Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
GB, GH		43-68						
		2224						
Reviewed By:	Date:							

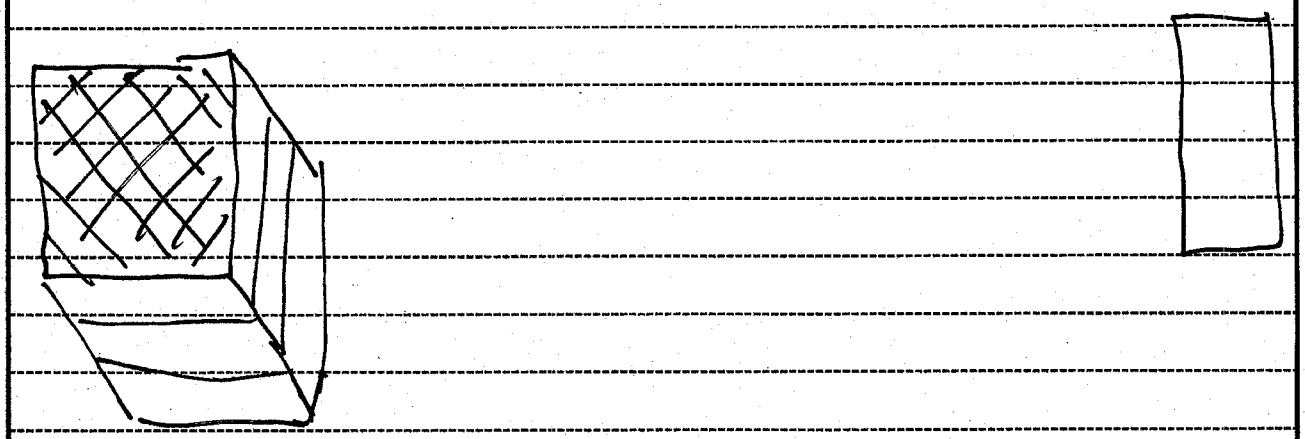
Key			
⬭	Smear	*-*	Boundary
▭	Dose Rate mrem/hr	■	A/S Location
*	Direct Reading CPM/100 cm^2		
△	Grab Sample		

OP-001-02 RADIOLOGICAL SURVEY SHEET (rev 1)

Location: Site: Natick SSC	RWP#	Survey #	Survey Type: Scan/Static/Smear	pg.__of__

Smear Results CPM/100cm^2					
No.	α	β	No.	α	β
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		
Comments					

Scanned stack → avg: 250 cpm
max: 250 cpm



Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
Reviewed By:	Date:							

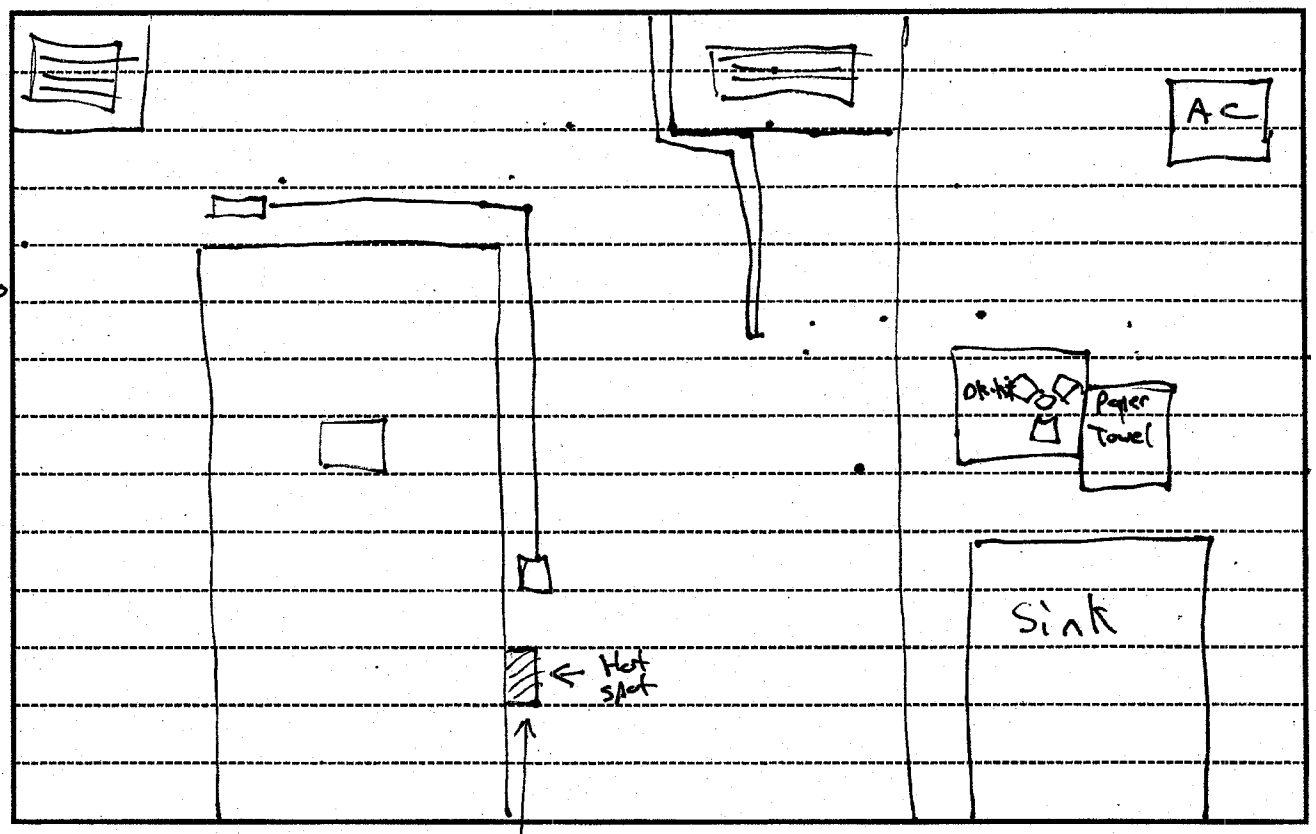
Key			
⬭	Smear	*-*	Boundary
▭	Dose Rate mrem/hr	■	A/S Location
*	Direct Reading CPM/100 cm^2		
△	Grab Sample		

OP-001-02 RADIOLOGICAL SURVEY SHEET (rev 1)

Location: Room 103 Site: Natick SSC	RWP#	Survey #	Survey Type: Scan/Static/Smear	pg.__of__

Smear Results CPM/100cm^2					
No.	α	β	No.	α	β
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		
Comments					

Room:
Ave-300
Max-400



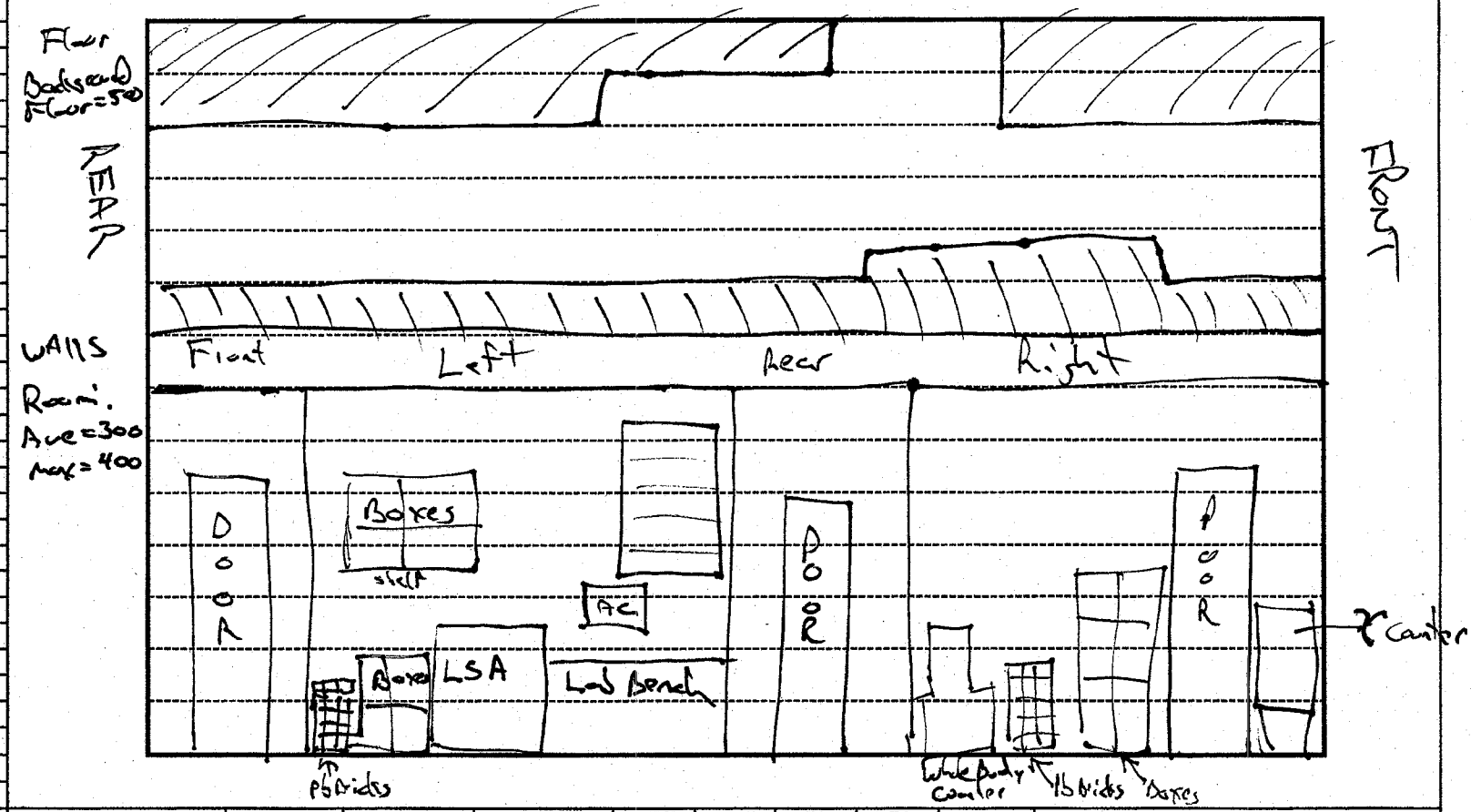
Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
Greg Bright	12/7/06	4368	088917					
Reviewed By:	Date:							

Key			
○	Smear	*-*	Boundary
□	Dose Rate mrem/hr	■	A/S Location
*	Direct Reading CPM/100 cm^2		
△	Grab Sample		

OP-001-02 RADIOLOGICAL SURVEY SHEET (rev 1)

Location: Room 101 Site: Natick SSC	RWP#	Survey #	Survey Type: Scan/Static/Smear	pg. __ of __

Smear Results CPM/100cm^2					
No.	α	β	No.	α	β
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		
Comments					



Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
Greg Bright	12/13/00	4368	088917					
Reviewed By:	Date:							

Key			
○	Smear	*-*	Boundary
□	Dose Rate mrem/hr	■	A/S Location
*	Direct Reading CPM/100 cm^2		
△	Grab Sample		

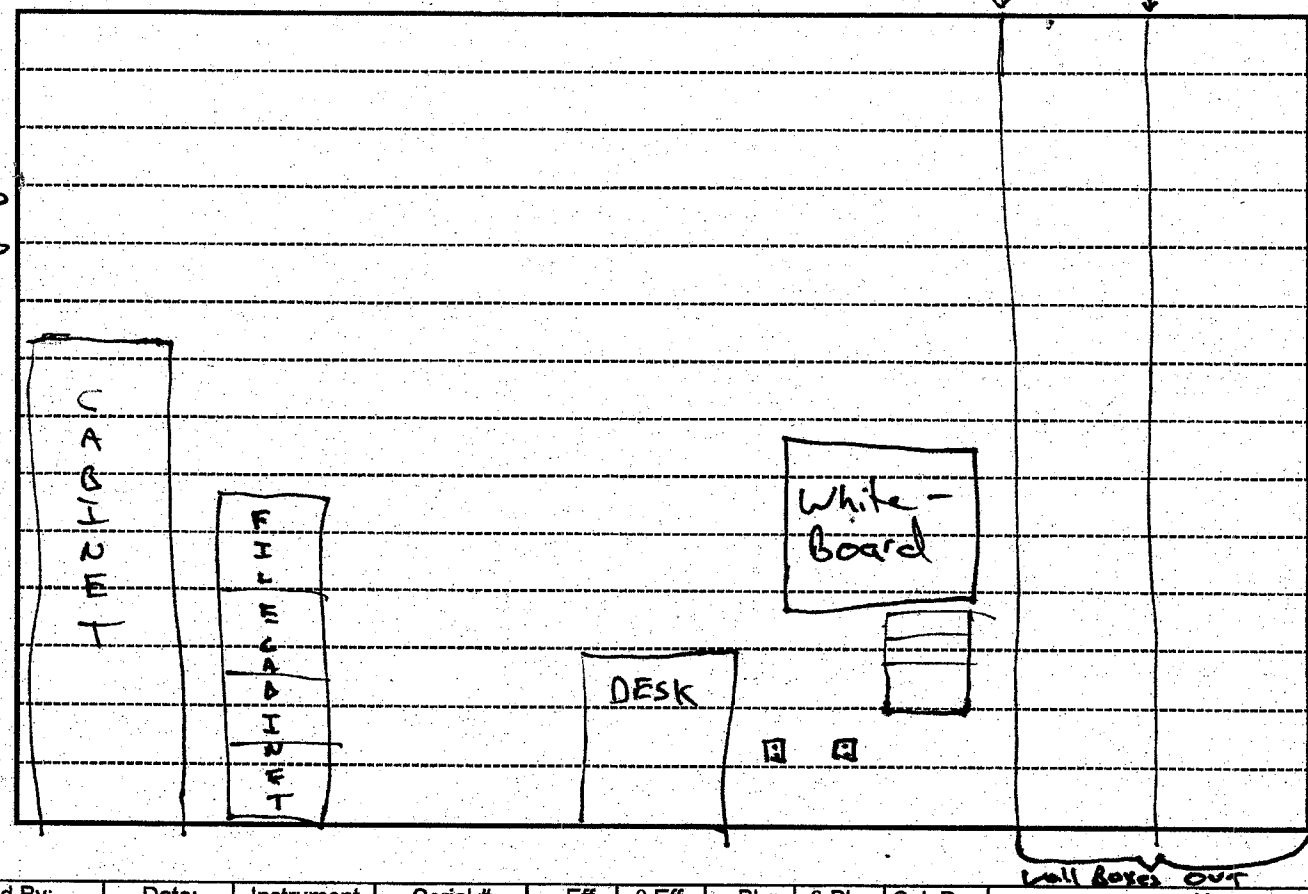
OP-001-02 RADIOLOGICAL SURVEY SHEET (rev 1)

Location: Room 108 Site: Natick SSC	RWP#	Survey #	Survey Type: Scan/Static/Smear	pg. __ of __

Smear Results CPM/100cm^2					
No.	α	β	No.	α	β
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

Room:
Ave: 200
MAX: 300



Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
Greg Bright	12/13/06	4368	088919					
Reviewed By:	Date:							

Key			
○	Smear	*-*	Boundary
□	Dose Rate mrem/hr	■	A/S Location
*	Direct Reading CPM/100 cm^2		
△	Grab Sample		

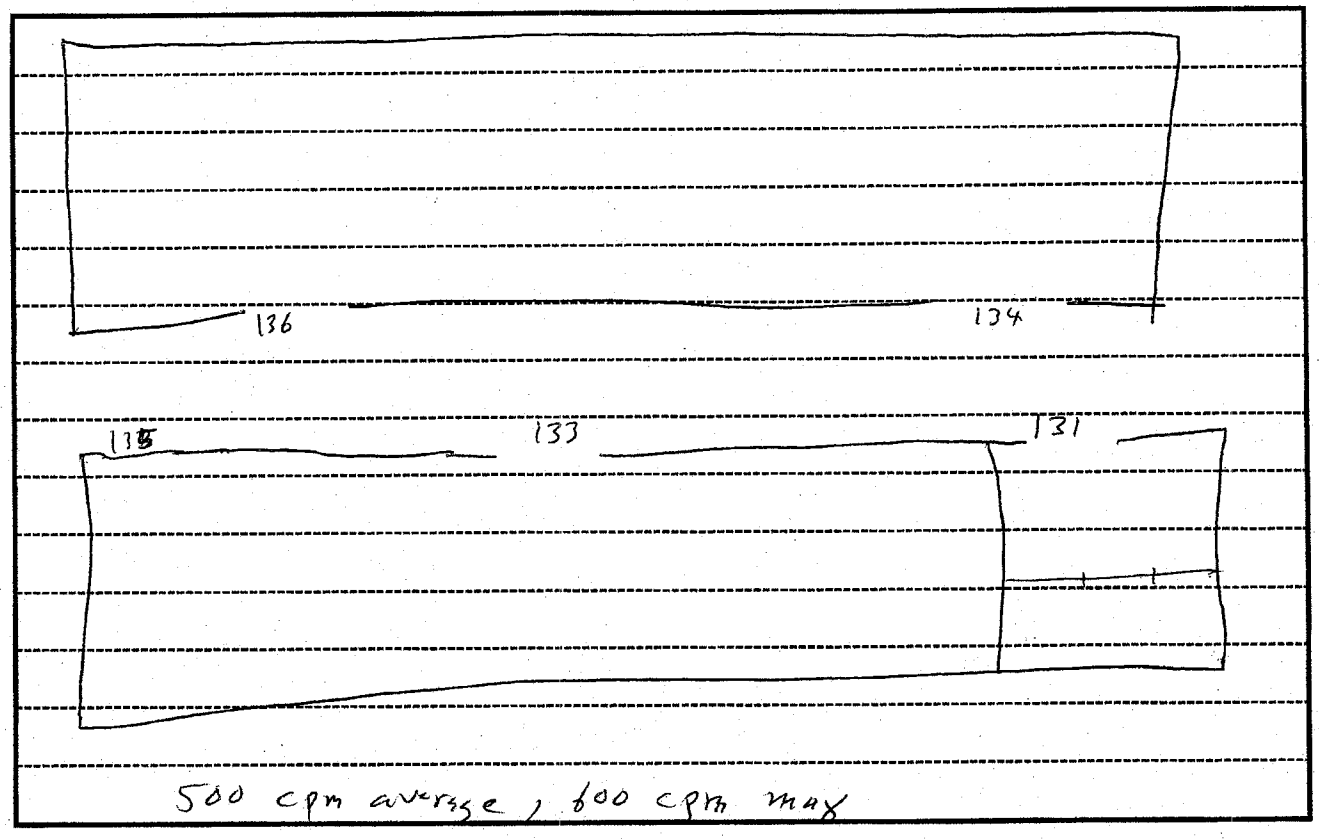
OP-001-02 RADIOLOGICAL SURVEY SHEET (rev 1)

Location: Site: Natick SSC	RWP#	Survey # 3-1W	Survey Type: Scan/Static/Smear	pg.__ of __

Smear Results CPM/100cm^2					
No.	α	β	No.	α	β
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

All carpet Floors other space



Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
G. Hisel	12/11/06	43-37						
Reviewed By:	Date:							

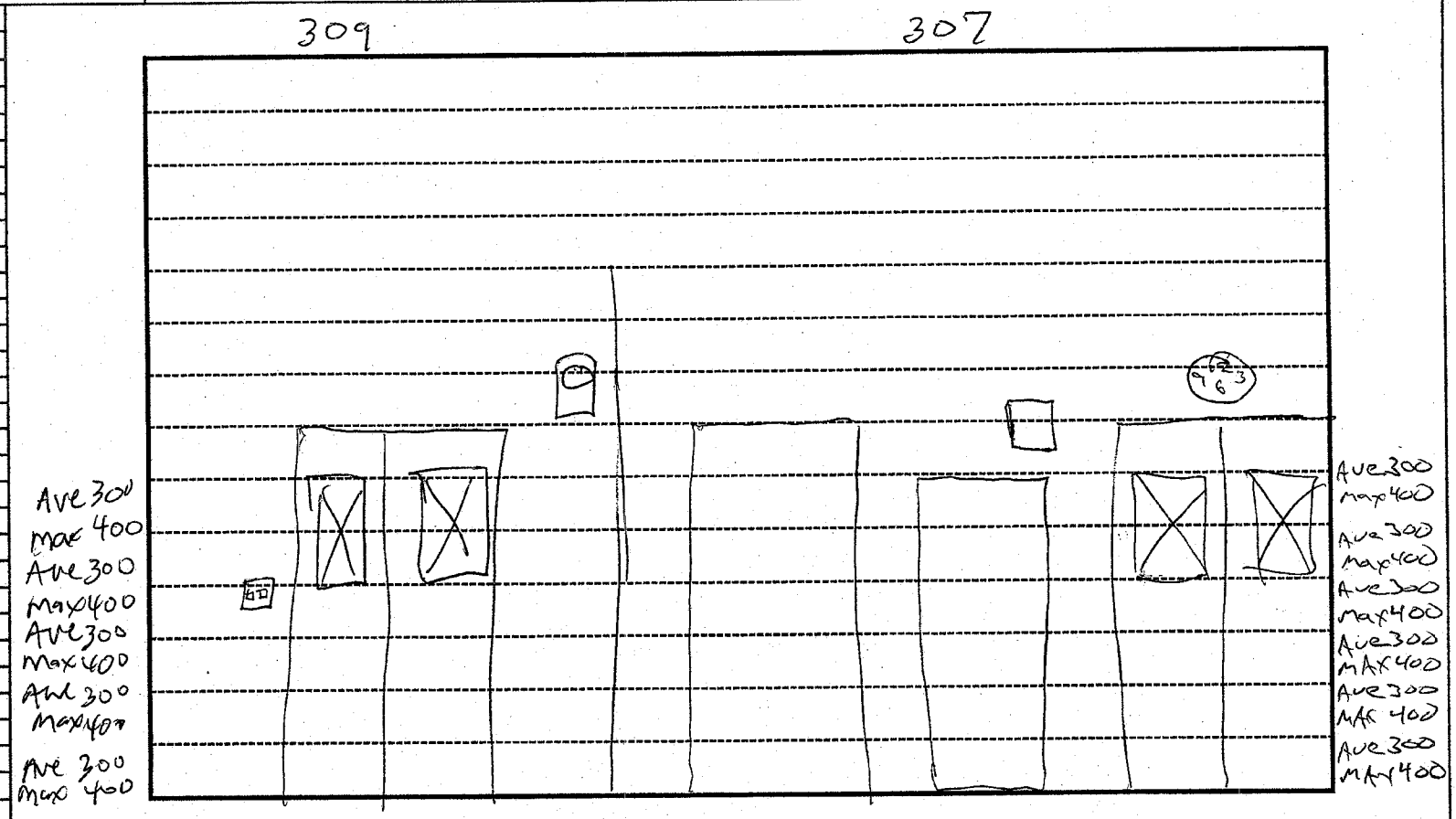
Key			
⬭	Smear	*-*	Boundary
▭	Dose Rate mrem/hr	■	A/S Location
*	Direct Reading CPM/100 cm^2		
△	Grab Sample		

OP-001-02 RADIOLOGICAL SURVEY SHEET (rev 1)

Location: 309, 307 North wall Site: Natick SSC	RWP#	Survey #	Survey Type: Scan/Static/Smear	pg.__of__

Smear Results CPM/100cm^2					
No.	α	β	No.	α	β
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments



Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
GB/BS		43-68						
		2224						
Reviewed By:	Date:							

Key			
○	Smear	*-*	Boundary
□	Dose Rate mrem/hr	■	A/S Location
*	Direct Reading CPM/100 cm^2		
△	Grab Sample		

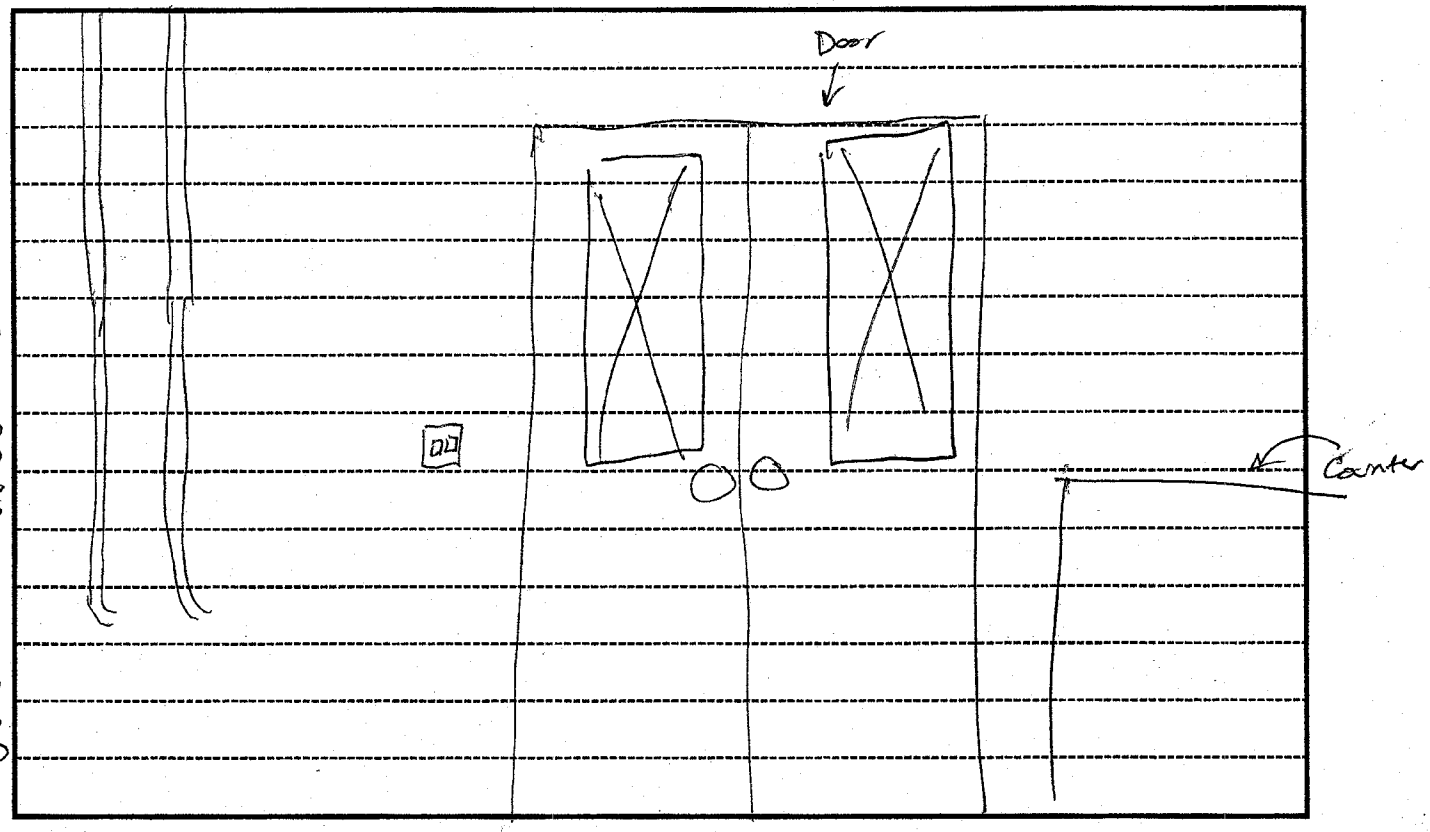
OP-001-02 RADIOLOGICAL SURVEY SHEET (rev 1)

Location: 214 Southwall Site: Natick SSC	RWP#	Survey #	Survey Type: Scan/Static/Smear	pg.__of__

Smear Results CPM/100cm^2					
No.	α	β	No.	α	β
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

Ave 300 max 400
Ave 300 max 400
Ave 300 max 400
Ave 300 max 400
Ave 300 max 400
Ave 300 max 400
Ave 300 max 400
Ave 300 max 400
Ave 300 max 400



Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
GB/BS	12/11/06	43-68						
	12/11/06	2224						
Reviewed By:	Date:							

Key			
○	Smear	*-*	Boundary
□	Dose Rate mrem/hr	■	A/S Location
*	Direct Reading CPM/100 cm^2		
△	Grab Sample		

OP-001-02 RADIOLOGICAL SURVEY SHEET (rev 1)

Location: 134/136 Wall South survey Site: Natick SSC	RWP#	Survey #	Survey Type: Scan/Static/Smear	pg.__ of __

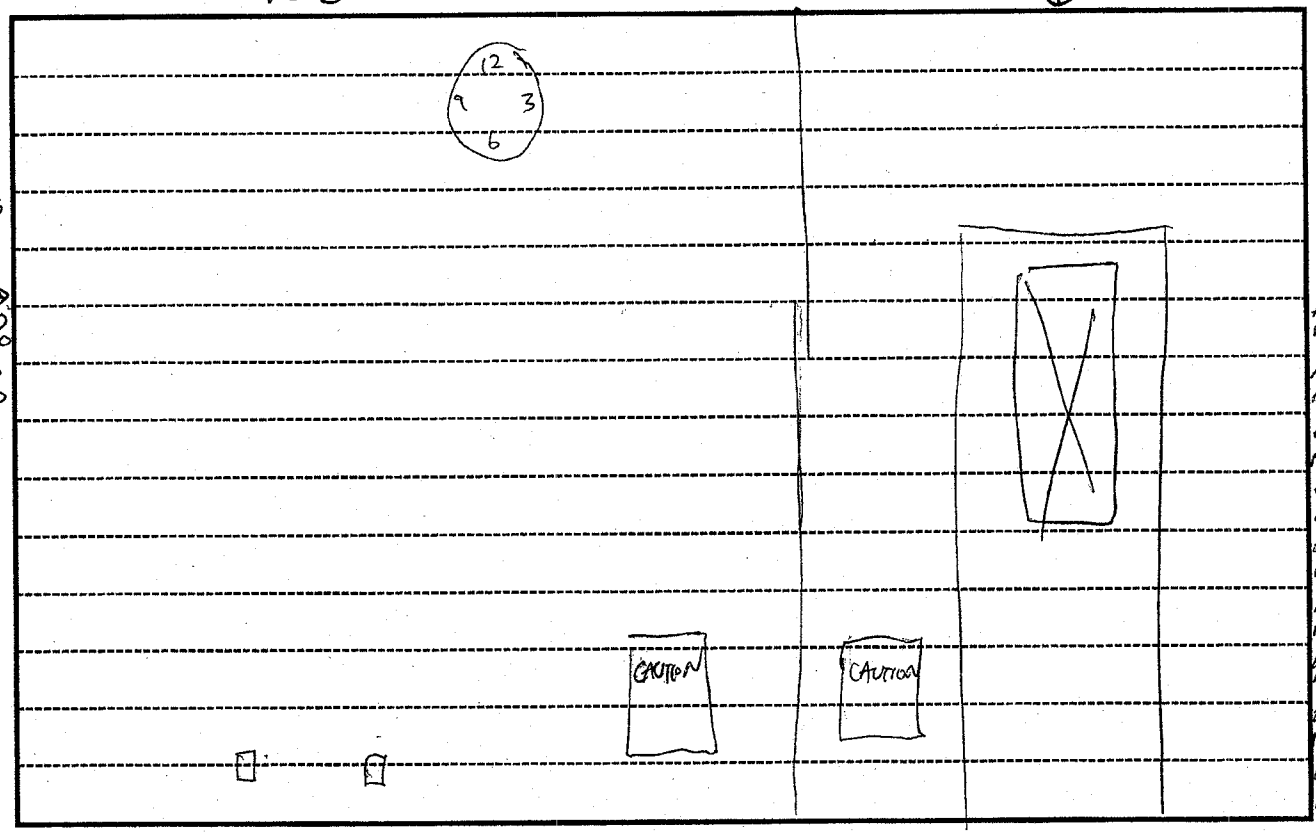
Smear Results CPM/100cm^2					
No.	α	β	No.	α	β
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

GB ~~136~~ 134

134 results

6 ft →
Ave 320
max 400
Ave 320
Max 400
Ave 320
max 400
Ave 320
max 400
Ave 320
max 400
Ave 320
Max 400
Ave 300
max 400
Ave 300
max 400



136

136 results

6 ft
Ave 300
Max 400
Ave 300
max 400
Ave 300
max 400
Ave 300
Max 400
Ave 300
Max 400
Ave 300
Max 400
Ave 300
Max 400
Ave 300
Max 400
Ave 300
Max 400

Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
GB / BS	12/11/06	43-68						
		2224						
Reviewed By:	Date:							

Key			
○	Smear	*-*	Boundary
□	Dose Rate mrem/hr	■	A/S Location
*	Direct Reading CPM/100 cm^2		
△	Grab Sample		

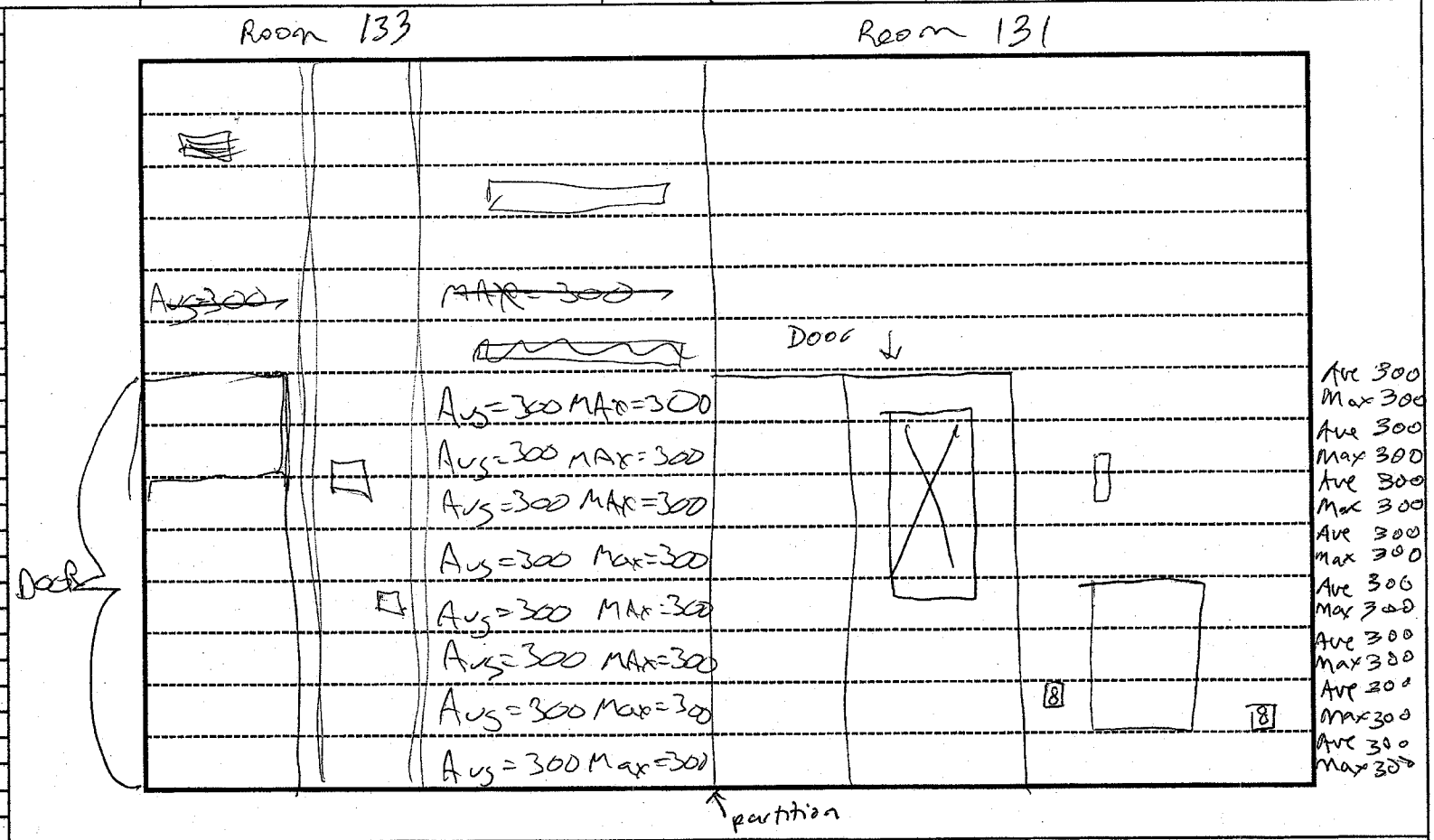
OP-001-02 RADIOLOGICAL SURVEY SHEET (rev 1)

Location: Room 133/131 Bldg 3 Site: Natick SSC	RWP#	Survey # ~~133~~ 06	Survey Type: Scan/Static/Smear	pg. __ of __

Northwall

Smear Results CPM/100cm^2					
No.	α	β	No.	α	β
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments



Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
GB/BS	12/11/06	43-68						
		2224						
Reviewed By:	Date:							

Key			
○	Smear	*-*	Boundary
□	Dose Rate mrem/hr	■	A/S Location
*	Direct Reading CPM/100 cm^2		
△	Grab Sample		

Natick SSC Sign Test Data Sheet

Survey Date:	12-Dec-06
Survey Unit #:	3-1W
Building:	3
Floor:	1
FSS Floor Classification:	3
Beta DCGLw (dpm/100cm^2):	3.60E+06

Instrument Number	Ratemeter/ Probe Models	Ratemeter S/N	Probe S/N	Efficiency[1]	Isotope	Probe Active Area (cm^2)
1	2224/43-68	154046	PR088917	3.60%	C-14	126
1	2224/43-68	154046	PR088917	17.20%	Th-230	126
2	2221/44-110	176947	PR178079	25.00%	H-3	126
3	19	87139				
Static Count Time (min):		0.5				
BKGD Count Time (min):		0.5				

SU Description: first floor formerly labs, now offices 131, 134, 135, 136

1	2	3	4	5	6	7	8	9	10	11	12	13
Sample ID	Sample Type[2]	Instrument Number	Sample Location[3]	Surface Material[4]	Alpha Fixed-Point Result (30 sec gross counts)	Beta Fixed-Point Result (30 sec gross counts)	Low Energy Beta Result (30 sec gross counts)	Gamma Result (gross uR/hr))	Material Specific Alpha Background[5] (cpm)	Material Specific Beta Background[5] (cpm)	Material Specific Low Energy Beta Background[5] (cpm)	Net Fixed-Point Alpha Result (net cpm)
3-1W-1	S	1, 2, 3	F	FC	3	121	223	14	1.60	260.00	391.20	4.40
3-1W-2	S	1, 2, 3	F	FC	0	123	408	13	1.60	260.00	391.20	-1.60
3-1W-3	S	1, 2, 3	F	FC	0	118	112	13	1.60	260.00	391.20	-1.60
3-1W-4	S	1, 2, 3	F	FC	1	128	156	14	1.60	260.00	391.20	0.40
3-1W-5	S	1, 2, 3	F	FC	1	126	212	14	1.60	260.00	391.20	0.40
3-1W-6	S	1, 2, 3	F	FC	0	143	158	15	1.60	260.00	391.20	-1.60
3-1W-7	S	1, 2, 3	F	FC	1	123	191	12	1.60	260.00	391.20	0.40
3-1W-8	S	1, 2, 3	F	FC	3	131	180	15	1.60	260.00	391.20	4.40
3-1W-9	S	1, 2, 3	F	FC	7	134	201	12	1.60	260.00	391.20	12.40
3-1W-10	S	1, 2, 3	F	FC	1	146	288	14	1.60	260.00	391.20	0.40
3-1W-11	S	1, 2, 3	F	FC	0	137	195	14	1.60	260.00	391.20	-1.60
3-1W-12	S	1, 2, 3	F	FC	1	126	155	14	1.60	260.00	391.20	0.40
3-1W-13	S	1, 2, 3	F	FC	0	120	329	13	1.60	260.00	391.20	-1.60
3-1W-14	S	1, 2, 3	F	FC	3	150	174	13	1.60	260.00	391.20	4.40
3-1W-15	S	1, 2, 3	F	FC	0	125	213	13	1.60	260.00	391.20	-1.60
3-1W-16	S	1, 2, 3	F	FC	1	120	161	14	1.60	260.00	391.20	0.40
3-1W-17	S	1, 2, 3	F	FC	0	132	168	14	1.60	260.00	391.20	-1.60

NOTES:

1 Instrument Efficiency = Instrument static 4-pi efficiency for isotope in next column
2 Sample Type: S = Static B = Biased Location
3 F = floor W = Lower wall (< 6 ft) CT = Counter Top
4 Surface Materials: BC (Bare Concrete), PC (Painted Concrete), BCB (Bare Cinder Block), FC (Floor Carpet), FT (Floor Tile), RS (Roof Sealant), M (Metal), O (Other)
5 Average of (5) 1-minute background readings collected in unimpacted areas for each building surface encountered during FSS
6 MARSSIM Sign Test parameter. If Result > DCGLw, Sign = -1, otherwise 1.
7 DCGL is based on C-14 beta emission

14	15	15	16	17	18
Net Fixed-Point Beta Result (net cpm)	Net Fixed-Point Low Energy Beta Result (net cpm)	Residual Alpha Surface Activity (dpm/100cm^2)	Residual Beta Surface Activity (dpm/100cm^2)	Residual Low Energy Beta Surface Activity (dpm/100cm^2)	Beta Sign Test Parameter[7]
-18.00	54.80	3.22E+01	-6.30E+02	4.01E+02	1
-14.00	424.80	-1.17E+01	-4.90E+02	3.11E+03	1
-24.00	-167.20	-1.17E+01	-8.40E+02	-1.22E+03	1
-4.00	-79.20	2.93E+00	-1.40E+02	-5.80E+02	1
-8.00	32.80	2.93E+00	-2.80E+02	2.40E+02	1
26.00	-75.20	-1.17E+01	9.10E+02	-5.51E+02	1
-14.00	-9.20	2.93E+00	-4.90E+02	-6.74E+01	1
2.00	-31.20	3.22E+01	7.00E+01	-2.29E+02	1
8.00	10.80	9.08E+01	2.80E+02	7.91E+01	1
32.00	184.80	2.93E+00	1.12E+03	1.35E+03	1
14.00	-1.20	-1.17E+01	4.90E+02	-8.79E+00	1
-8.00	-81.20	2.93E+00	-2.80E+02	-5.95E+02	1
-20.00	266.80	-1.17E+01	-7.00E+02	1.95E+03	1
40.00	-43.20	3.22E+01	1.40E+03	-3.16E+02	1
-10.00	34.80	-1.17E+01	-3.50E+02	2.55E+02	1
-20.00	-69.20	2.93E+00	-7.00E+02	-5.07E+02	1
4.00	-55.20	-1.17E+01	1.40E+02	-4.04E+02	1

Mean	**7.24**	**-28.82**	**171.33**
Median	**2.93**	**-280.00**	**-67.40**
Max	**90.84**	**1400.00**	**3111.91**
Range	**102.56**	**2240.00**	**4336.74**
Std Dev (1 σ)	**26.80**	**672.35**	**1066.52**

Natick SSC Sign Test Data Sheet

Survey Date:	12-Dec-06
Survey Unit #:	3-2W
Building:	3
Floor:	2
FSS Floor Classification:	3
SU DCGLw (dpm/100cm^2):	3.60E+05

Instrument Number	Ratemeter/ Probe Models	Ratemeter S/N	Probe S/N	Efficiency[1]	Isotope	Probe Active Area (cm^2)
1	2224/43-68	154046	PR088917	3.60%	C-14	126
1	2224/43-68	154046	PR088917	17.20%	Th-230	126
2	2221/44-110	176947	PR178079	25.00%	H-3	126
3	19	87139				
Static Count Time (min):		0.5				
BKGD Count Time (min):		0.5				

SU Description: Second floor, room 214, formerly labs, now offices and vending area.

1	2	3	4	5	6	7	8	9	10	11	12	13
Sample ID	Sample Type[2]	Instrument Number	Sample Location[3]	Surface Material[4]	Alpha Fixed-Point Result (30 sec gross counts)	Beta Fixed-Point Result (30 sec gross counts)	Low Energy Beta Result (30 sec gross counts)	Gamma Result (gross uR/hr))	Material Specific Alpha Background[5] (cpm)	Material Specific Beta Background[5] (cpm)	Material Specific Low Energy Beta Background[5] (cpm)	Net Fixed-Point Alpha Result (net cpm)
3-2W-1	S	1, 2, 3	F	FT	0	132	164	14	0.40	292.00	352.80	-0.40
3-2W-2	S	1, 2, 3	F	FT	0	139	192	13	0.40	292.00	352.80	-0.40
3-2W-3	S	1, 2, 3	F	FT	0	125	162	13	0.40	292.00	352.80	-0.40
3-2W-4	S	1, 2, 3	F	FT	0	137	165	14	0.40	292.00	352.80	-0.40
3-2W-5	S	1, 2, 3	F	FT	0	142	132	14	0.40	292.00	352.80	-0.40
3-2W-6	S	1, 2, 3	F	FT	1	141	124	14	0.40	292.00	352.80	1.60
3-2W-7	S	1, 2, 3	CT	O	1	124	137	12	0.60	192.40	242.80	1.40
3-2W-8	S	1, 2, 3	F	FT	0	113	150	14	0.40	292.00	352.80	-0.40
3-2W-9	S	1, 2, 3	F	FT	0	110	84	11	0.40	292.00	352.80	-0.40
3-2W-10	S	1, 2, 3	CT	O	1	98	115	12	0.60	192.40	242.80	1.40
3-2W-11	S	1, 2, 3	F	FT	4	149	152	14	0.40	292.00	352.80	7.60
3-2W-12	S	1, 2, 3	CT	O	1	104	163	14	0.60	192.40	242.80	1.40
3-2W-13	S	1, 2, 3	F	FT	1	153	163	14	0.40	292.00	352.80	1.60
3-2W-14	S	1, 2, 3	F	FT	1	123	166	14	0.40	292.00	352.80	1.60
3-2W-15	S	1, 2, 3	F	FT	0	144	159	14	0.40	292.00	352.80	-0.40
3-2W-16	S	1, 2, 3	F	FT	1	141	118	14	0.40	292.00	352.80	1.60
3-2W-17	S	1, 2, 3	F	FT	1	160	139	14	0.40	292.00	352.80	1.60
3-2W-18	B	1, 2, 3	ET-D	M	0	107	173	14	0.00	126.60	148.00	0.00
3-2W-19	B	1, 2, 3	ET-D	M	0	100	127	13	0.00	126.60	148.00	0.00

NOTES:

1 Instrument Efficiency = Instrument static 4-pi efficiency for isotope in next column
2 Sample Type: S = Static B = Biased Location
3 F = floor W = Lower wall (< 6 ft) CT = Counter Top
4 Surface Materials: BC (Bare Concrete), PC (Painted Concrete), BCB (Bare Cinder Block), FC (Floor Carpet), FT (Floor Tile), RS (Roof Sealant), M (Metal), O (Other)
5 Average of (5) 1-minute background readings collected in unimpacted areas for each building surface encountered during FSS
6 MARSSIM Sign Test parameter. If Result > DCGLw, Sign = -1, otherwise 1.
7 DCGL is based on C-14 beta emission

14	15	15	16	17	18
Net Fixed-Point Beta Result (net cpm)	Net Fixed-Point Low Energy Beta Result (net cpm)	Residual Alpha Surface Activity (dpm/100cm^2)	Residual Beta Surface Activity (dpm/100cm^2)	Residual Low Energy Beta Surface Activity (dpm/100cm^2)	Beta Sign Test Parameter[7]
-28.00	-24.80	-2.93E+00	-9.80E+02	-1.82E+02	1
-14.00	31.20	-2.93E+00	-4.90E+02	2.29E+02	1
-42.00	-28.80	-2.93E+00	-1.47E+03	-2.11E+02	1
-18.00	-22.80	-2.93E+00	-6.30E+02	-1.67E+02	1
-8.00	-88.80	-2.93E+00	-2.80E+02	-6.51E+02	1
-10.00	-104.80	1.17E+01	-3.50E+02	-7.68E+02	1
55.60	31.20	1.03E+01	1.95E+03	2.29E+02	1
-66.00	-52.80	-2.93E+00	-2.31E+03	-3.87E+02	1
-72.00	-184.80	-2.93E+00	-2.52E+03	-1.35E+03	1
3.60	-12.80	1.03E+01	1.26E+02	-9.38E+01	1
6.00	-48.80	5.57E+01	2.10E+02	-3.57E+02	1
15.60	83.20	1.03E+01	5.46E+02	6.09E+02	1
14.00	-26.80	1.17E+01	4.90E+02	-1.96E+02	1
-46.00	-20.80	1.17E+01	-1.61E+03	-1.52E+02	1
-4.00	-34.80	-2.93E+00	-1.40E+02	-2.55E+02	1
-10.00	-116.80	1.17E+01	-3.50E+02	-8.56E+02	1
28.00	-74.80	1.17E+01	9.80E+02	-5.48E+02	1
-19.60	25.00	0.00E+00	-6.86E+02	1.83E+02	N/A
-26.60	-21.00	0.00E+00	-9.31E+02	-1.54E+02	N/A

Mean	**7.15**	**-401.88**	**-300.61**
Median	**10.26**	**-350.00**	**-210.98**
Max	**55.67**	**1946.00**	**609.49**
Range	**58.60**	**4466.00**	**1963.26**
Std Dev (1 σ)	**14.36**	**1145.09**	**456.60**

Natick SSC Sign Test Data Sheet

Survey Date:	12-Dec-06
Survey Unit #:	3-1E
Building:	3
Floor:	1
FSS Floor Classification:	3
SU DCGLw (dpm/100cm^2):	3.60E+05

Instrument Number	Ratemeter/ Probe Models	Ratemeter S/N	Probe S/N	Efficiency[1]	Isotope	Probe Active Area (cm^2)
1	2224/43-68	154046	PR088917	3.60%	C-14	126
1	2224/43-68	154046	PR088917	17.20%	Th-230	126
2	2221/44-110	176947	PR178079	25.00%	H-3	126
3	19	87139				
Static Count Time (min):		0.5				
BKGD Count Time (min):		0.5				

SU Description: Third floor formerly lab, now offices 307, 309

1	2	3	4	5	6	7	8	9	10	11	12
Sample ID	Sample Type[2]	Instrument Number	Sample Location[3]	Surface Material[4]	Alpha Fixed-Point Result (30 sec gross counts)	Beta Fixed-Point Result (30 sec gross	Low Energy Beta Result (30 sec gross	Gamma Result (gross uR/hr))	Material Specific Alpha Background[5] (cpm)	Material Specific Beta Background[5] (cpm)	Material Specific Low Energy Beta Background[5] (cpm)
3-1E-1	S	1, 2, 3	F	FC	2	145	140	12	1.60	260.00	391.20
3-1E-2	S	1, 2, 3	F	FC	1	96	176	12	1.60	260.00	391.20
3-1E-3	S	1, 2, 3	F	FC	1	108	109	12	1.60	260.00	391.20
3-1E-4	S	1, 2, 3	F	FC	3	140	194	12	1.60	260.00	391.20
3-1E-5	S	1, 2, 3	F	FC	2	144	231	11	1.60	260.00	391.20
3-1E-6	S	1, 2, 3	F	FC	1	138	131	11	1.60	260.00	391.20
3-1E-7	S	1, 2, 3	F	FC	0	140	186	12	1.60	260.00	391.20
3-1E-8	S	1, 2, 3	F	FC	0	91	198	13	1.60	260.00	391.20
3-1E-9	S	1, 2, 3	F	FC	1	136	87	12	1.60	260.00	391.20
3-1E-10	S	1, 2, 3	F	FC	2	112	16	12	1.60	260.00	391.20
3-1E-11	S	1, 2, 3	F	FC	0	142	230	12	1.60	260.00	391.20
3-1E-12	S	1, 2, 3	F	FC	0	121	119	12	1.60	260.00	391.20
3-1E-13	S	1, 2, 3	F	FC	2	153	145	11	1.60	260.00	391.20
3-1E-14	S	1, 2, 3	F	FC	0	115	109	12	1.60	260.00	391.20
3-1E-15	S	1, 2, 3	F	FC	1	137	130	12	1.60	260.00	391.20
3-1E-16	S	1, 2, 3	F	FC	0	149	181	12	1.60	260.00	391.20
3-1E-17	S	1, 2, 3	F	FC	0	111	143	12	1.60	260.00	391.20

NOTES:

1 Instrument Efficiency = Instrument static 4-pi efficiency for isotope in next column
2 Sample Type: S = Static B = Biased Location
3 F = floor W = Lower wall (< 6 ft) CT = Counter Top
4 Surface Materials: BC (Bare Concrete), PC (Painted Concrete), BCB (Bare Cinder Block), FC (Floor Carpet), FT (Floor Tile), RS (Roof Sealant), M (Metal), O (Other)
5 Average of (5) 1-minute background readings collected in unimpacted areas for each building surface encountered during FSS
6 MARSSIM Sign Test parameter. If Result > DCGLw, Sign = -1, otherwise 1.
7 DCGL is based on C-14 beta emission

13	14	15	15	16	17	18
Net Fixed-Point Alpha Result (net cpm)	Net Fixed-Point Beta Result (net cpm)	Net Fixed-Point Low Energy Beta Result (net cpm)	Residual Alpha Surface Activity (dpm/100cm^2)	Residual Beta Surface Activity (dpm/100cm^2)	Residual Low Energy Beta Surface Activity (dpm/100cm^2)	Beta Sign Test Parameter[7]
2.40	30.00	-111.20	1.76E+01	1.05E+03	-8.15E+02	1
0.40	-68.00	-39.20	2.93E+00	-2.38E+03	-2.87E+02	1
0.40	-44.00	-173.20	2.93E+00	-1.54E+03	-1.27E+03	1
4.40	20.00	-3.20	3.22E+01	7.00E+02	-2.34E+01	1
2.40	28.00	70.80	1.76E+01	9.80E+02	5.19E+02	1
0.40	16.00	-129.20	2.93E+00	5.60E+02	-9.46E+02	1
-1.60	20.00	-19.20	-1.17E+01	7.00E+02	-1.41E+02	1
-1.60	-78.00	4.80	-1.17E+01	-2.73E+03	3.52E+01	1
0.40	12.00	-217.20	2.93E+00	4.20E+02	-1.59E+03	1
2.40	-36.00	-359.20	1.76E+01	-1.26E+03	-2.63E+03	1
-1.60	24.00	68.80	-1.17E+01	8.40E+02	5.04E+02	1
-1.60	-18.00	-153.20	-1.17E+01	-6.30E+02	-1.12E+03	1
2.40	46.00	-101.20	1.76E+01	1.61E+03	-7.41E+02	1
-1.60	-30.00	-173.20	-1.17E+01	-1.05E+03	-1.27E+03	1
0.40	14.00	-131.20	2.93E+00	4.90E+02	-9.61E+02	1
-1.60	38.00	-29.20	-1.17E+01	1.33E+03	-2.14E+02	1
-1.60	-38.00	-105.20	-1.17E+01	-1.33E+03	-7.71E+02	1

Mean	**2.07**	**-131.76**	**-689.64**
Median	**2.93**	**490.00**	**-770.65**
Max	**32.23**	**1610.00**	**518.65**
Range	**43.95**	**4340.00**	**3150.00**
Std Dev (1 σ)	**14.16**	**1343.72**	**796.44**

Natick SSC Sign Test Data Sheet

Survey Date:	12-Dec-06
Survey Unit #:	89
Building:	89
Floor:	1
FSS Floor Classification:	3
SU DCGLw (dpm/100cm^2):	3.60E+05

Instrument Number	Ratemeter/ Probe Models	Ratemeter S/N	Probe S/N	Efficiency[1]	Isotope	Probe Active Area (cm^2)
1	2224/43-68	154046	PR088917	3.60%	C-14	126
1	2224/43-68	154046	PR088917	17.20%	Th-230	126
2	2221/44-110	176947	PR178079	25.00%	H-3	126
3	19	87139				
Static Count Time (min):		0.5				
BKGD Count Time (min):		0.5				

SU Description: Waste storage building.

1	2	3	4	5	6	7	8	9	10	11	12	13
Sample ID	Sample Type[2]	Instrument Number	Sample Location[3]	Surface Material[4]	Alpha Fixed-Point Result (30 sec gross	Beta Fixed-Point Result (30 sec gross counts)	Low Energy Beta Result (30 sec gross counts)	Gamma Result (gross uR/hr))	Material Specific Alpha Background[5] (cpm)	Material Specific Beta Background[5] (cpm)	Material Specific Low Energy Beta Background[5] (cpm)	Net Fixed-Point Alpha Result (net cpm)
89-1	S	1, 2, 3	F	BC	1	79	144	15	3.20	294.80	382.40	-1.20
89-2	S	1, 2, 3	F	BC	1	209	151	15	3.20	294.80	382.40	-1.20
89-3	S	1, 2, 3	F	BC	1	148	127	15	3.20	294.80	382.40	-1.20
89-4	S	1, 2, 3	F	BC	1	126	199	15	3.20	294.80	382.40	-1.20
89-5	S	1, 2, 3	F	BC	2	175	150	15	3.20	294.80	382.40	0.80
89-6	S	1, 2, 3	F	BC	1	156	166	15	3.20	294.80	382.40	-1.20
89-7	S	1, 2, 3	F	BC	1	133	157	15	3.20	294.80	382.40	-1.20
89-8	S	1, 2, 3	F	BC	1	178	163	15	3.20	294.80	382.40	-1.20
89-9	S	1, 2, 3	F	BC	4	135	192	15	3.20	294.80	382.40	4.80
89-10	S	1, 2, 3	F	BC	0	68	111	15	3.20	294.80	382.40	-3.20
89-11	S	1, 2, 3	F	BC	1	113	148	15	3.20	294.80	382.40	-1.20
89-12	S	1, 2, 3	F	BC	1	150	144	15	3.20	294.80	382.40	-1.20
89-13	S	1, 2, 3	F	BC	2	156	169	15	3.20	294.80	382.40	0.80
89-14	S	1, 2, 3	F	BC	1	137	150	15	3.20	294.80	382.40	-1.20
89-15	S	1, 2, 3	F	BC	0	132	183	15	3.20	294.80	382.40	-3.20
89-16	S	1, 2, 3	F	BC	2	133	139	15	3.20	294.80	382.40	0.80
89-17	S	1, 2, 3	F	BC	0	140	135	15	3.20	294.80	382.40	-3.20

NOTES:

1. Instrument Efficiency = Instrument static 4-pi efficiency for isotope in next column
2. Sample Type: S = Static B = Biased Location
3. F = floor W = Lower wall (< 6 ft) CT = Counter Top
4. Surface Materials: BC (Bare Concrete), PC (Painted Concrete), BCB (Bare Cinder Block), FC (Floor Carpet), FT (Floor Tile), RS (Roof Sealant), M (Metal), O (Other)
5. Average of (5) 1-minute background readings collected in unimpacted areas for each building surface encountered during FSS
6. MARSSIM Sign Test parameter. If Result > DCGLw, Sign = -1, otherwise 1.
7. DCGL is based on C-14 beta emission

14	15	15	16	17	18
Net Fixed-Point Beta Result (net cpm)	Net Fixed-Point Low Energy Beta Result (net cpm)	Residual Alpha Surface Activity (dpm/100cm^2)	Residual Beta Surface Activity (dpm/100cm^2)	Residual Low Energy Beta Surface Activity (dpm/100cm^2)	Beta Sign Test Parameter[7]
-136.80	-94.40	-8.79E+00	-4.79E+03	-6.92E+02	1
123.20	-80.40	-8.79E+00	4.31E+03	-5.89E+02	1
1.20	-128.40	-8.79E+00	4.20E+01	-9.41E+02	1
-42.80	15.60	-8.79E+00	-1.50E+03	1.14E+02	1
55.20	-82.40	5.86E+00	1.93E+03	-6.04E+02	1
17.20	-50.40	-8.79E+00	6.02E+02	-3.69E+02	1
-28.80	-68.40	-8.79E+00	-1.01E+03	-5.01E+02	1
61.20	-56.40	-8.79E+00	2.14E+03	-4.13E+02	1
-24.80	1.60	3.52E+01	-8.68E+02	1.17E+01	1
-158.80	-160.40	-2.34E+01	-5.56E+03	-1.18E+03	1
-68.80	-86.40	-8.79E+00	-2.41E+03	-6.33E+02	1
5.20	-94.40	-8.79E+00	1.82E+02	-6.92E+02	1
17.20	-44.40	5.86E+00	6.02E+02	-3.25E+02	1
-20.80	-82.40	-8.79E+00	-7.28E+02	-6.04E+02	1
-30.80	-16.40	-2.34E+01	-1.08E+03	-1.20E+02	1
-28.80	-104.40	5.86E+00	-1.01E+03	-7.65E+02	1
-14.80	-112.40	-2.34E+01	-5.18E+02	-8.23E+02	1

Mean	**-6.21**	**-567.41**	**-536.40**
Median	**-8.79**	**-728.00**	**-603.63**
Max	**35.16**	**4312.00**	**114.28**
Range	**58.60**	**9870.00**	**1289.30**
Std Dev (1 σ)	**13.93**	**2355.91**	**331.76**

Natick SSC Sign Test Data Sheet

Survey Date:	12-Dec-06
Survey Unit #:	30-roof
Building:	30
Floor:	roof
FSS Floor Classification:	3
SU DCGLw (dpm/100cm^2):	3.60E+05

Instrument Number	Ratemeter/ Probe Models	Ratemeter S/N	Probe S/N	Efficiency[1]	Isotope	Probe Active Area (cm^2)
1	2224/43-68	154046	PR088917	3.60%	C-14	126
1	2224/43-68	154046	PR088917	17.20%	Th-230	126
2	2221/44-110	176947	PR178079	25.00%	H-3	126
3	19	87139				
Static Count Time (min):		0.5				
BKGD Count Time (min):		0.5				

SU Description: Roof over room 108

1	2	3	4	5	6	7	8	9	10	11	12
Sample ID	Sample Type[2]	Instrument Number	Sample Location[3]	Surface Material[4]	Alpha Fixed-Point Result (30 sec gross counts)	Beta Fixed-Point Result (30 sec gross counts)	Low Energy Beta Result (30 sec gross counts)	Gamma Result (gross uR/hr))	Material Specific Alpha Background[5] (cpm)	Material Specific Beta Background[5] (cpm)	Material Specific Low Energy Beta Background[5] (cpm)
30-roof-1	S	1	R	RS	2	110	N/A	N/A	3.20	294.80	N/A
30-roof-2	S	1	R	RS	1	97	N/A	N/A	3.20	294.80	N/A
30-roof-3	S	1	R	RS	0	92	N/A	N/A	3.20	294.80	N/A
30-roof-4	S	1	R	RS	0	94	N/A	N/A	3.20	294.80	N/A
30-roof-5	S	1	R	RS	1	104	N/A	N/A	3.20	294.80	N/A
30-roof-6	S	1	R	RS	1	111	N/A	N/A	3.20	294.80	N/A
30-roof-7	S	1	R	RS	1	88	N/A	N/A	3.20	294.80	N/A
30-roof-8	S	1	R	RS	2	158	N/A	N/A	3.20	294.80	N/A
30-roof-9	S	1	R	RS	0	90	N/A	N/A	3.20	294.80	N/A
30-roof-10	S	1	R	RS	2	91	N/A	N/A	3.20	294.80	N/A
30-roof-11	S	1	R	RS	2	105	N/A	N/A	3.20	294.80	N/A
30-roof-12	S	1	R	RS	1	93	N/A	N/A	3.20	294.80	N/A
30-roof-13	S	1	R	RS	2	117	N/A	N/A	3.20	294.80	N/A
30-roof-14	S	1	R	RS	3	88	N/A	N/A	3.20	294.80	N/A
30-roof-15	S	1	R	RS	2	92	N/A	N/A	3.20	294.80	N/A
30-roof-16	S	1	R	RS	0	106	N/A	N/A	3.20	294.80	N/A
30-roof-17	S	1	R	RS	2	175	N/A	N/A	3.20	294.80	N/A
30-roof-18	B	1	R	RS	3	128	N/A	N/A	1.60	147.40	N/A

NOTES:

1 Instrument Efficiency = Instrument static 4-pi efficiency for isotope in next column
2 Sample Type: S = Static B = Biased Location
3 F = floor W = Lower wall (< 6 ft) CT = Counter Top
4 Surface Materials: BC (Bare Concrete), PC (Painted Concrete), BCB (Bare Cinder Block), FC (Floor Carpet), FT (Floor Tile), RS (Roof Sealant), M (Metal), O (Other)
5 Average of (5) 1-minute background readings collected in unimpacted areas for each building surface encountered during FSS
6 MARSSIM Sign Test parameter. If Result > DCGLw, Sign = -1, otherwise 1.
7 DCGL is based on C-14 beta emission

13	14	15	15	16	17	18
Net Fixed-Point Alpha Result (net cpm)	Net Fixed-Point Beta Result (net cpm)	Net Fixed-Point Low Energy Beta Result (net cpm)	Residual Alpha Surface Activity (dpm/100cm^2)	Residual Beta Surface Activity (dpm/100cm^2)	Residual Low Energy Beta Surface Activity (dpm/100cm^2)	Beta Sign Test Parameter[7]
0.80	-74.80	N/A	5.86E+00	-2.62E+03	N/A	1
-1.20	-100.80	N/A	-8.79E+00	-3.53E+03	N/A	1
-3.20	-110.80	N/A	-2.34E+01	-3.88E+03	N/A	1
-3.20	-106.80	N/A	-2.34E+01	-3.74E+03	N/A	1
-1.20	-86.80	N/A	-8.79E+00	-3.04E+03	N/A	1
-1.20	-72.80	N/A	-8.79E+00	-2.55E+03	N/A	1
-1.20	-118.80	N/A	-8.79E+00	-4.16E+03	N/A	1
0.80	21.20	N/A	5.86E+00	7.42E+02	N/A	1
-3.20	-114.80	N/A	-2.34E+01	-4.02E+03	N/A	1
0.80	-112.80	N/A	5.86E+00	-3.95E+03	N/A	1
0.80	-84.80	N/A	5.86E+00	-2.97E+03	N/A	1
-1.20	-108.80	N/A	-8.79E+00	-3.81E+03	N/A	1
0.80	-60.80	N/A	5.86E+00	-2.13E+03	N/A	1
2.80	-118.80	N/A	2.05E+01	-4.16E+03	N/A	1
0.80	-110.80	N/A	5.86E+00	-3.88E+03	N/A	1
-3.20	-82.80	N/A	-2.34E+01	-2.90E+03	N/A	1
0.80	55.20	N/A	5.86E+00	1.93E+03	N/A	1
1.40	-19.40	N/A	1.03E+01	-6.79E+02	N/A	N/A

Mean	**-4.48**	**-2860.94**	**N/A**
Median	**-8.79**	**-3528.00**	**N/A**
Max	**20.51**	**1932.00**	**N/A**
Range	**43.95**	**6090.00**	**N/A**
Std Dev (1 σ)	**13.47**	**1709.48**	**N/A**

Natick SSC Sign Test Data Sheet

Survey Date:	13-Dec-06
Survey Unit #:	30-1
Building:	30
Floor:	1
FSS Floor Classification:	3
SU DCGLw (dpm/100cm^2):	3.60E+05

Instrument Number	Ratemeter/ Probe Models	Ratemeter S/N	Probe S/N	Efficiency[1]	Isotope	Probe Active Area (cm^2)
1	2224/43-68	154046	PR088917	3.60%	C-14	126
1	2224/43-68	154046	PR088917	17.20%	Th-230	126
2	2221/44-110	176947	PR178079	25.00%	H-3	126
3	19	87139				
Static Count Time (min):		0.5				
BKGD Count Time (min):		0.5				

SU Description: Building 30, rm 101, 103, 108

1	2	3	4	5	6	7	8	9	10	11	12	13
Sample ID	Sample Type[2]	Instrument Number	Sample Location[3]	Surface Material[4]	Alpha Fixed-Point Result (30 sec gross counts)	Beta Fixed-Point Result (30 sec gross counts)	Low Energy Beta Result (30 sec gross counts)	Gamma Result (gross uR/hr))	Material Specific Alpha Background[5] (cpm)	Material Specific Beta Background[5] (cpm)	Material Specific Low Energy Beta Background[5]	Net Fixed-Point Alpha Result (net cpm)
30-1-1	S	1, 2, 3	F	FT	0	176	250	9	0.40	292.00	352.80	-0.40
30-1-2	S	1, 2, 3	F	FT	1	150	174	9	0.40	292.00	352.80	1.60
30-1-3	S	1, 2, 3	F	FT	1	155	139	9	0.40	292.00	352.80	1.60
30-1-4	S	1, 2, 3	F	FT	1	181	182	9	0.40	292.00	352.80	1.60
30-1-5	S	1, 2, 3	F	FT	3	141	215	10	0.40	292.00	352.80	5.60
30-1-6	S	1, 2, 3	F	FT	1	171	236	9	0.40	292.00	352.80	1.60
30-1-7	S	1, 2, 3	F	FT	1	163	227	9	0.40	292.00	352.80	1.60
30-1-8	S	1, 2, 3	H	M	2	103	144	9	0.00	253.20	296.00	4.00
30-1-9	S	1, 2, 3	CT	O	1	167	204	9	0.60	192.40	242.80	1.40
30-1-10	S	1, 2, 3	F	FC	2	149	84	11	1.60	260.00	391.20	2.40
30-1-11	S	1, 2, 3	F	FC	2	130	103	11	1.60	260.00	391.20	2.40
30-1-12	S	1, 2, 3	F	FC	2	164	95	10	1.60	260.00	391.20	2.40
30-1-13	S	1, 2, 3	F	FC	3	110	124	10	1.60	260.00	391.20	4.40
30-1-14	S	1, 2, 3	F	FC	0	129	88	11	1.60	260.00	391.20	-1.60
30-1-15	S	1, 2, 3	F	FC	1	138	101	10	1.60	260.00	391.20	0.40
30-1-16	S	1, 2, 3	F	PC	1	170	153	11	3.20	294.80	382.40	-1.20
30-1-17	S	1, 2, 3	F	FC	2	114	101	10	1.60	260.00	391.20	2.40
30-1-18	B	1, 2, 3	W	PCB	0	2212	8811	11	1.60	147.40	191.20	-1.60

NOTES:

1 Instrument Efficiency = Instrument static 4-pi efficiency for isotope in next column
2 Sample Type: S = Static B = Biased Location
3 F = floor W = Lower wall (< 6 ft) CT = Counter Top
4 Surface Materials: BC (Bare Concrete), PC (Painted Concrete), BCB (Bare Cinder Block), FC (Floor Carpet), FT (Floor Tile), RS (Roof Sealant), M (Metal), O (Other)
5 Average of (5) 1-minute background readings collected in unimpacted areas for each building surface encountered during FSS
6 MARSSIM Sign Test parameter. If Result > DCGLw, Sign = -1, otherwise 1.
7 DCGL is based on C-14 beta emission

14	15	15	16	17	18
Net Fixed-Point Beta Result (net cpm)	Net Fixed-Point Low Energy Beta Result (net cpm)	Residual Alpha Surface Activity (dpm/100cm^2)	Residual Beta Surface Activity (dpm/100cm^2)	Residual Low Energy Beta Surface Activity (dpm/100cm^2)	Beta Sign Test Parameter[7]
60.00	147.20	-2.93E+00	2.10E+03	1.08E+03	1
8.00	-4.80	1.17E+01	2.80E+02	-3.52E+01	1
18.00	-74.80	1.17E+01	6.30E+02	-5.48E+02	1
70.00	11.20	1.17E+01	2.45E+03	8.20E+01	1
-10.00	77.20	4.10E+01	-3.50E+02	5.66E+02	1
50.00	119.20	1.17E+01	1.75E+03	8.73E+02	1
34.00	101.20	1.17E+01	1.19E+03	7.41E+02	1
-47.20	-8.00	2.93E+01	-1.65E+03	-5.86E+01	1
141.60	165.20	1.03E+01	4.96E+03	1.21E+03	1
38.00	-223.20	1.76E+01	1.33E+03	-1.64E+03	1
0.00	-185.20	1.76E+01	0.00E+00	-1.36E+03	1
68.00	-201.20	1.76E+01	2.38E+03	-1.47E+03	1
-40.00	-143.20	3.22E+01	-1.40E+03	-1.05E+03	1
-2.00	-215.20	-1.17E+01	-7.00E+01	-1.58E+03	1
16.00	-189.20	2.93E+00	5.60E+02	-1.39E+03	1
45.20	-76.40	-8.79E+00	1.58E+03	-5.60E+02	1
-32.00	-189.20	1.76E+01	-1.12E+03	-1.39E+03	1
2064.60	8619.80	-1.17E+01	7.23E+04	6.31E+04	N/A

Mean	**13.01**	**859.76**	**-383.17**
Median	**11.72**	**630.00**	**-547.95**
Max	**41.02**	**4956.00**	**1210.19**
Range	**52.74**	**6608.00**	**2845.26**
Std Dev (1 σ)	**13.61**	**1652.32**	**1015.58**

APPENDIX C

ANALYTICAL RESULTS

Natick SSC Analytical LSC Results

	C-14					H-3				
AL[1] (dpm/100cm^2)	360,000					12,000,000				
Sample Locations	RESULT (dpm/ 100cm^2)	TPU[2]	Flags[3]	MDC[4]	>AL?	RESULT (dpm/ 100cm^2)	TPU[2]	Flags[3]	MDC[4]	>AL?
3-1W-1	0.4 +/-	4.7	U	7.8		-9.3 +/-	9.1	U	15.8	
3-1W-2	0.9 +/-	4.2	U	7.1		-3.1 +/-	8.0	U	13.8	
3-1W-3	0.2 +/-	4.4	U	7.5		-8.0 +/-	8.4	U	14.9	
3-1W-4	0.2 +/-	4.0	U	6.9		-6.9 +/-	7.5	U	13.1	
3-1W-5	-5.6 +/-	4.4	U	8.0		-8.0 +/-	9.1	U	16.0	
3-1W-6	-0.7 +/-	4.0	U	6.7		-6.0 +/-	7.1	U	12.4	
3-1W-7	-0.4 +/-	5.8	U	9.8		-10.9 +/-	11.5	U	20.4	
3-1W-8	3.1 +/-	4.2	U	7.1		-1.3 +/-	8.0	U	13.5	
3-1W-9	-2.2 +/-	4.2	U	7.3		-2.9 +/-	8.4	U	14.4	
3-1W-10	-3.1 +/-	3.8	U	6.7		-2.9 +/-	7.1	U	12.4	
3-1W-11	2.4 +/-	4.2	U	6.9		-5.8 +/-	7.3	U	12.9	
3-1W-12	1.1 +/-	4.2	U	6.9		0.2 +/-	7.5	U	12.9	
3-1W-13	-3.3 +/-	4.2	U	7.3		-7.5 +/-	8.2	U	14.4	
3-1W-14	-5.3 +/-	4.7	U	8.0		-9.5 +/-	9.3	U	16.4	
3-1W-15	-3.1 +/-	4.7	U	8.0		-8.7 +/-	9.3	U	16.4	
3-1W-16	-0.9 +/-	4.0	U	6.9		-3.8 +/-	7.8	U	13.3	
3-1W-17	-1.6 +/-	4.0	U	6.9		-2.9 +/-	7.5	U	12.9	
3-2W-1	-2.0 +/-	4.4	U	7.5		-1.3 +/-	8.2	U	14.2	
3-2W-2	0.0 +/-	4.2	U	7.1		6.4 +/-	8.0	U	13.1	
3-2W-3	-3.1 +/-	4.0	U	6.9		-2.2 +/-	7.1	U	12.2	
3-2W-4	-0.9 +/-	4.2	U	7.1		-6.4 +/-	7.5	U	13.1	
3-2W-5	3.6 +/-	4.2	U	6.9		3.3 +/-	7.8	U	12.9	
3-2W-6	-0.9 +/-	6.9	U	11.5		-7.8 +/-	13.3	U	23.1	
3-2W-7	0.2 +/-	4.2	U	7.1		-5.8 +/-	7.5	U	13.1	
3-2W-8	-4.7 +/-	3.8	U	6.7		0.2 +/-	7.1	U	12.2	
3-2W-9	-0.4 +/-	4.2	U	7.1		1.8 +/-	7.5	U	12.7	
3-2W-10	-2.7 +/-	4.2	U	7.1		-6.4 +/-	7.3	U	12.9	
3-2W-11	0.0 +/-	4.0	U	6.9		0.0 +/-	7.5	U	13.1	
3-2W-12	1.3 +/-	4.2	U	7.1		0.0 +/-	8.0	U	13.5	
3-2W-13	2.2 +/-	4.2	U	6.9		-4.9 +/-	7.3	U	12.9	
3-2W-14	0.7 +/-	4.2	U	7.3		0.0 +/-	8.0	U	13.5	
3-2W-15	-0.7 +/-	4.4	U	7.3		-3.6 +/-	8.2	U	14.2	
3-2W-16	-2.4 +/-	4.4	U	7.8		-5.6 +/-	8.7	U	14.9	
3-2W-17	0.4 +/-	4.2	U	7.3		1.1 +/-	8.2	U	13.8	
3-2W-18	-0.7 +/-	4.2	U	7.1		-6.4 +/-	7.3	U	13.1	
3-2W-19	0.4 +/-	4.2	U	7.1		-2.4 +/-	7.5	U	13.1	
3-3E-1	1.3 +/-	4.0	U	6.7		2.7 +/-	6.4	U	10.7	
3-3E-2	-0.4 +/-	4.0	U	6.7		7.1 +/-	7.3	U	12.0	
3-3E-3	2.2 +/-	4.2	U	7.1		5.3 +/-	7.5	U	12.7	
3-3E-4	-0.4 +/-	4.4	U	7.5		4.2 +/-	8.4	U	14.0	
3-3E-5	-1.3 +/-	4.0	U	7.1		6.2 +/-	7.8	U	12.7	
3-3E-6	-0.9 +/-	3.8	U	6.7		6.2 +/-	6.9	U	11.3	
3-3E-7	-0.7 +/-	4.0	U	6.7		5.6 +/-	7.1	U	11.5	
3-3E-8	-1.1 +/-	4.0	U	6.9		4.0 +/-	7.3	U	12.0	
3-3E-9	1.8 +/-	4.2	U	6.9		0.2 +/-	7.3	U	12.4	
3-3E-10	-0.9 +/-	3.8	U	6.7		-1.6 +/-	6.7	U	11.3	
3-3E-11	-2.4 +/-	4.0	U	6.9		0.2 +/-	7.3	U	12.4	
3-3E-12	0.7 +/-	4.0	U	6.7		4.0 +/-	6.7	U	10.9	
3-3E-13	-1.6 +/-	4.4	U	7.5		1.3 +/-	7.8	U	13.3	
3-3E-14	-0.2 +/-	4.0	U	6.9		6.2 +/-	7.3	U	11.8	
3-3E-15	-0.2 +/-	4.0	U	6.9		4.4 +/-	7.1	U	11.8	

Natick SSC Analytical LSC Results

	C-14					H-3				
AL[1] (dpm/100cm^2)	360,000					12,000,000				
Sample Locations	RESULT (dpm/ 100cm^2)	TPU[2]	Flags[3]	MDC[4]	>AL?	RESULT (dpm/ 100cm^2)	TPU[2]	Flags[3]	MDC[4]	>AL?
3-3E-16	0.0 +/-	4.2	U	7.1		8.4 +/-	7.5	U	12.0	
3-3E-17	1.6 +/-	4.2	U	6.9		0.2 +/-	6.9	U	11.5	
30-1-1	-4.0 +/-	4.9	U	8.4		-0.9 +/-	9.8	U	16.4	
30-1-2	-1.8 +/-	4.9	U	8.2		-4.7 +/-	9.3	U	16.2	
30-1-3	-6.0 +/-	5.6	U	9.8		-5.8 +/-	11.3	U	19.5	
30-1-4	4.7 +/-	6.7	U	10.9		16.4 +/-	13.8	U	21.8	
30-1-5	1.1 +/-	4.9	U	8.0		-6.4 +/-	9.1	U	15.8	
30-1-6	-4.4 +/-	5.3	U	9.1		-11.8 +/-	10.4	U	18.2	
30-1-7	-5.1 +/-	4.9	U	8.4		-13.8 +/-	9.3	U	16.4	
30-1-8	-2.0 +/-	4.0	U	6.9		-3.1 +/-	7.3	U	12.9	
30-1-9	-2.9 +/-	6.9	U	11.8		-12.2 +/-	13.3	U	23.3	
30-1-10	1.8 +/-	4.2	U	6.9		5.8 +/-	8.0	U	12.9	
30-1-11	0.0 +/-	4.0	U	6.7		3.1 +/-	6.9	U	11.5	
30-1-12	-2.7 +/-	4.0	U	6.9		4.0 +/-	7.5	U	12.4	
30-1-13	-1.1 +/-	5.1	U	8.7		-11.8 +/-	9.8	U	17.1	
30-1-14	-1.1 +/-	8.4	U	14.4		-11.8 +/-	16.2	U	28.2	
30-1-15	2.9 +/-	4.2	U	6.9		3.1 +/-	7.5	U	12.9	
30-1-16	-1.6 +/-	4.0	U	6.7		-1.3 +/-	7.1	U	12.2	
30-1-17	0.0 +/-	4.0	U	6.9		2.4 +/-	7.5	U	12.7	
30-1-18	5372.4 +/-	821.4		0.0		4817.4 +/-	732.6		22.2	
30-1-19	3.8 +/-	3.8	U	6.2		4.0 +/-	6.7	U	11.1	
30-1-20	3.3 +/-	3.8	U	6.2		8.2 +/-	6.9	U	11.1	
30-roof-1	-1.6 +/-	4.0	U	6.9		4.0 +/-	7.3	U	12.2	
30-roof-2	0.0 +/-	4.0	U	6.9		-2.4 +/-	7.1	U	12.2	
30-roof-3	-0.2 +/-	4.0	U	6.9		2.9 +/-	7.3	U	12.4	
30-roof-4	-1.8 +/-	4.0	U	6.9		-1.6 +/-	7.1	U	12.2	
30-roof-5	-0.9 +/-	4.4	U	7.5		-1.3 +/-	8.2	U	14.2	
30-roof-6	-2.2 +/-	4.0	U	7.1		0.9 +/-	7.3	U	12.7	
30-roof-7	0.0 +/-	4.0	U	6.9		2.7 +/-	7.3	U	12.2	
30-roof-8	-2.0 +/-	4.2	U	7.3		-6.2 +/-	7.5	U	13.3	
30-roof-9	1.1 +/-	4.0	U	6.9		-0.2 +/-	7.1	U	12.0	
30-roof-10	0.0 +/-	4.2	U	7.1		4.7 +/-	7.5	U	12.7	
30-roof-11	-0.2 +/-	4.2	U	7.3		1.8 +/-	8.0	U	13.3	
30-roof-12	-3.6 +/-	4.0	U	7.1		-2.7 +/-	7.3	U	12.7	
30-roof-13	0.0 +/-	4.0	U	6.9		4.7 +/-	7.5	U	12.4	
30-roof-14	4.0 +/-	4.4	U	7.1		2.2 +/-	7.8	U	12.9	
30-roof-15	-0.2 +/-	4.0	U	6.9		5.6 +/-	7.3	U	12.2	
30-roof-16	-0.7 +/-	4.2	U	7.1		2.9 +/-	7.5	U	12.7	
30-roof-17	-1.8 +/-	4.0	U	6.9		3.6 +/-	7.1	U	12.0	
30-roof-18	-1.3 +/-	4.0	U	7.1		-0.7 +/-	7.3	U	12.7	
89-1	3.6 +/-	6.7	U	11.1		1.8 +/-	12.4	U	21.3	
89-2	10.4 +/-	6.7	U	10.4		23.1 +/-	13.3	LT	20.2	
89-3	6.7 +/-	7.3	U	12.0		13.5 +/-	14.2	U	22.9	
89-4	-1.3 +/-	5.6	U	9.5		-4.0 +/-	10.7	U	18.4	
89-5	10.2 +/-	8.2	U	13.1		30.2 +/-	16.7	LT	25.1	
89-6	3.6 +/-	5.6	U	9.1		6.2 +/-	10.4	U	17.3	
89-7	-0.4 +/-	8.7	U	14.4		-12.0 +/-	15.5	U	27.1	
89-8	7.1 +/-	5.8	U	9.1		18.6 +/-	11.5	LT	17.8	
89-9	3.1 +/-	6.4	U	10.7		5.8 +/-	12.4	U	20.6	
89-10	3.8 +/-	5.3	U	8.7		17.8 +/-	11.1	LT	16.9	
89-11	-1.3 +/-	6.7	U	11.5		2.4 +/-	13.1	U	22.2	
89-12	-2.4 +/-	4.4	U	7.8		-0.7 +/-	8.4	U	14.4	
89-13	4.2 +/-	6.0	U	9.8		10.2 +/-	11.5	U	18.6	
89-14	4.2 +/-	6.0	U	9.8		3.1 +/-	11.3	U	19.1	
89-15	0.0 +/-	5.3	U	9.1		5.6 +/-	10.7	U	17.8	
89-16	3.3 +/-	5.1	U	8.4		0.7 +/-	9.3	U	16.0	
89-17	0.0 +/-	5.6	U	9.3		4.7 +/-	10.9	U	18.2	

NOTES:

1) AL = Action Level
2) TPU = Total Propagated Uncertainty
3) Flags = Qualifier
4) MDC = Minimum Detectable Concentration

Natick SSC Analytical LSC Results Summary

	C-14					H-3				
AL[1] (dpm/100cm²)	360,000					12,000,000				
Sample Locations	RESULT (dpm/ 100cm²)	TPU[2]	Flags[3]	MDC[4]	>AL?	RESULT (dpm/ 100cm²)	TPU[2]	Flags[3]	MDC[4]	>AL?
3-1W-1	0.4	4.7	U	7.8		-9.3	9.1	U	15.8	
3-1W-2	0.9	4.2	U	7.1		-3.1	8.0	U	13.8	
3-1W-3	0.2	4.4	U	7.5		-8.0	8.4	U	14.9	
3-1W-4	0.2	4.0	U	6.9		-6.9	7.5	U	13.1	
3-1W-5	-5.6	4.4	U	8.0		-8.0	9.1	U	16.0	
3-1W-6	-0.7	4.0	U	6.7		-6.0	7.1	U	12.4	
3-1W-7	-0.4	5.8	U	9.8		-10.9	11.5	U	20.4	
3-1W-8	3.1	4.2	U	7.1		-1.3	8.0	U	13.5	
3-1W-9	-2.2	4.2	U	7.3		-2.9	8.4	U	14.4	
3-1W-10	-3.1	3.8	U	6.7		-2.9	7.1	U	12.4	
3-1W-11	2.4	4.2	U	6.9		-5.8	7.3	U	12.9	
3-1W-12	1.1	4.2	U	6.9		0.2	7.5	U	12.9	
3-1W-13	-3.3	4.2	U	7.3		-7.5	8.2	U	14.4	
3-1W-14	-5.3	4.7	U	8.0		-9.5	9.3	U	16.4	
3-1W-15	-3.1	4.7	U	8.0		-8.7	9.3	U	16.4	
3-1W-16	-0.9	4.0	U	6.9		-3.8	7.8	U	13.3	
3-1W-17	-1.6	4.0	U	6.9		-2.9	7.5	U	12.9	
Average	-1.04			**Number of Locations Exceeding AL**	0	-5.7			**Number of Locations Exceeding AL**	0
Std. Dev	2.5					3.2				
Max	3.1					0.2				
3-2W-1	-2.0	4.4	U	7.5		-1.3	8.2	U	14.2	
3-2W-2	0.0	4.2	U	7.1		6.4	8.0	U	13.1	
3-2W-3	-3.1	4.0	U	6.9		-2.2	7.1	U	12.2	
3-2W-4	-0.9	4.2	U	7.1		-6.4	7.5	U	13.1	
3-2W-5	3.6	4.2	U	6.9		3.3	7.8	U	12.9	
3-2W-6	-0.9	6.9	U	11.5		-7.8	13.3	U	23.1	
3-2W-7	0.2	4.2	U	7.1		-5.8	7.5	U	13.1	
3-2W-8	-4.7	3.8	U	6.7		0.2	7.1	U	12.2	
3-2W-9	-0.4	4.2	U	7.1		1.8	7.5	U	12.7	
3-2W-10	-2.7	4.2	U	7.1		-6.4	7.3	U	12.9	
3-2W-11	0.0	4.0	U	6.9		0.0	7.5	U	13.1	
3-2W-12	1.3	4.2	U	7.1		0.0	8.0	U	13.5	
3-2W-13	2.2	4.2	U	6.9		-4.9	7.3	U	12.9	
3-2W-14	0.7	4.2	U	7.3		0.0	8.0	U	13.5	
3-2W-15	-0.7	4.4	U	7.3		-3.6	8.2	U	14.2	
3-2W-16	-2.4	4.4	U	7.8		-5.6	8.7	U	14.9	
3-2W-17	0.4	4.2	U	7.3		1.1	8.2	U	13.8	
3-2W-18	-0.7	4.2	U	7.1		-6.4	7.3	U	13.1	
3-2W-19	0.4	4.2	U	7.1		-2.4	7.5	U	13.1	
Average	-0.50			**Number of Locations Exceeding AL**	0	-2.10			**Number of Locations Exceeding AL**	0
Std. Dev	1.92					3.9				
Max	3.6					6.4				

Natick SSC Analytical LSC Results Summary

	C-14					H-3				
AL[1] (dpm/100cm^2)	360,000					12,000,000				
Sample Locations	RESULT (dpm/ 100cm^2)	TPU[2]	Flags[3]	MDC[4]	>AL?	RESULT (dpm/ 100cm^2)	TPU[2]	Flags[3]	MDC[4]	>AL?
3-3E-1	1.3	+/- 4.0	U	6.7		2.7	+/- 6.4	U	10.7	
3-3E-2	-0.4	+/- 4.0	U	6.7		7.1	+/- 7.3	U	12.0	
3-3E-3	2.2	+/- 4.2	U	7.1		5.3	+/- 7.5	U	12.7	
3-3E-4	-0.4	+/- 4.4	U	7.5		4.2	+/- 8.4	U	14.0	
3-3E-5	-1.3	+/- 4.0	U	7.1		6.2	+/- 7.8	U	12.7	
3-3E-6	-0.9	+/- 3.8	U	6.7		6.2	+/- 6.9	U	11.3	
3-3E-7	-0.7	+/- 4.0	U	6.7		5.6	+/- 7.1	U	11.5	
3-3E-8	-1.1	+/- 4.0	U	6.9		4.0	+/- 7.3	U	12.0	
3-3E-9	1.8	+/- 4.2	U	6.9		0.2	+/- 7.3	U	12.4	
3-3E-10	-0.9	+/- 3.8	U	6.7		-1.6	+/- 6.7	U	11.3	
3-3E-11	-2.4	+/- 4.0	U	6.9		0.2	+/- 7.3	U	12.4	
3-3E-12	0.7	+/- 4.0	U	6.7		4.0	+/- 6.7	U	10.9	
3-3E-13	-1.6	+/- 4.4	U	7.5		1.3	+/- 7.8	U	13.3	
3-3E-14	-0.2	+/- 4.0	U	6.9		6.2	+/- 7.3	U	11.8	
3-3E-15	-0.2	+/- 4.0	U	6.9		4.4	+/- 7.1	U	11.8	
3-3E-16	0.0	+/- 4.2	U	7.1		8.4	+/- 7.5	U	12.0	
3-3E-17	1.6	+/- 4.2	U	6.9		0.2	+/- 6.9	U	11.5	
Average	-0.16					3.8				
Std. Dev	1.28			Number of Locations Exceeding AL	0	2.9			Number of Locations Exceeding AL	0
Max	2.2					8.4				
30-1-1	-4.0	+/- 4.9	U	8.4		-0.9	+/- 9.8	U	16.4	
30-1-2	-1.8	+/- 4.9	U	8.2		-4.7	+/- 9.3	U	16.2	
30-1-3	-6.0	+/- 5.6	U	9.8		-5.8	+/- 11.3	U	19.5	
30-1-4	4.7	+/- 6.7	U	10.9		16.4	+/- 13.8	U	21.8	
30-1-5	1.1	+/- 4.9	U	8.0		-6.4	+/- 9.1	U	15.8	
30-1-6	-4.4	+/- 5.3	U	9.1		-11.8	+/- 10.4	U	18.2	
30-1-7	-5.1	+/- 4.9	U	8.4		-13.8	+/- 9.3	U	16.4	
30-1-8	-2.0	+/- 4.0	U	6.9		-3.1	+/- 7.3	U	12.9	
30-1-9	-2.9	+/- 6.9	U	11.8		-12.2	+/- 13.3	U	23.3	
30-1-10	1.8	+/- 4.2	U	6.9		5.8	+/- 8.0	U	12.9	
30-1-11	0.0	+/- 4.0	U	6.7		3.1	+/- 6.9	U	11.5	
30-1-12	-2.7	+/- 4.0	U	6.9		4.0	+/- 7.5	U	12.4	
30-1-13	-1.1	+/- 5.1	U	8.7		-11.8	+/- 9.8	U	17.1	
30-1-14	-1.1	+/- 8.4	U	14.4		-11.8	+/- 16.2	U	28.2	
30-1-15	2.9	+/- 4.2	U	6.9		3.1	+/- 7.5	U	12.9	
30-1-16	-1.6	+/- 4.0	U	6.7		-1.3	+/- 7.1	U	12.2	
30-1-17	0.0	+/- 4.0	U	6.9		2.4	+/- 7.5	U	12.7	
30-1-18	5372.4	+/- 821.4		0.0		4817.4	+/- 732.6		22.2	
30-1-19	3.8	+/- 3.8	U	6.2		4.0	+/- 6.7	U	11.1	
30-1-20	3.3	+/- 3.8	U	6.2		8.2	+/- 6.9	U	11.1	
Average	268					239				
Std. Dev	1201			Number of Locations Exceeding AL	0	1078			Number of Locations Exceeding AL	0
Max	5372					4817				

Natick SSC Analytical LSC Results Summary

	C-14					H-3				
AL[1] (dpm/100cm^2)	360,000					12,000,000				
Sample Locations	RESULT (dpm/100cm^2)	TPU[2]	Flags[3]	MDC[4]	>AL?	RESULT (dpm/100cm^2)	TPU[2]	Flags[3]	MDC[4]	>AL?
30-roof-1	-1.6	+/- 4.0	U	6.9		4.0	+/- 7.3	U	12.2	
30-roof-2	0.0	+/- 4.0	U	6.9		-2.4	+/- 7.1	U	12.2	
30-roof-3	-0.2	+/- 4.0	U	6.9		2.9	+/- 7.3	U	12.4	
30-roof-4	-1.8	+/- 4.0	U	6.9		-1.6	+/- 7.1	U	12.2	
30-roof-5	-0.9	+/- 4.4	U	7.5		-1.3	+/- 8.2	U	14.2	
30-roof-6	-2.2	+/- 4.0	U	7.1		0.9	+/- 7.3	U	12.7	
30-roof-7	0.0	+/- 4.0	U	6.9		2.7	+/- 7.3	U	12.2	
30-roof-8	-2.0	+/- 4.2	U	7.3		-6.2	+/- 7.5	U	13.3	
30-roof-9	1.1	+/- 4.0	U	6.9		-0.2	+/- 7.1	U	12.0	
30-roof-10	0.0	+/- 4.2	U	7.1		4.7	+/- 7.5	U	12.7	
30-roof-11	-0.2	+/- 4.2	U	7.3		1.8	+/- 8.0	U	13.3	
30-roof-12	-3.6	+/- 4.0	U	7.1		-2.7	+/- 7.3	U	12.7	
30-roof-13	0.0	+/- 4.0	U	6.9		4.7	+/- 7.5	U	12.4	
30-roof-14	4.0	+/- 4.4	U	7.1		2.2	+/- 7.8	U	12.9	
30-roof-15	-0.2	+/- 4.0	U	6.9		5.6	+/- 7.3	U	12.2	
30-roof-16	-0.7	+/- 4.2	U	7.1		2.9	+/- 7.5	U	12.7	
30-roof-17	-1.8	+/- 4.0	U	6.9		3.6	+/- 7.1	U	12.0	
30-roof-18	-1.3	+/- 4.0	U	7.1		-0.7	+/- 7.3	U	12.7	
Average	-0.63			Number of Locations Exceeding AL	0	1.15			Number of Locations Exceeding AL	0
Std. Dev	1.60					3.1				
Max	4.0					5.6				
89-1	3.6	+/- 6.7	U	11.1		1.8	+/- 12.4	U	21.3	
89-2	10.4	+/- 6.7	U	10.4		23.1	+/- 13.3	LT	20.2	
89-3	6.7	+/- 7.3	U	12.0		13.5	+/- 14.2	U	22.9	
89-4	-1.3	+/- 5.6	U	9.5		-4.0	+/- 10.7	U	18.4	
89-5	10.2	+/- 8.2	U	13.1		30.2	+/- 16.7	LT	25.1	
89-6	3.6	+/- 5.6	U	9.1		6.2	+/- 10.4	U	17.3	
89-7	-0.4	+/- 8.7	U	14.4		-12.0	+/- 15.5	U	27.1	
89-8	7.1	+/- 5.8	U	9.1		18.6	+/- 11.5	LT	17.8	
89-9	3.1	+/- 6.4	U	10.7		5.8	+/- 12.4	U	20.6	
89-10	3.8	+/- 5.3	U	8.7		17.8	+/- 11.1	LT	16.9	
89-11	-1.3	+/- 6.7	U	11.5		2.4	+/- 13.1	U	22.2	
89-12	-2.4	+/- 4.4	U	7.8		-0.7	+/- 8.4	U	14.4	
89-13	4.2	+/- 6.0	U	9.8		10.2	+/- 11.5	U	18.6	
89-14	4.2	+/- 6.0	U	9.8		3.1	+/- 11.3	U	19.1	
89-15	0.0	+/- 5.3	U	9.1		5.6	+/- 10.7	U	17.8	
89-16	3.3	+/- 5.1	U	8.4		0.7	+/- 9.3	U	16.0	
89-17	0.0	+/- 5.6	U	9.3		4.7	+/- 10.9	U	18.2	
Average	3.2			Number of Locations Exceeding AL	0	7.5			Number of Locations Exceeding AL	0
Std. Dev	3.9					10.5				
Max	10.4					30.2				

NOTES:

1) AL = Action Level
2) TPU = Total Propagated Uncertainty
3) Flags = Qualifier
4) MDC = Minimum Detectable Concentration

APPENDIX D

FINAL STATUS SURVEY ANALYSIS – SIGN TEST FORMS

Natick SSC Sign Test Data Sheet- Material Specific Background Counts for S/N:

Measured Background Counts for Various Surfaces.

All values reported in counts of 30 sec (Note 1).

Probe		Floor Carpet (FC)		Floor Tiles (FT)		Painted Cinder Block (PCB)		Wall door-metal (M)		Desk (D)		Plastic/Vinyl Partition (VP)		Wall White	
		Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
Ludlum 2224 / 43-68		0	114	0	136	2	147	0	130	0	101	0	91	0	98
(Instrument #1)		2	117	1	155	1	143	0	127	0	98	1	107	0	95
		0	135	0	139	1	141	0	138	0	85	1	85	0	96
		2	166	0	144	1	142	0	116	0	103	0	79	0	98
		0	118	0	156	3	164	0	122	0	116	1	97	0	96
	Mean	0.8	130.0	0.2	146.0	1.6	147.4	0.0	126.6	0.0	100.6	0.6	91.8	0.0	96.6
	Std Dev (cpm, 1 σ)	1.1	21.7	0.4	9.1	0.9	9.6	0.0	8.3	0.0	11.1	0.5	10.8	0.0	1.3
	Std Dev (%, 1 σ)	136.9%	16.7%	223.6%	6.3%	55.9%	6.5%	N/A	6.6%	N/A	11.0%	91.3%	11.8%	N/A	1.4%

NOTES:

1 CPM values are mean and standard deviation of (5) 30-sec counts with the 43-68.

Material	Alpha	Beta
FC	0.8	130.0
FT	0.2	146.0
PCB	1.6	147.4
M	0.0	126.6
BC	1.6	147.4
RS	1.6	147.4
PC	1.6	147.4
O	0.3	96.2

Natick SSC Sign Test Data Sheet- Material Specific Background Counts for S/N: 176947

Measured Background Counts for Various Surfaces.

All values reported in counts of 30 sec (Note 1).

Probe		Floor Carpet (FC)	Floor Tiles (FT)	Wall door-metal (M)	Painted Cinder Block (PCB)	Plastic/ Vinyl Partition (VP)	Wall White
Ludlum 2221 / 44-110		180	148	111	189	114	123
(Instrument #2)		165	180	140	164	139	157
		194	185	148	187	109	126
		250	167	164	169	104	133
		189	202	177	247	141	134
	Mean	195.6	176.4	148.0	191.2	121.4	134.6
	Std Dev (cpm, 1 σ)	32.3	20.2	25.1	33.0	17.4	13.4
	Std Dev (%, 1 σ)	16.5%	11.5%	17.0%	17.3%	14.3%	9.9%

NOTES:

1 CPM values are mean and standard deviation of (5) 30-sec counts with the 44-110

Material	Tritium Beta
FC	195.6
FT	176.4
M	148
PCB	191.2
PC	191.2
BC	191.2
O	121.4

Natick SSC Sign Test Data Sheet

Survey Date:	12-Dec-06
Survey Unit #:	3-1W
Building:	3
Floor:	1
FSS Floor Classification:	3
Beta DCGLw (dpm/100cm^2):	3.60E+06

Instrument Number	Ratemeter/ Probe Models	Ratemeter S/N	Probe S/N	Efficiency[1]	Isotope	Probe Active Area (cm^2)
1	2224/43-68	154046	PR088917	3.60%	C-14	126
1	2224/43-68	154046	PR088917	17.20%	Th-230	126
2	2221/44-110	176947	PR178079	25.00%	H-3	126
3	19	87139				
Static Count Time (min):		0.5				
BKGD Count Time (min):		0.5				

SU Description: first floor formerly labs, now offices 131, 134, 135, 136

1	2	3	4	5	7	8	11	12	14	15	16	17	18
Sample ID	Sample Type[2]	Instrument Number	Sample Location[3]	Surface Material[4]	Beta Fixed-Point Result (30 sec gross count)	Low Energy Beta Fixed-Point Result (30 sec gross count)	Material Specific Beta Background[5] (cpm)	Material Specific Low Energy Beta Background[5] (cpm)	Net Fixed-Point Beta Result (net cpm)	Net Fixed-Point Low Energy Beta Result (net cpm)	Residual Beta Surface Activity (dpm/100cm^2)	Residual Low Energy Beta Surface Activity (dpm/100cm^2)	Beta Sign Test Parameter[7]
3-1W-1	S	1, 2, 3	F	FC	121	223	260.00	391.20	-18.00	54.80	-6.30E+02	2.76E+02	1
3-1W-2	S	1, 2, 3	F	FC	123	408	260.00	391.20	-14.00	424.80	-4.90E+02	2.14E+03	1
3-1W-3	S	1, 2, 3	F	FC	118	112	260.00	391.20	-24.00	-167.20	-8.40E+02	-8.43E+02	1
3-1W-4	S	1, 2, 3	F	FC	128	156	260.00	391.20	-4.00	-79.20	-1.40E+02	-3.99E+02	1
3-1W-5	S	1, 2, 3	F	FC	126	212	260.00	391.20	-8.00	32.80	-2.80E+02	1.65E+02	1
3-1W-6	S	1, 2, 3	F	FC	143	158	260.00	391.20	26.00	-75.20	9.10E+02	-3.79E+02	1
3-1W-7	S	1, 2, 3	F	FC	123	191	260.00	391.20	-14.00	-9.20	-4.90E+02	-4.64E+01	1
3-1W-8	S	1, 2, 3	F	FC	131	180	260.00	391.20	2.00	-31.20	7.00E+01	-1.57E+02	1
3-1W-9	S	1, 2, 3	F	FC	134	201	260.00	391.20	8.00	10.80	2.80E+02	5.44E+01	1
3-1W-10	S	1, 2, 3	F	FC	146	288	260.00	391.20	32.00	184.80	1.12E+03	9.31E+02	1
3-1W-11	S	1, 2, 3	F	FC	137	195	260.00	391.20	14.00	-1.20	4.90E+02	-6.05E+00	1
3-1W-12	S	1, 2, 3	F	FC	126	155	260.00	391.20	-8.00	-81.20	-2.80E+02	-4.09E+02	1
3-1W-13	S	1, 2, 3	F	FC	120	329	260.00	391.20	-20.00	266.80	-7.00E+02	1.34E+03	1
3-1W-14	S	1, 2, 3	F	FC	150	174	260.00	391.20	40.00	-43.20	1.40E+03	-2.18E+02	1
3-1W-15	S	1, 2, 3	F	FC	125	213	260.00	391.20	-10.00	34.80	-3.50E+02	1.75E+02	1
3-1W-16	S	1, 2, 3	F	FC	120	161	260.00	391.20	-20.00	-69.20	-7.00E+02	-3.49E+02	1
3-1W-17	S	1, 2, 3	F	FC	132	168	260.00	391.20	4.00	-55.20	1.40E+02	-2.78E+02	1

NOTES:

1 Instrument Efficiency = Instrument static 4-pi efficiency for isotope in next column
2 Sample Type: S = Static B = Biased Location
3 F = floor W = Lower wall (< 6 ft) CT = Counter Top
4 Surface Materials: BC (Bare Concrete), PC (Painted Concrete), BCB (Bare Cinder Block), FC (Floor Carpet), FT (Floor Tile), RS (Roof Sealant), M (Metal), O (Other)
5 Average of (5) 1-minute background readings collected in unimpacted areas for each building surface encountered during FSS
6 MARSSIM Sign Test parameter. If Result > DCGLw, Sign = -1, otherwise 1.

Mean	-2.88E+01	1.18E+02
Median	-2.80E+02	-4.64E+01
Range	2.24E+03	2.98E+03
Std Dev (1σ)	6.72E+02	7.34E+02
MARSSIM Sign Test Required?		No
MARSSIM SIGN TEST EVALUATION		
Sum of Positive Signs		17
Sign Test Critical Value n= 17		12
Null Hypothesis Evaluation		PASS

Natick SSC Sign Test Data Sheet

Survey Date:	12-Dec-06
Survey Unit #:	3-2W
Building:	3
Floor:	2
FSS Floor Classification:	3
SU DCGLw (dpm/100cm^2):	3.60E+05

Instrument Number	Ratemeter/ Probe Models	Ratemeter S/N	Probe S/N	Efficiency[1]	Isotope	Probe Active Area (cm^2)
1	2224/43-68	154046	PR088917	3.60%	C-14	126
1	2224/43-68	154046	PR088917	17.20%	Th-230	126
2	2221/44-110	176947	PR178079	25.00%	H-3	126
3	19	87139				
Static Count Time (min):		0.5				
BKGD Count Time (min):		0.5				

SU Description: Second floor, room 214, formerly labs, now offices and vending area.

1	2	3	4	5	7	8	11	12	14	15	16	17	18
Sample ID	Sample Type[2]	Instrument Number	Sample Location[3]	Surface Material[4]	Beta Fixed-Point Result (30 sec gross count)	Low Energy Beta Fixed-Point Result (30 sec gross count)	Material Specific Beta Background[5] (cpm)	Material Specific Low Energy Beta Background[5] (cpm)	Net Fixed-Point Beta Result (net cpm)	Net Fixed-Point Low Energy Beta Result (net cpm)	Residual Beta Surface Activity (dpm/100cm^2)	Residual Low Energy Beta Surface Activity (dpm/100cm^2)	Beta Sign Test Parameter[7]
3-2W-1	S	1, 2, 3	F	FT	132	164	292.00	352.80	-28.00	-24.80	-9.80E+02	-1.25E+02	1
3-2W-2	S	1, 2, 3	F	FT	139	192	292.00	352.80	-14.00	31.20	-4.90E+02	1.57E+02	1
3-2W-3	S	1, 2, 3	F	FT	125	162	292.00	352.80	-42.00	-28.80	-1.47E+03	-1.45E+02	1
3-2W-4	S	1, 2, 3	F	FT	137	165	292.00	352.80	-18.00	-22.80	-6.30E+02	-1.15E+02	1
3-2W-5	S	1, 2, 3	F	FT	142	132	292.00	352.80	-8.00	-88.80	-2.80E+02	-4.48E+02	1
3-2W-6	S	1, 2, 3	F	FT	141	124	292.00	352.80	-10.00	-104.80	-3.50E+02	-5.28E+02	1
3-2W-7	S	1, 2, 3	CT	O	124	137	192.40	242.80	55.60	31.20	1.95E+03	1.57E+02	1
3-2W-8	S	1, 2, 3	F	FT	113	150	292.00	352.80	-66.00	-52.80	-2.31E+03	-2.66E+02	1
3-2W-9	S	1, 2, 3	F	FT	110	84	292.00	352.80	-72.00	-184.80	-2.52E+03	-9.31E+02	1
3-2W-10	S	1, 2, 3	CT	O	98	115	192.40	242.80	3.60	-12.80	1.26E+02	-6.45E+01	1
3-2W-11	S	1, 2, 3	F	FT	149	152	292.00	352.80	6.00	-48.80	2.10E+02	-2.46E+02	1
3-2W-12	S	1, 2, 3	CT	O	104	163	192.40	242.80	15.60	83.20	5.46E+02	4.19E+02	1
3-2W-13	S	1, 2, 3	F	FT	153	163	292.00	352.80	14.00	-26.80	4.90E+02	-1.35E+02	1
3-2W-14	S	1, 2, 3	F	FT	123	166	292.00	352.80	-46.00	-20.80	-1.61E+03	-1.05E+02	1
3-2W-15	S	1, 2, 3	F	FT	144	159	292.00	352.80	-4.00	-34.80	-1.40E+02	-1.75E+02	1
3-2W-16	S	1, 2, 3	F	FT	141	118	292.00	352.80	-10.00	-116.80	-3.50E+02	-5.89E+02	1
3-2W-17	S	1, 2, 3	F	FT	160	139	292.00	352.80	28.00	-74.80	9.80E+02	-3.77E+02	1
3-2W-18	B	1, 2, 3	ET-D	M	107	173	253.20	296.00	-39.20	50.00	-1.37E+03	2.52E+02	N/A
3-2W-19	B	1, 2, 3	ET-D	M	100	127	253.20	296.00	-53.20	-42.00	-1.86E+03	-2.12E+02	N/A

Mean	**-4.02E+02**	**-2.07E+02**	
Median	**-3.50E+02**	**-1.45E+02**	
Range	**4.47E+03**	**1.35E+03**	
Std Dev (1σ)	**1.15E+03**	**3.14E+02**	
MARSSIM Sign Test Required?			**No**
MARSSIM SIGN TEST EVALUATION			
Sum of Positive Signs			**17**
Sign Test Critical Value n= 17			**12**
Null Hypothesis Evaluation			**PASS**

NOTES:

1 Instrument Efficiency = Instrument static 4-pi efficiency for isotope in next column

2 Sample Type: S = Static B = Biased Location

3 F = floor W = Lower wall (< 6 ft) CT = Counter Top

4 Surface Materials: BC (Bare Concrete), PC (Painted Concrete), BCB (Bare Cinder Block), FC (Floor Carpet), FT (Floor Tile), RS (Roof Sealant), M (Metal), O (Other)

5 Average of (5) 1-minute background readings collected in unimpacted areas for each building surface encountered during FSS

6 MARSSIM Sign Test parameter. If Result > DCGLw, Sign = -1, otherwise 1.

7 DCGL is based on C-14 beta emission

Natick SSC Sign Test Data Sheet

Survey Date:	12-Dec-06
Survey Unit #:	3-1E
Building:	3
Floor:	1
FSS Floor Classification:	3
SU DCGLw (dpm/100cm^2):	3.60E+05

Instrument Number	Ratemeter/ Probe Models	Ratemeter S/N	Probe S/N	Efficiency[1]	Isotope	Probe Active Area (cm^2)
1	2224/43-68	154046	PR088917	3.60%	C-14	126
1	2224/43-68	154046	PR088917	17.20%	Th-230	126
2	2221/44-110	176947	PR178079	25.00%	H-3	126
3	19	87139				
Static Count Time (min):		0.5				
BKGD Count Time (min):		0.5				

SU Description: Third floor formerly lab, now offices 307, 309

1	2	3	4	5	7	8	11	12	14	15	16	17	18
Sample ID	Sample Type[2]	Instrument Number	Sample Location[3]	Surface Material[4]	Beta Fixed-Point Result (30 sec gross count)	Low Energy Beta Fixed-Point Result (30 sec gross count)	Material Specific Beta Background[5] (cpm)	Material Specific Low Energy Beta Background[5] (cpm)	Net Fixed-Point Beta Result (net cpm)	Net Fixed-Point Low Energy Beta Result (net cpm)	Residual Beta Surface Activity (dpm/100cm^2)	Residual Low Energy Beta Surface Activity (dpm/100cm^2)	Beta Sign Test Parameter[7]
3-1E-1	S	1, 2, 3	F	FC	145	140	260.00	391.20	30.00	-111.20	1.05E+03	-5.60E+02	1
3-1E-2	S	1, 2, 3	F	FC	96	176	260.00	391.20	-68.00	-39.20	-2.38E+03	-1.98E+02	1
3-1E-3	S	1, 2, 3	F	FC	108	109	260.00	391.20	-44.00	-173.20	-1.54E+03	-8.73E+02	1
3-1E-4	S	1, 2, 3	F	FC	140	194	260.00	391.20	20.00	-3.20	7.00E+02	-1.61E+01	1
3-1E-5	S	1, 2, 3	F	FC	144	231	260.00	391.20	28.00	70.80	9.80E+02	3.57E+02	1
3-1E-6	S	1, 2, 3	F	FC	138	131	260.00	391.20	16.00	-129.20	5.60E+02	-6.51E+02	1
3-1E-7	S	1, 2, 3	F	FC	140	186	260.00	391.20	20.00	-19.20	7.00E+02	-9.68E+01	1
3-1E-8	S	1, 2, 3	F	FC	91	198	260.00	391.20	-78.00	4.80	-2.73E+03	2.42E+01	1
3-1E-9	S	1, 2, 3	F	FC	136	87	260.00	391.20	12.00	-217.20	4.20E+02	-1.09E+03	1
3-1E-10	S	1, 2, 3	F	FC	112	16	260.00	391.20	-36.00	-359.20	-1.26E+03	-1.81E+03	1
3-1E-11	S	1, 2, 3	F	FC	142	230	260.00	391.20	24.00	68.80	8.40E+02	3.47E+02	1
3-1E-12	S	1, 2, 3	F	FC	121	119	260.00	391.20	-18.00	-153.20	-6.30E+02	-7.72E+02	1
3-1E-13	S	1, 2, 3	F	FC	153	145	260.00	391.20	46.00	-101.20	1.61E+03	-5.10E+02	1
3-1E-14	S	1, 2, 3	F	FC	115	109	260.00	391.20	-30.00	-173.20	-1.05E+03	-8.73E+02	1
3-1E-15	S	1, 2, 3	F	FC	137	130	260.00	391.20	14.00	-131.20	4.90E+02	-6.61E+02	1
3-1E-16	S	1, 2, 3	F	FC	149	181	260.00	391.20	38.00	-29.20	1.33E+03	-1.47E+02	1
3-1E-17	S	1, 2, 3	F	FC	111	143	260.00	391.20	-38.00	-105.20	-1.33E+03	-5.30E+02	1

NOTES:

1. Instrument Efficiency = Instrument static 4-pi efficiency for isotope in next column
2. Sample Type: S = Static B = Biased Location
3. F = floor W = Lower wall (< 6 ft) CT = Counter Top
4. Surface Materials: BC (Bare Concrete), PC (Painted Concrete), BCB (Bare Cinder Block), FC (Floor Carpet), FT (Floor Tile), RS (Roof Sealant), M (Metal), O (Other)
5. Average of (5) 1-minute background readings collected in unimpacted areas for each building surface encountered during FSS
6. MARSSIM Sign Test parameter. If Result > DCGLw, Sign = -1, otherwise 1.
7. DCGL is based on C-14 beta emission

Mean	**-1.32E+02**	**-4.74E+02**	
Median	**4.90E+02**	**-5.30E+02**	
Range	**4.34E+03**	**2.17E+03**	
Std Dev (1 σ)	**1.34E+03**	**5.48E+02**	
MARSSIM Sign Test Required?			**No**
MARSSIM SIGN TEST EVALUATION			
Sum of Positive Signs			**17**
Sign Test Critical Value n= 17			**12**
Null Hypothesis Evaluation			**PASS**

Natick SSC Sign Test Data Sheet

Survey Date:	12-Dec-06
Survey Unit #:	89
Building:	89
Floor:	1
FSS Floor Classification:	3
SU DCGLw (dpm/100cm^2):	3.60E+05

Instrument Number	Ratemeter/ Probe Models	Ratemeter S/N	Probe S/N	Efficiency[1]	Isotope	Probe Active Area (cm^2)
1	2224/43-68	154046	PR088917	3.60%	C-14	126
1	2224/43-68	154046	PR088917	17.20%	Th-230	126
2	2221/44-110	176947	PR178079	25.00%	H-3	126
3	19	87139				
Static Count Time (min):		0.5				
BKGD Count Time (min):		0.5				

SU Description: Waste storage building.

1	2	3	4	5	7	8	11	12	14	15	16	17	18
Sample ID	Sample Type[2]	Instrument Number	Sample Location[3]	Surface Material[4]	Beta Fixed-Point Result (30 sec gross count)	Low Energy Beta Fixed-Point Result (30 sec gross count)	Material Specific Beta Background[5] (cpm)	Material Specific Low Energy Beta Background[5] (cpm)	Net Fixed-Point Beta Result (net cpm)	Net Fixed-Point Low Energy Beta Result (net cpm)	Residual Beta Surface Activity (dpm/100cm^2)	Residual Low Energy Beta Surface Activity (dpm/100cm^2)	Beta Sign Test Parameter[7]
89-1	S	1, 2, 3	F	BC	79	144	294.80	382.40	-136.80	-94.40	-4.79E+03	-4.76E+02	1
89-2	S	1, 2, 3	F	BC	209	151	294.80	382.40	123.20	-80.40	4.31E+03	-4.05E+02	1
89-3	S	1, 2, 3	F	BC	148	127	294.80	382.40	1.20	-128.40	4.20E+01	-6.47E+02	1
89-4	S	1, 2, 3	F	BC	126	199	294.80	382.40	-42.80	15.60	-1.50E+03	7.86E+01	1
89-5	S	1, 2, 3	F	BC	175	150	294.80	382.40	55.20	-82.40	1.93E+03	-4.15E+02	1
89-6	S	1, 2, 3	F	BC	156	166	294.80	382.40	17.20	-50.40	6.02E+02	-2.54E+02	1
89-7	S	1, 2, 3	F	BC	133	157	294.80	382.40	-28.80	-68.40	-1.01E+03	-3.45E+02	1
89-8	S	1, 2, 3	F	BC	178	163	294.80	382.40	61.20	-56.40	2.14E+03	-2.84E+02	1
89-9	S	1, 2, 3	F	BC	135	192	294.80	382.40	-24.80	1.60	-8.68E+02	8.06E+00	1
89-10	S	1, 2, 3	F	BC	68	111	294.80	382.40	-158.80	-160.40	-5.56E+03	-8.08E+02	1
89-11	S	1, 2, 3	F	BC	113	148	294.80	382.40	-68.80	-86.40	-2.41E+03	-4.35E+02	1
89-12	S	1, 2, 3	F	BC	150	144	294.80	382.40	5.20	-94.40	1.82E+02	-4.76E+02	1
89-13	S	1, 2, 3	F	BC	156	169	294.80	382.40	17.20	-44.40	6.02E+02	-2.24E+02	1
89-14	S	1, 2, 3	F	BC	137	150	294.80	382.40	-20.80	-82.40	-7.28E+02	-4.15E+02	1
89-15	S	1, 2, 3	F	BC	132	183	294.80	382.40	-30.80	-16.40	-1.08E+03	-8.27E+01	1
89-16	S	1, 2, 3	F	BC	133	139	294.80	382.40	-28.80	-104.40	-1.01E+03	-5.26E+02	1
89-17	S	1, 2, 3	F	BC	140	135	294.80	382.40	-14.80	-112.40	-5.18E+02	-5.66E+02	1

NOTES:

1. Instrument Efficiency = Instrument static 4-pi efficiency for isotope in next column
2. Sample Type: S = Static B = Biased Location
3. F = floor W = Lower wall (< 6 ft) CT = Counter Top
4. Surface Materials: BC (Bare Concrete), PC (Painted Concrete), BCB (Bare Cinder Block), FC (Floor Carpet), FT (Floor Tile), RS (Roof Sealant), M (Metal), O (Other)
5. Average of (5) 1-minute background readings collected in unimpacted areas for each building surface encountered during FSS
6. MARSSIM Sign Test parameter. If Result > DCGLw, Sign = -1, otherwise 1.
7. DCGL is based on C-14 beta emission

Mean	-5.67E+02	-3.69E+02
Median	-7.28E+02	-4.15E+02
Range	9.87E+03	8.87E+02
Std Dev (1σ)	2.36E+03	2.28E+02
MARSSIM Sign Test Required?		No
MARSSIM SIGN TEST EVALUATION		
Sum of Positive Signs		17
Sign Test Critical Value n= 17		12
Null Hypothesis Evaluation		PASS

Natick SSC Sign Test Data Sheet

Survey Date:	12-Dec-06
Survey Unit #:	30-roof
Building:	30
Floor:	roof
FSS Floor Classification:	3
SU DCGLw (dpm/100cm^2):	3.60E+05

Instrument Number	Ratemeter/ Probe Models	Ratemeter S/N	Probe S/N	Efficiency[1]	Isotope	Probe Active Area (cm^2)
1	2224/43-68	154046	PR088917	3.60%	C-14	126
1	2224/43-68	154046	PR088917	17.20%	Th-230	126
2	2221/44-110	176947	PR178079	25.00%	H-3	126
3	19	87139				
Static Count Time (min):		0.5				
BKGD Count Time (min):		0.5				

SU Description: Roof over room 108

1	2	3	4	5	7	8	11	12	14	15	16	17	18
Sample ID	Sample Type[2]	Instrument Number	Sample Location[3]	Surface Material[4]	Beta Fixed-Point Result (30 sec gross count)	Low Energy Beta Fixed-Point Result (30 sec gross count)	Material Specific Beta Background[5] (cpm)	Material Specific Low Energy Beta Background[5] (cpm)	Net Fixed-Point Beta Result (net cpm)	Net Fixed-Point Low Energy Beta Result (net cpm)	Residual Beta Surface Activity (dpm/100cm^2)	Residual Low Energy Beta Surface Activity (dpm/100cm^2)	Beta Sign Test Parameter[7]
30-roof-1	S	1	R	RS	110	N/A	294.80	N/A	-74.80	N/A	-2.62E+03	N/A	1
30-roof-2	S	1	R	RS	97	N/A	294.80	N/A	-100.80	N/A	-3.53E+03	N/A	1
30-roof-3	S	1	R	RS	92	N/A	294.80	N/A	-110.80	N/A	-3.88E+03	N/A	1
30-roof-4	S	1	R	RS	94	N/A	294.80	N/A	-106.80	N/A	-3.74E+03	N/A	1
30-roof-5	S	1	R	RS	104	N/A	294.80	N/A	-86.80	N/A	-3.04E+03	N/A	1
30-roof-6	S	1	R	RS	111	N/A	294.80	N/A	-72.80	N/A	-2.55E+03	N/A	1
30-roof-7	S	1	R	RS	88	N/A	294.80	N/A	-118.80	N/A	-4.16E+03	N/A	1
30-roof-8	S	1	R	RS	158	N/A	294.80	N/A	21.20	N/A	7.42E+02	N/A	1
30-roof-9	S	1	R	RS	90	N/A	294.80	N/A	-114.80	N/A	-4.02E+03	N/A	1
30-roof-10	S	1	R	RS	91	N/A	294.80	N/A	-112.80	N/A	-3.95E+03	N/A	1
30-roof-11	S	1	R	RS	105	N/A	294.80	N/A	-84.80	N/A	-2.97E+03	N/A	1
30-roof-12	S	1	R	RS	93	N/A	294.80	N/A	-108.80	N/A	-3.81E+03	N/A	1
30-roof-13	S	1	R	RS	117	N/A	294.80	N/A	-60.80	N/A	-2.13E+03	N/A	1
30-roof-14	S	1	R	RS	88	N/A	294.80	N/A	-118.80	N/A	-4.16E+03	N/A	1
30-roof-15	S	1	R	RS	92	N/A	294.80	N/A	-110.80	N/A	-3.88E+03	N/A	1
30-roof-16	S	1	R	RS	106	N/A	294.80	N/A	-82.80	N/A	-2.90E+03	N/A	1
30-roof-17	S	1	R	RS	175	N/A	294.80	N/A	55.20	N/A	1.93E+03	N/A	1
30-roof-18	B	1	R	RS	128	N/A	294.80	N/A	-38.80	N/A	-1.36E+03	N/A	N/A

NOTES:

1. Instrument Efficiency = Instrument static 4-pi efficiency for isotope in next column
2. Sample Type: S = Static B = Biased Location
3. F = floor W = Lower wall (< 6 ft) CT = Counter Top
4. Surface Materials: BC (Bare Concrete), PC (Painted Concrete), BCB (Bare Cinder Block), FC (Floor Carpet), FT (Floor Tile), RS (Roof Sealant), M (Metal), O (Other)
5. Average of (5) 1-minute background readings collected in unimpacted areas for each building surface encountered during FSS
6. MARSSIM Sign Test parameter. If Result > DCGLw, Sign = -1, otherwise 1.
7. DCGL is based on C-14 beta emission

Mean	**-2.86E+03**
Median	**-3.53E+03**
Range	**6.09E+03**
Std Dev (1σ)	**1.71E+03**
MARSSIM Sign Test Required?	**No**
MARSSIM SIGN TEST EVALUATION	
Sum of Positive Signs	**17**
Sign Test Critical Value n= 17	**12**
Null Hypothesis Evaluation	**PASS**

Natick SSC Sign Test Data Sheet

Survey Date:	13-Dec-06
Survey Unit #:	30-1
Building:	30
Floor:	1
FSS Floor Classification:	3
SU DCGLw (dpm/100cm^2):	3.60E+05

Instrument Number	Ratemeter/ Probe Models	Ratemeter S/N	Probe S/N	Efficiency[1]	Isotope	Probe Active Area (cm^2)
1	2224/43-68	154046	PR088917	3.60%	C-14	126
1	2224/43-68	154046	PR088917	17.20%	Th-230	126
2	2221/44-110	176947	PR178079	25.00%	H-3	126
3	19	87139				
Static Count Time (min):		0.5				
BKGD Count Time (min):		0.5				

SU Description: Building 30, rm 101, 103, 108

1	2	3	4	5	7	8	11	12	14	15	16	17	18
Sample ID	Sample Type[2]	Instrument Number	Sample Location[3]	Surface Material[4]	Beta Fixed-Point Result (30 sec gross count)	Low Energy Beta Fixed-Point Result (30 sec gross count)	Material Specific Beta Background[5] (cpm)	Material Specific Low Energy Beta Background[5] (cpm)	Net Fixed-Point Beta Result (net cpm)	Net Fixed-Point Low Energy Beta Result (net cpm)	Residual Beta Surface Activity (dpm/100cm^2)	Residual Low Energy Beta Surface Activity (dpm/100cm^2)	Beta Sign Test Parameter[7]
30-1-1	S	1, 2, 3	F	FT	176	250	292.00	352.80	60.00	147.20	2.10E+03	7.42E+02	1
30-1-2	S	1, 2, 3	F	FT	150	174	292.00	352.80	8.00	-4.80	2.80E+02	-2.42E+01	1
30-1-3	S	1, 2, 3	F	FT	155	139	292.00	352.80	18.00	-74.80	6.30E+02	-3.77E+02	1
30-1-4	S	1, 2, 3	F	FT	181	182	292.00	352.80	70.00	11.20	2.45E+03	5.64E+01	1
30-1-5	S	1, 2, 3	F	FT	141	215	292.00	352.80	-10.00	77.20	-3,50E+02	3.89E+02	1
30-1-6	S	1, 2, 3	F	FT	171	236	292.00	352.80	50.00	119.20	1.75E+03	6.01E+02	1
30-1-7	S	1, 2, 3	F	FT	163	227	292.00	352.80	34.00	101.20	1.19E+03	5.10E+02	1
30-1-8	S	1, 2, 3	H	M	103	144	253.20	296.00	-47.20	-8.00	-1.65E+03	-4.03E+01	1
30-1-9	S	1, 2, 3	CT	O	167	204	192.40	242.80	141.60	165.20	4.96E+03	8.33E+02	1
30-1-10	S	1, 2, 3	F	FC	149	84	260.00	391.20	38.00	-223.20	1.33E+03	-1.12E+03	1
30-1-11	S	1, 2, 3	F	FC	130	103	260.00	391.20	0.00	-185.20	0.00E+00	-9.33E+02	1
30-1-12	S	1, 2, 3	F	FC	164	95	260.00	391.20	68.00	-201.20	2.38E+03	-1.01E+03	1
30-1-13	S	1, 2, 3	F	FC	110	124	260.00	391.20	-40.00	-143.20	-1.40E+03	-7.22E+02	1
30-1-14	S	1, 2, 3	F	FC	129	88	260.00	391.20	-2.00	-215.20	-7.00E+01	-1.08E+03	1
30-1-15	S	1, 2, 3	F	FC	138	101	260.00	391.20	16.00	-189.20	5.60E+02	-9.54E+02	1
30-1-16	S	1, 2, 3	F	PC	170	153	294.80	382.40	45.20	-76.40	1.58E+03	-3.85E+02	1
30-1-17	S	1, 2, 3	F	FC	114	101	260.00	391.20	-32.00	-189.20	-1.12E+03	-9.54E+02	1
30-1-18	B	1, 2, 3	W	PCB	2212	8811	294.80	382.40	4129.20	17239.60	1.45E+05	8.69E+04	N/A
30-1-19	B	1, 2, 3	W	PCB	2197	4122	294.80	382.40	4099.20	7861.60	1.43E+05	3.96E+04	N/A

Mean	**8.60E+02**	**-2.64E+02**	
Median	**6.30E+02**	**-3.77E+02**	
Range	**6.61E+03**	**1.96E+03**	
Std Dev (1 σ)	**1.65E+03**	**6.99E+02**	
MARSSIM Sign Test Required?			**No**
MARSSIM SIGN TEST EVALUATION			
Sum of Positive Signs			**17**
Sign Test Critical Value n=	**17**		**12**
Null Hypothesis Evaluation			**PASS**

NOTES:

1. Instrument Efficiency = Instrument static 4-pi efficiency for isotope in next column
2. Sample Type: S = Static B = Biased Location
3. F = floor W = Lower wall (< 6 ft) CT = Counter Top
4. Surface Materials: BC (Bare Concrete), PC (Painted Concrete), BCB (Bare Cinder Block), FC (Floor Carpet), FT (Floor Tile), RS (Roof Sealant), M (Metal), O (Other)
5. Average of (5) 1-minute background readings collected in unimpacted areas for each building surface encountered during FSS
6. MARSSIM Sign Test parameter. If Result > DCGLw, Sign = -1, otherwise 1.
7. DCGL is based on C-14 beta emission

APPENDIX E

QA/QC RECORDS

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER CABRERA SERVICES ORDER NO. 254101/301564

Mfg. Ludlum Measurements, Inc. Model 2360 Serial No. 193675

Mfg. Ludlum Measurements, Inc. Model 43-37 Serial No. PR-216984

Cal. Date 20-Apr-06 Cal Due Date 20-Apr-07 Cal. Interval 1 Year Meterface 202-855

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 20 % Alt 697.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☐ F/S Resp. ck ☑ Reset ck. ☐ Window Operation ☑ Geotropism
☑ Audio ck. ☑ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) _____ VDC
☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

nstrument Volt Set 1650 V

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 1500 / 1500 V

Firmware Version: 39010n27
Alpha Threshold: 90
Beta Threshold: 4
Beta Window: 40
Overload Checked but not set
Instrument calibrated with a 5' cable.
High voltage set with detector disconnected

(EEPROM Settings)
User Time: 1.00
Alpha Alarm: 050000
Beta Alarm: 050000
A/B Alarm: 050000
Model 2360 Date: 20 Apr 06
Calibration Date Due: 20 Apr 07

COMMENTS:

4 pi efficiencies(see plateau for details). Tc-99: 27.4 % SN: 5279-04
Sr90y90: 22.5 % SN: 4016
Ni-63: 4 % SN: 4017
Th-230: 19 % SN: 1495

Calibrated with a 5' cable

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X1000	400 kcpm	400	400
X1000	100 kcpm	100	100
X100	40 kcpm	400	400
X100	10 kcpm	100	100
X10	4 kcpm	400	400
X10	1 kcpm	100	100
X1	400 cpm	400	400
X1	100 cpm	100	100

*Uncertainty within ± 10% C.F. within ± 20%

Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400 kcpm	40109 (0)	40109 (0)	Log Scale			
	40 kcpm	4011	4011				
	4 kcpm	401	401				
	400 cpm	40	40				
	40 cpm	4	4				

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☑ Alpha S/N Th 230 SN: 1495 ☑ Beta S/N Tc 99 SN: 5279-04 / Sr90Y90 SN: 4016 Ni-63 SN: 4017 ☐ Other _____

☑ m 500 S/N 134709 ☐ Oscilloscope S/N _____ ☑ Multimeter S/N 86250390

Calibrated By: Charles Disk Date 20 Apr 06

Reviewed By: Debby Gilmore Date 21 Apr 06

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.
FORM C22S 11/26/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: _____

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 43-37 Serial No. PR-216984 Order #. 254101/301564

Customer CABRERA SERVICES Alpha Input Sensitivity 90 mV

Counter 2360 Serial No. 193675 Beta Input Sensitivity 4 mV

Count Time 1 Minute Beta Window 40 mV

Other w/5' cable Distance Source to Detector Surface

High Voltage	Background		Isotope Tc99 Size 28800 dpm		Isotope Sr90Y90 Size 59338 dpm		Isotope Ni-63 Size 291060 dpm	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
1600	6	223	18	6995	6	9161	7	10027
1625	6	332	17	8098	6	10984	5	11252
1650	5	424	19	8333	10	13823	6	12083
1675	7	540	10	9560	12	15371	6	12742
1700	9	567	23	9642	21	16302	11	13519

☐ Gas Proportional detector count rate decreased ≤ 10% after 15 hour static test using 39" cable.

☑ Gas proportional detector count rate decreased ≤ 10% after 5 hour static test using 39" cable and alpha/beta counter.

Signature Charles Disk Date 20 Apr 06

FORM C48 04/09/2003

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 43-37 Serial No. PR-216984 Order #. 254101/301564

Customer CABRERA SERVICES Alpha Input Sensitivity 90 mV

Counter 2360 Serial No. 193675 Beta Input Sensitivity 4 mV

Count Time 1Minute Beta Window 40 mV

Other w/5' cable Distance Source to Detector Surface

High Voltage	Background Alpha	Background Beta	Isotope Th 230 Size 19800 cpm Alpha	Beta	Isotope ____ Size ____ Alpha	Beta	Isotope ____ Size ____ Alpha	Beta
1600	6	223	3299	1489				
1625	6	332	3514	1668				
1650	5	424	3756	1697				
1675	7	540	3885	1839				
1700	9	567	4035	2067				

☐ Gas Proportional detector count rate decreased ≤ 10% after 15 hour static test using 39" cable.

☑ Gas proportional detector count rate decreased ≤ 10% after 5 hour static test using 39" cable and alpha/beta counter.

Signature Charles Lisk Date 20 Apr 06

FORM C4B 04/09/2003

• Serving The Nuclear Industry Since 1962 •

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER CABRERA SERVICES ORDER NO. 252136/300508

Mfg. Ludlum Measurements, Inc. Model 3 Serial No. 79517

Mfg. Ludlum Measurements, Inc. Model 44-9 Serial No. PR-137500

Cal. Date 23-Mar-06 Cal Due Date 23-Mar-07 Cal. Interval 1 Year Meterface 202-002

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 20 % Alt 705.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☐ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC
☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

nstrument Volt Set 900 V Input Sens. 28 mV Det. Oper. 900 V at 28 mV Threshold Dial Ratio = mV

☐ HV Readout (2 points) Ref./Inst. / V Ref./Inst. / V

COMMENTS:

Efficiency readings(4pi using 44-9)
Th230sn:5020-03, Act=5730dpm, background≈30cpm, Source count≈1100cpm, Eff≈18.6%
Ni-63sn:4017, Act=291364dpm, background≈30cpm, Source count≈2000cpm, Eff≈0.6%
Tc99sn:5279-04, Act=28800dpm, background≈30cpm, Source count≈8000cpm, Eff≈27.7%
Sr90Y90sn:4016, Act=59453dpm, background≈30cpm, Source count≈24000cpm, Eff≈40.3%

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 100	400 K cpm	4K	4K
X 100	100 K cpm	1K	1K
X 10	40 K cpm	4K	4K
X 10	10 K cpm	1.1K	1.1K
X 1	4 K cpm	4K	4K
X 1	1 K cpm	1.1K	1.1K
X 0.1	400 cpm	4K	4K
X 0.1	100 cpm	1K	1K

*Uncertainty within ± 10% C.F. within ± 20% ALL **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout				Log Scale			

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☑ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☑ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ☐ Beta S/N ☐ Other

☑ m 500 S/N 50800 ☐ Oscilloscope S/N ☑ Multimeter S/N 83990502

Calibrated By: Charles Dick Date 23 Mar 06

Reviewed By: Michael J Shu Date 24-Mar-06

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.
FORM C22A 11/26/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CONVERSION CHART

Customer CABRERA SERVICES Date 23-Mar-06 Order #. 252136/300508

Model 3 Serial No. 79517 Detector Model 44-9 Serial No. PR-137500

Source Cs-137 150 mCi Cs-137 21 mCi High Voltage 900 V

Input Sensitivity 28 mV

Reference Point	"As Found" Readings (CPM): Meter Reading	Range/Scale	After Adjustment Readings (CPM): Meter Reading	Range/Scale
150 mR/hr	3K	x 100	3K	x 100
50 mR/hr	1.5K	x 100	1.5K	x 100
15 mR/hr	0.6K	x 100	0.6K	x 100
5 mR/hr	1.9K	x 10	1.9K	x 10
1.5 mR/hr	0.6K	x 10	0.6K	x 10
1.0 mR/hr	3.2K	x 1	3.2K	x 1

Signature: Charles Lisk Date 23 Mar 06

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Alpha Standard

S.O.# 6361
P.O.# 06-356

Description of Standard:

Model No. DNS-11 Serial No. 5633-05 Isotope Th-230

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi alpha emission rate was measured using an internal gas flow proportional chamber. Absolute counting of alpha particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated alpha source S/N 4001-02.

Measurement Result:

The observed alpha particles emitted from the surface of the disc per minute (cpm) on the calibration date was:

8,550 ± 342

The total disintegration rate (dpm) assuming 1.5% backscatter of alpha particles from the surface of the disc, was:

16,800 ± 673 (0.00759 μCi)

The uncertainty of the measurement is 4 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by: [signature]

Calibration Technician: [signature] Q.A. Representative: Anthony W. Toth

Calibration Date: 12-28-2005 Reviewed Date: 12-28-05

Analytical Services
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 345-3461 Fax (505) 761-5416
Toll Free (866) RAD-LABS (723-5227)
www.eberlineservices.com

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661•309•1010
Fax 661•257•8303

CERTIFICATE OF CALIBRATION
BETA STANDARD SOURCE

Radionuclide:	C-14	**Customer:**	CABRERA SERVICES, INC.
Half-life:	5730 ± 40 years	**P.O. No.:**	07-147
Catalog No.:	BF-014-MF2	**Reference Date:**	1-Dec-06 12:00 PST
Source No.:	1116-85	**Contained Radioactivity:**	0.1507 µCi 5.576 kBq

Physical Description:

A. Capsule type:	MF-2
B. Nature of active deposit:	Evaporated carbon compound
C. Active diameter/volume:	3 mm
D. Backing:	0.9 mg/cm² aluminized mylar
E. Cover:	0.9 mg/cm² aluminized mylar

Radioimpurities:

None detected

Method of Calibration:

This source was prepared from a weighed aliquot of solution whose activity in µCi/g was determined using a liquid scintillation counter.

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 2.0 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.7 %
D. Total uncertainty at the 99% confidence level:	± 3.7 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from NCRP Report No. 58, 1985.
- This source has a working life of 5 years.
- This source had a surface emission rate of 84370 β/min in 2π on 23 Oct 06 when configured with a stainless steel backing.

Daniel James Van Dalsem
Quality Control

23-OCT-06
Date

IPL Ref. No.: 1116-85

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER CABRERA SERVICES ORDER NO. 254097 / 301563

Mfg. Ludlum Measurements, Inc. Model 2221 Serial No. 163673

Mfg. Ludlum Measurements, Inc. Model 44-3 Serial No. PR045385

Cal. Date 18-Apr-06 Cal Due Date 18-Apr-07 Cal. Interval 1 Year Meterface 202-159

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 20 % Alt 693.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 5.0 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

nstrument Volt Set 850 V Input Sens. 10 mV Det. Oper. 850 V at 10 mV Threshold Dial Ratio 100 = 10 mV

☑ HV Readout (2 points) Ref./Inst. 500 / 498 V Ref./Inst. 2000 / 1998 V

COMMENTS:
Cal'd with the window in the off position.
Cal'd with a 12' C Cable.
Firmware: 26 10 27
High voltage set with the detector connected.

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1000	400 Kcpm	400	400
X 1000	100 Kcpm	100	100
X 100	40 Kcpm	400	400
X 100	10 Kcpm	100	100
X 10	4 Kcpm	400	400
X 10	1 Kcpm	100	100
X 1	400 cpm	400	400
X 1	100 cpm	100	100

*Uncertainty within ± 10% C.F. within ± 20% ALL **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400 K cpm	400692	400692	Log Scale	500 K cpm	500k	500k
	40 K cpm	40076	40076		50 K cpm	50K	50k
	4 K cpm	4010	4010		5 K cpm	5K	5k
	400 cpm	401	401		500 cpm	500	500
	40 cpm	40	40		50 cpm	50	50

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:
Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ☐ Beta S/N ☑ Other I-129 #021087

☑ m 500 S/N 134709 ☐ Oscilloscope S/N ☑ Multimeter S/N 86250390

Calibrated By: [signature] Date 18 Apr 06

Reviewed By: [signature] Date 18-Apr-06

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.
FORM C22A 11/26/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-3 Serial No. PR045385

Customer CABRERA SERVICES Order #. 254097 / 301563

Counter 2221 Serial No. 163673 Counter Input Sensitivity 10 mV

Count Time 1 MINUTE Distance Source to Detector SURFACE

Other

High Voltage	Background	Isotope I-129 Size 85470 cpm	Isotope Size	Isotope Size	Isotope Size
850	213	26585			
900	236	32319			
950	237	38612			
1000	263	39097			
1050	707	41488			

Signature W R Robison Date 18 APR 06

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER CABRERA SERVICES ORDER NO. 248314 / 298361

Mfg. Ludlum Measurements, Inc. Model 19 Serial No. 87139

Mfg. Model Serial No.

Cal. Date 9-Jan-06 Cal Due Date 9-Jan-07 Cal. Interval 1 Year Meterface 202-016

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 77 °F RH 20 % Alt 707.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☐ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC

☐ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☑ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set 650 V Input Sens. 40 mV Det. Oper. V at mV Threshold Dial Ratio = mV

☐ HV Readout (2 points) Ref./Inst. / V Ref./Inst. / V

COMMENTS:

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
5000	4000 µR/hr	4000	4000
5000	1000 µR/hr	1000	1000
500	400 µR/hr = 74,800 cpm	420	400
500	100 µR/hr	110	100
250	200 µR/hr = 38,000 cpm	220	200
250	100 µR/hr	110	100
50	7,480 cpm	42	40
50	1,870 cpm	11	10
25	3,800 cpm	21	20
25	950 cpm	5.5	5

*Uncertainty within ± 10% C.F. within ± 20% 50, 25 **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout				Log Scale			

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☑ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ☐ Beta S/N ☐ Other

☑ m 500 S/N 189491 ☐ Oscilloscope S/N ☑ Multimeter S/N 82250292

Calibrated By: Donnie Mieros Date 9-Jan-06

Reviewed By: [illegible] Date 9 Jan 06

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.
FORM C22A 11/26/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER CABRERA SERVICES ORDER NO. 261066 / 304869

Mfg. Ludlum Measurements, Inc. Model 2221 Serial No. 176947

Mfg. Ludlum Measurements, Inc. Model 44-110 Serial No. PR-178079

Cal. Date 16-Aug-06 Cal Due Date 16-Aug-07 Cal. Interval 1 Year Meterface 202-159

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 46 % Alt 700.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 4.4 VDC
☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set 1650 V Input Sens. 5 mV Det. Oper. 1650 V at 5 mV Threshold Dial Ratio 100 = 5 mV

☑ HV Readout (2 points) Ref./Inst. 500 / 499 V Ref./Inst. 2000 / 2002 V

COMMENTS:

Firmware: 26 10 27

Calibrated using 5' C-cable.

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1K	400k cpm	400	400
X 1K	100k cpm	100	100
X 100	40k cpm	400	400
X 100	10k cpm	100	100
X 10	4k cpm	400	400
X 10	1k cpm	100	100
X 1	400 cpm	400	400
X 1	100 cpm	100	100

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400k cpm	399440)	399440)	Log Scale	500k cpm	500K	500K
	40k cpm	399.6	399.6		50k cpm	50K	50K
	4k cpm	400	400		5k cpm	5K	5K
	400 cpm	40	40		500 cpm	500	500
	40 cpm	4	4		50 cpm	50	50

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ☑ Beta S/N H-3 s/n 306 Tc99 s/n 5279 ☐ Other

☑ m 500 S/N 81084 ☐ Oscilloscope S/N ☑ Multimeter S/N 78401030

Calibrated By: Sebastian Ceballos Date 16-Aug-06

Reviewed By: [illegible] Date 16 Aug 06

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.
FORM C22A 11/26/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-110 Serial No. PR-178079

Customer CABRERA SERVICES Order #. 261066 / 304869

Counter 2221 Serial No. 176947 Counter Input Sensitivity 5 mV

Count Time 1 minute Distance Source to Detector Surface

Other

High Voltage	Background	Isotope H-3 Size 2,730 dpm	Isotope Tc99 Size 28,800 dpm	Isotope Size	Isotope Size
1600V	224	638	13,964		
* 1650	355	1,176	17,119		
1700	442	1,517	18,160		

Signature Sebastn Ceballos Date 16-Aug-06

FORM C4A 04/09/2003

Duratek™

CALIBRATION CERTIFICATE

Duratek Instrument Services
628 Gallaher Road
Kingston, TN 37763
Phone: (865) 376-8337
Fax: (865) 376-8331

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		INSTRUMENT INFORMATION	
Customer Name: Duratek Instrument Services		**Manufacturer: Ludlum**	
Address: 628 Gallaher Road, Kingston, TN 37763		**Model: 2224**	**Serial Number: 154046**
Contact Name: Tony Riggs		**Probe: N/A**	**Serial Number: N/A**
Customer Purchase Order Number: N/A	**Work Order Number: 2006-03971**	**Calibration Method: Electronic**	

INSTRUMENT CALIBRATION INFORMATION

Instrument Range	Calibration Standard Value	Ratemeter Response		Calibration Standard Value	Tolerances (cpm) ± 2%	Scaler Response	
		As Found	As Left			As Found	As Left
X 1	100	100	100	40	40	40	40
X 1	200	200	200	400	392-408	400	400
X 1	400	400	400	4,000	3,920-4,080	4,001	4,001
X 10	1,000	1,000	1,000	40,000	39.2K-40.8K	40,001	40,001
X 10	2,000	2,000	2,000	400,000	392K-408K	400,011	400,011
X 10	4,000	4,000	4,000				
X 100	10,000	10,000	10,000				
X 100	20,000	20,000	20,000				
X 100	40,000	40,000	40,000				
X 1000	100,000	100,000	100,000				
X 1000	200,000	200,000	200,000				
X 1000	400,000	400,000	400,000				

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this instrument).

Instrument Calibrated By: Mike Paul	**Reviewed By:** Jeff Nelson **Date:** 9/8/06
Calibration Date: 09/08/06	**Calibration Due: 09/08/07**

Model: 2224 Serial Number: 154046

M&TE				Environmental Conditions		
Volt Meter	ID# TW12662	Cal Due:	02/23/07	Barometer	ID# 2551	Cal Due: 10/13/06
Pulser	ID# 101500	Cal Due:	09/28/06	Thermometer	ID# 2551	Cal Due: 10/13/06
Humidity	ID# 958670	Cal Due:	03/29/07	Temp: 23.2 °C	Pressure: 742mHg	Humidity: 57%

Special Test			
Geotropism	Sat (√) Unsat ( )	As Found	As Left
Audio Check	Sat (√) Unsat ( )	Alpha Sensitivity= 145mv	Alpha Sensitivity= 120mv
Mechanical Zero	Sat (√) Unsat ( )	Beta Sensitivity= 4.5mv	Beta Sensitivity= 3.5mv
Reset	Sat (√) Unsat ( )	Beta Window= 40mv	Beta Window= 30mv
HV Analog Display	Sat (√) Unsat ( )	See detector sheet for proper High Voltage setting	
Batt. Ck. (Min. Volt 2.2VDC)	Sat (√) Unsat ( )	Overload Not Set	Overload Not Set

High Voltage Calibration				H.V. Set With Detector Not Connected			
Voltage	Tolerance	As Found	As Left				
500	450-550	501	501				
1000	900-1100	997	997				
1500	1350-1650	1,531	1,531				

COMMENTS

Calibrated with 5ft. Cable

Calibrated in accordance with OEM Technical Manual

Instrument Calibrated By: Mike Paul	Reviewed By: Jeff Palermo Date: 9/8/06
Calibration Date: 09/08/06	Calibration Due: 09/08/07

Duratek™

DETECTOR CERTIFICATE

Duratek Instrument Services
628 Gallaher Road
Kingston, TN 37763
Phone: (865) 376-8337
Fax: (865) 376-8331

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		DETECTOR INFORMATION
Customer Name: Duratek Instrument Services		**Manufacturer:** Ludlum
Address: 628 Gallaher Rd Kingston, TN 37763		**Detector Model:** 43-68A
Contact Name: Tony Riggs		**Serial Number:** 088917
Customer Purchase Order Number: N/A	**Work Order Number:** 2006-03971	**Evaluation Method:** Source

DETECTOR EFFICIENCY/RESPONSE/PRECISION INFORMATION

1) Source Nuclide: Th^{230}	Serial Number: 119709	Activity (dpm): 2,442	Certification Date: 10/14/97

Parameter	As Found	As Left	Precision Test	CPM (Source #1)
Count 1	423	423	Count 1(Heel)	375
Count 2	410	410	Count 2(Center)	412
Count 3	425	425	Count 3(Toe)	414
Average	419	419	Average	400
Background (cpm)	0	0	Tolerance	All counts within ±10% of Average
Net Counts	419	419	Pass/Fail	PASS
Efficiency	17.2%	17.2%		

Low Sample Activity: Source #: N/A	High Sample Activity: Source #: N/A	Dead Time (DT): N/A	Calibration Constant (CC): N/A

SCALER INFORMATION		DETECTOR INFORMATION			
Model	Serial Number	Due Date	Background	Operating Voltage	Threshold
2224	154046	09/08/07	0	1575V	120mV

Detector Setup Report YES NO √	Barcode Report YES NO √	Voltage Plateau YES √ NO

COMMENTS

1 minute background* **Calibrated with 5Ft. Cable** Efficiency determined w/43-68 source jig*

STATEMENT OF CERTIFICATION

We Certify that the detector listed above was evaluated for proper operation prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this detector).

Detector Certified By: M. Pauli	Reviewed By: Jeff Dabeinson	Date: 9/8/06
Certification Date: 09/08/06		Certification Due: 09/08/07

Duratek™

DETECTOR CERTIFICATE

Duratek Instrument Services
628 Gallaher Road
Kingston, TN 37763
Phone: (865) 376-8337
Fax: (865) 376-8331

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		DETECTOR INFORMATION
Customer Name: Duratek Instrument Services		**Manufacturer:** Ludlum
Address: 628 Gallaher Rd Kingston, TN 37763		**Detector Model:** 43-68B
Contact Name: Tony Riggs		**Serial Number:** 088917
Customer Purchase Order Number: N/A	**Work Order Number:** 2006-03971	**Evaluation Method:** Source

DETECTOR EFFICIENCY/RESPONSE/PRECISION INFORMATION

1) Source Nuclide: Tc99	Serial Number: 119713	Activity (dpm): 2,616	Certification Date: 10/14/97

Parameter	As Found	As Left	Precision Test	CPM (Source #1)
Count 1	645	645	Count 1(Heel)	589
Count 2	593	593	Count 2(Center)	562
Count 3	629	629	Count 3(Toe)	621
Average	622	622	Average	591
Background (cpm)	159	159	Tolerance	All counts within ±10% of Average
Net Counts	463	463	Pass/Fail	PASS
Efficiency	18.0%	18.0%		

Low Sample Activity: Source #: N/A	High Sample Activity: Source #: N/A	Dead Time (DT): N/A	Calibration Constant (CC): N/A

SCALER INFORMATION		DETECTOR INFORMATION			
Model	Serial Number	Due Date	Background	Operating Voltage	Threshold
2224	154046	09/08/07	159	1575V	3.5-30 mV

Detector Setup Report YES NO √	Barcode Report YES NO √	Voltage Plateau YES √ NO

COMMENTS

10 minute background* Efficiency determined w/43-68 source jig* **Calibrated with 5Ft. Cable**

STATEMENT OF CERTIFICATION

We Certify that the detector listed above was evaluated for proper operation prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this detector).

Detector Certified By: M. Pauli	Reviewed By: [signature]	Date: 9/8/06
Certification Date: 09/08/06		Certification Due: 09/08/07

Detector 43-68 #088917 Raw Data (Counts)										
	Background		Th-230		Tc-99		N/A		N/A	
Voltage	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
1525	0	93	354	204	2	599				
1550	0	129	391	200	3	589				
1575	**2**	**163**	**433**	**218**	**1**	**593**				
1600	1	186	416	252	1	599				
1625	3	202	456	250	8	555				
1650	5	197	459	253	21	492				

Source Info

Nuclide	**Th-230**	**Tc-99**	**N/A**	**N/A**
ID	119709	119713		
Initial DPM	2442	2616		
Certification Date	10/14/1997	10/14/1997		
Today's Date	9/8/2006	9/8/2006	9/8/2006	9/8/2006
Source Age (Years)	8.90	8.90	106.69	106.69
Half-Life (Years)	7.70E+04	2.13E+05		
Corrected Activity	2442	2616	#DIV/0!	#DIV/0!

Net CPM														
	MDA/Cross-Talk			Beta Eff.	Alpha Eff.	Th-230		Tc-99		N/A		N/A	
Voltage	Beta MDA	Alpha MDA	Beta-Alpha	(%)	(%)	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
1525	246.0	18.7	0.3%	19.34%	14.5%	354	111	2	506	0	-93	0	-93
1550	315.9	16.9	0.5%	17.58%	16.0%	391	71	3	460	0	-129	0	-129
1575	**377.9**	**52.6**	**0.2%**	**16.44%**	**17.7%**	**431**	**55**	**-1**	**430**	-2	-163	-2	-163
1600	419.1	43.3	0.2%	15.79%	17.0%	415	66	0	413	-1	-186	-1	-186
1625	510.1	58.0	1.4%	13.49%	18.6%	453	48	5	353	-3	-202	-3	-202
1650	603.1	70.5	4.1%	11.28%	18.6%	454	56	16	295	-5	-197	-5	-197
	#DIV/0!	#DIV/0!	#DIV/0!	0.00%	0.0%	0	0	0	0	0	0	0	0
	#DIV/0!	#DIV/0!	#DIV/0!	0.00%	0.0%	0	0	0	0	0	0	0	0
	#DIV/0!	#DIV/0!	#DIV/0!	0.00%	0.0%	0	0	0	0	0	0	0	0

Performed By: Mike Pauli Date: 9/8/06

Reveiwed By: Jeff Dakeman Date: 9/8/06

Cabrera Services, Inc.

Instrumentation Logbook

Natick SSC Final Status Survey

Project #03-3040.27

Dec 2006

Source Data Page

Source	Activity	S/N	Half Life (years)	Generation Date	Vendor
Th-230	16,800dpm	1308	77,000 yr	12-28-05	Eberline
Cs-137	1 uC;	1184 ~~1184~~ ~~1137~~	30.17 yr		
C-14	0.1507 uC;	1116-85	5730 yr	12-1-06	Isotope Product Labs
H-3	100 kBq	1390	12.28 yr	12-5-06	QSA Global

Instrument Inventory Log

Vendor	Make	Model / Probe	S/N	Cal Cert	Date Rec'd	Date Ret'd	Comments
Ludlum	Ludlum	2360	193675	Yes	12/11/06	12/13/06	
Ludlum	Ludlum	43-37	PR-216984	Yes			
Ludlum	Ludlum	3	79517	Yes			
Ludlum	Ludlum	44-9	PR-137500	Yes			
Ludlum	Ludlum	2221	163673	Yes			
Ludlum	Ludlum	44-3	PR045385	Yes			
Ludlum	Ludlum	19	87139	Yes			
Ludlum	Ludlum	2221	176947	Yes			
Ludlum	Ludlum	44-110	PR-178079	Yes			
Duratek	Ludlum	2224	154046	Yes			
Duratek	Ludlum	43-68A/ 43-68B	088917	Yes			
Duratek	Ludlum	43-68A/ 43-68B	088917	Yes	2/16/07	2/16/07	Follow-up Post-Decon Survey

DAILY FIF) LOG
Instrument QC

units are cpm or , hr

Make	Model	S/N	Probe	S/N	DOC
Ludlum	19	87139	—	—	1/9/06
Bkgd Count	**Source Count**	**Source #1 ID**	**Source #2 ID**	**Source #3 ID**	**CDD**
		1184			

Date	12/11/06										
Intial QC's	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Tech**
Bkgd	16	17	17	18	18	15	17	16	16	18	Hisel
Source #1	310	320	310	320	300	320	310	300	310	300	Hisel
Source #2											
Source #3											

Daily QC's

Date	Bkgd	Source #1 (Cs-137) α / β / γ	Source #2 ( ) α / β / γ	Source #3 ( ) α / β / γ	Battery OK	Tech
12/12/06	16	~~6200 cpm~~ 310 uR/hr GH			Yes / No	GSH
12/13/06	15	310 uR/hr			Yes / No	GB
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	

DAILY F[illegible]D LOG
Instrument QC

units are cpm [illegible] ur/hr

Make	Model	S/N	Probe	S/N	DOC
Ludlum	3	79517	44-9	PR-137500	3/23/06
Bkgd Count	**Source Count**	**Source #1 ID**	**Source #2 ID**	**Source #3 ID**	**CDD**
		1184			

Date	12/11/06										
Intial QC's	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Tech**
Bkgd	80	70	60	70	80	60	60	50	70	60	Hisel
Source #1	6000	6200	6000	6500	6500	6500	6800	6000	6200	6500	
Source #2											
Source #3											

β
β/γ

Daily QC's

Date	Bkgd	Source #1 (Cs-137) α / β / γ	Source #2 ( ) α / β / γ	Source #3 ( ) α / β / γ	Battery OK	Tech
12/12/06	60 cpm	6200 cpm			Yes / No	GSH
12/13/06	60	6200 cpm			Yes / No	GSH
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	

DAILY FI[illegible] LOG
Instrument QC

units are cpm o[illegible] /hr

Make	Model	S/N	Probe	S/N	DOC
Ludlum	2221	176947	44-110	PR-178079	8/16/06
Bkgd Count	**Source Count**	**Source #1 ID**	**Source #2 ID**	**Source #3 ID**	**CDD**

Date	12/11/06										
Intial QC's	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Tech**
Bkgd	153	116	122	119	137	125	127	128	130	161	GB
Source #1	~~8413~~	~~9140~~	~~8176~~	~~7944~~	~~7427~~	~~9519~~	GB 12/11/06	Found Clear plastic QC			GB
Source #2	9519	10149	8917	9835	9699	9006	8350	10658	8710	10378	GB
Source #3											

M-3

30-sec Count

Daily QC's

Date	Bkgd	Source #1 (M-3) α / β / γ	Source #2 ( ) α / β / γ	Source #3 ( ) α / β / γ	Battery OK	Tech
12/12/06	117	11069	—	—	Yes / No	[illegible]
12/13/06	139	10904	—	—	Yes / No	GB
2/16/07	165	10076	—	—	Yes / No	[illegible]
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	

DAILY FI[illegible] LOG
Instrument QC

units are cpm o[illegible]/hr

Make	Model	S/N	Probe	S/N	DOC
Ludlum	2224	154046	43-68A/43-68B	088917	9/8/06
Bkgd Count	**Source Count**	**Source #1 ID**	**Source #2 ID**	**Source #3 ID**	**CDD**

Date											
Intial QC's	1	2	3	4	5	6	7	8	9	10	Tech
Bkgd	1/117	0/92	0/101	0/100	0/101	0/106	1/114	1/111	0/86	0/100	GB
Source #1	1682	1765	1644	1791	1700	1668	1719	1686	1662	1687	GB
Source #2	17904	15089	19050	17879	15693	18984	15139	16871	17952	19664	GB
Source #3											

30s counts

α only
β only

Daily QC's

Date	Bkgd	Source #1 (Th-230) α / β / γ	Source #2 (C-14) α / β / γ	Source #3 ( ) α / β / γ	Battery OK	Tech
12/12/06	0/105	1741	GB 12/12/06 ~~4375~~ 20278*		Yes / No	RJ
12/13/06	0/100	GK ~~1893~~ 1684	14792		Yes / No	GSK
2/16/07	0/~~84~~98 GSK		15732		Yes / No	GSK
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	

*- Performed recount since initial count seemed low

DAILY F .D LOG
Instrument QC

units are cpm or ur/hr

Make	Model	S/N	Probe	S/N	DOC
Ludlum	2360	193675	43-37	PR-216984	~~+2~~ 4/20/06
Bkgd Count	**Source Count**	**Source #1 ID**	**Source #2 ID**	**Source #3 ID**	**CDD**
		5633-05	1116-85		

Date	12/11/06										
Intial QC's	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Tech**
Bkgd	500	516	511	536	533	538	512	510	536	519	Hisel β
Source #1	753	740	753	796	756	736	732	738	762	747	Hisel α
Source #2	17352	17454	17749	18433	17733	17880	18087	17921	18097	18609	Hisel β
Source #3											

Daily QC's

Date	Bkgd	Source #1 (Th-230) α / β / γ	Source #2 (C-14) α / β / γ	Source #3 ( ) α / β / γ	Battery OK	Tech
12/12/06	536	762	16942		Yes / No	GLL
12/13/06	536	708	18371		Yes / No	GLL
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	

Natick Countrate Meter Daily Beta Background QC

43-68 (088917)		
QC Daily Source		
Date	Result (cpm)	P/F
12/12/2006	105	Pass
12/13/2006	100	Pass
2/16/2007	94	Pass

43-68 (088917)		Source Ser. #	
Initial Source Readings		Nuclide	
Date	Result (cpm)		
12/11/2006	117		
12/11/2006	92		
12/11/2006	101		
12/11/2006	100		
12/11/2006	101		
12/11/2006	106		
12/11/2006	114		
12/11/2006	111		
12/11/2006	186		
12/11/2006	100		
	Average		
	113		

Natick Countrate Meter Daily Alpha Source QC

43-68 (088971)		
QC Daily Source		
Date	Result (cpm)	P/F
12/12/2006	1741	Pass
12/13/2006	1684	Pass

43-68 (088971)		Source Ser. #	1308
Initial Source Readings		Nuclide	Th-230
Date	Result (cpm)		
12/11/2006	1682		
12/11/2006	1765		
12/11/2006	1644		
12/11/2006	1791		
12/11/2006	1700		
12/11/2006	1668		
12/11/2006	1719		
12/11/2006	1686		
12/11/2006	1662		
12/11/2006	1687		
	Average		
	1700		

Natick Countrate Meter Daily Beta Source QC

43-68 (088917)		
QC Daily Source		
Date	Result (cpm)	P/F
12/12/2006	20278	Pass
12/13/2006	14792	Pass
2/16/2007	15732	Pass

43-68 (088917)		Source Ser. #	1116-85
Initial Source Readings		Nuclide	C-14
Date	Result (cpm)		
12/11/2006	17904		
12/11/2006	15089		
12/11/2006	19050		
12/11/2006	17879		
12/11/2006	15693		
12/11/2006	18984		
12/11/2006	15139		
12/11/2006	16871		
12/11/2006	17952		
12/11/2006	19664		
	Average		
	17423		

Natick Countrate Meter Daily Beta Background QC

43-37(PR216984)		
QC Daily Source		
Date	Result (cpm)	P/F
12/12/2006	536	Pass
12/13/2006	536	Pass

Natick Countrate Meter Daily Beta Source QC

43-37 (PR216984)		
QC Daily Source		
Date	Result (cpm)	P/F
12/12/2006	16942	Pass
12/13/2006	18371	Pass

43-37 (PR216984)		Source Ser. #	1116-85
Initial Source Readings		Nuclide	C-14
Date	Result (cpm)		
12/11/2006	17352		
12/11/2006	17454		
12/11/2006	17749		
12/11/2006	18433		
12/11/2006	17733		
12/11/2006	17880		
12/11/2006	18087		
12/11/2006	17921		
12/11/2006	18097		
12/11/2006	15609		
	Average		
	17632		

Natick Countrate Meter Daily Beta Background QC

44-110 (PR178079)		
QC Daily Source		
Date	Result (cpm)	P/F
12/12/2006	117	Pass
12/13/2006	139	Pass
2/16/2007	155	Pass

44-110 (PR178079)		Source Ser. #	
Initial Source Readings		Nuclide	
Date	Result (cpm)		
12/11/2006	153		
12/11/2006	116		
12/11/2006	122		
12/11/2006	119		
12/11/2006	137		
12/11/2006	125		
12/11/2006	127		
12/11/2006	128		
12/11/2006	130		
12/11/2006	161		
	Average		
	132		

Natick Countrate Meter Daily Beta Source QC

44-110 (PR178079)		
QC Daily Source		
Date	Result (cpm)	P/F
12/12/2006	11069	Pass
12/13/2006	10904	Pass
2/16/2007	10076	Pass

44-110 (PR178079)		Source Ser. #	1390
Initial Source Readings		Nuclide	H-3
Date	Result (cpm)		
12/11/2006	9519		
12/11/2006	10149		
12/11/2006	8917		
12/11/2006	9835		
12/11/2006	9699		
12/11/2006	9006		
12/11/2006	8350		
12/11/2006	10658		
12/11/2006	8710		
12/11/2006	10378		
	Average		
	9522		

Natick Countrate Meter Daily Background QC

44-9 (PR137500)		
QC Daily Source		
Date	Result (cpm)	P/F
12/12/2006	60	Pass
12/13/2006	60	Pass

44-9 (PR137500)		Source Ser. #	
Initial Source Readings		Nuclide	
Date	Result (cpm)		
12/11/2006	80		
12/11/2006	70		
12/11/2006	60		
12/11/2006	70		
12/11/2006	80		
12/11/2006	60		
12/11/2006	60		
12/11/2006	50		
12/11/2006	70		
12/11/2006	60		
	Average		
	66		

Natick Countrate Meter Daily Source QC

44-9 (PR137500)		
QC Daily Source		
Date	Result (cpm)	P/F
12/12/2006	6200	Pass
12/13/2006	6200	Pass

44-9 (PR137500)		Source Ser. #	1184
Initial Source Readings		Nuclide	Cs-137
Date	Result (cpm)		
12/11/2006	6000		
12/11/2006	6200		
12/11/2006	6000		
12/11/2006	6500		
12/11/2006	6500		
12/11/2006	6500		
12/11/2006	6800		
12/11/2006	6000		
12/11/2006	6200		
12/11/2006	6500		
	Average		
	6320		

Natick Countrate Meter Daily Background QC

Inst.#87139		
QC Daily Source		
Date	Result (cpm)	P/F
12/12/2006	16	Pass
12/13/2006	15	Pass

Inst.#87139		Source Ser. #	
Initial Source Readings		Nuclide	
Date	Result (cpm)		
12/11/2006	16		
12/11/2006	17		
12/11/2006	17		
12/11/2006	18		
12/11/2006	18		
12/11/2006	15		
12/11/2006	17		
12/11/2006	16		
12/11/2006	16		
12/11/2006	18		
	Average		
	17		

Natick Countrate Meter Daily Source QC

Inst.#87139		
QC Daily Source		
Date	Result (cpm)	P/F
12/12/2006	310	Pass
12/13/2006	310	Pass

Inst.#87139		Source Ser. #	1184
Initial Source Readings		Nuclide	Cs-137
Date	Result (cpm)		
12/11/2006	310		
12/11/2006	320		
12/11/2006	310		
12/11/2006	320		
12/11/2006	300		
12/11/2006	320		
12/11/2006	310		
12/11/2006	300		
12/11/2006	310		
12/11/2006	300		
	Average		
	310		

APPENDIX F

HEALTH AND SAFETY RECORDS

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

Daily Safety Toolbox Meeting	
Project Name: SSC Natick Final Status Survey	Project Number: 03-3040.27 Task 31
Location: Natick, MA	Date/Time: 12/11/06
General Scope of Work: Final Status Survey of former laboratories and radiological use areas within the Soldier Systems Center in Natick.	

Emergency Telephone Numbers		
Police: 911	Fire: 911	Ambulance: 911
Other (UXO, Facility, etc.):		
Name:	Phone #:	
Name:	Phone #:	
Name:	Phone #:	
Name:	Phone #:	

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

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

Safety and Health Information (continued)
Lessons Learned from Previous Day: N/A
Questions and Feedback from Attendees:

Meeting Conducted By	Printed Name	Signature	Company
CABRERA Field Lead	Greg Bright		Cabrera
Radiological Lead	Greg Hisel		Cabrera
Safety and Health Rep			

Meeting Attendees		
Print Name	Signature	Company
Greg Bright		Cabrera
Greg Hisel		Cabrera
Robert L Shoemaker		Cabrera

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.

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

Daily Safety Toolbox Meeting	
Project Name: SSC Natick Final Status Survey	Project Number: 03-3040.27 Task 31
Location: Natick, MA	Date/Time: 12/12/06
General Scope of Work: Final Status Survey of former laboratories and radiological use areas within the Soldier Systems Center in Natick.	

Emergency Telephone Numbers		
Police: 911	Fire: 911	Ambulance: 911
Other (UXO, Facility, etc.):		
Name:	Phone #:	
Name:	Phone #:	
Name:	Phone #:	
Name:	Phone #:	

Day's Work Tasks	
Task 1: Indoor surveys	Task 2: Roof survey
Task 3:	Task 4:
Task 5:	Task 6:
Training Requirements: HAZWOPER	

Safety and Health Information					
Job Safety Analysis Completed for this Work?			X	Yes	No
RWP Permit:		Yes	X	No	RWP #
Confined Space Permit:		Yes	X	No	#
Radiation Hazards: N/A					
Chemical Hazards (including marking tape, decon agents, etc.): N/A					
Physical Hazards: ~~Stay 6 ft fro~~ Roof surveys - stay 6 ft from edge					
Work Control Methods (JHA, Work Plan, monitoring, etc.):					
PPE: N/A					
Special Equipment (Generators, ISOCS, Backhoes, etc.): N/A					
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	Greg Bright		Cabrera
Radiological Lead	Greg Bright		Cabrera
Safety and Health Rep			

Meeting Attendees		
Print Name	Signature	Company
Greg Bright		Cabrera
Greg Hiser		Cabrera
Robert Shoemaker		Cabrera

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.

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

Daily Safety Toolbox Meeting	
Project Name: SSC Natick Final Status Survey	Project Number: 03-3040.27 Task 31
Location: Natick, MA	Date/Time: 12 / 13 / 06
General Scope of Work: Final Status Survey of former laboratories and radiological use areas within the Soldier Systems Center in Natick.	

Emergency Telephone Numbers		
Police: 911	Fire: 911	Ambulance: 911
Other (UXO, Facility, etc.):		
Name:	Phone #:	
Name:	Phone #:	
Name:	Phone #:	
Name:	Phone #:	

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

Safety and Health Information					
Job Safety Analysis Completed for this Work?			X	Yes	No
RWP Permit:		Yes	X	No	RWP #
Confined Space Permit:		Yes	X	No	#
Radiation Hazards: N/A					
Chemical Hazards (including marking tape, decon agents, etc.): N/A					
Physical Hazards: N/A					
Work Control Methods (JHA, Work Plan, monitoring, etc.):					
PPE: N/A					
Special Equipment (Generators, ISOCS, Backhoes, etc.): N/A					
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	Greg Bright		Cabrera
Radiological Lead	Greg Hisel		Cabrera
Safety and Health Rep			

Meeting Attendees		
Print Name	Signature	Company
Greg Bright		Cabrera
Greg Hisel		Cabrera
Robert L Shoemaker		Cabrera

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.