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February 8, 2019

Mr. Michael LaFranzo
U.S. Nuclear Regulatory Commission
Region III
2443 Warrenville Road
Lisle, IL 60532

SUBJECT: **NRC License Number 24-00196-07; Amendment Request to Remove St. Mary's Health Center – West Pavilion, 1027 Bellevue Avenue, St. Louis, Missouri (License Condition 10.C.) and Authorize Free Release**

Dear Mr. LaFranzo:

This letter is to request an amendment to Saint Louis University's broad scope license, NRC License Number 24-00196-07, authorizing unrestricted release of St. Mary's Health Center – West Pavilion, located at 1027 Bellevue Avenue, St. Louis, Missouri, which is no longer used by Saint Louis University for radioactive materials.

Licensed activities were limited to the research laboratory suite (Suite 110), and ceased in 2005, with a possibility that work with licensed materials would resume in the future. This possibility was active until a determination was made in 2018 by department leadership that they would not resume licensed activities in this location. A decision to permanently remove this location from the Saint Louis University NRC license was made. The facility has undergone decommissioning, which was conducted under the provisions of the Saint Louis University radioactive materials license and in accordance with a MARSSIM-based Decommissioning Work Plan. Chase Environmental Group, Inc. was employed to assist the University with decommissioning efforts. The enclosed Final Status Report provides conclusive evidence that the facility meets the criteria for unrestricted use specified in 10 CFR 20 Subpart E. Additionally, each final status measurement indicates that residual licensed material at the facility is less than the ALARA goal of 5000 dpm/100cm^2 total activity, and 200 dpm/100cm^2 removable activity. Dose modeling indicates that the TEDE to an average member of the critical group under the building occupancy scenario of DandD Version 2.1 is 2.3 E-5 mrem/year (<1E-5% of the NRC release criterion of 25 mrem/yr).

I appreciate your time and efforts with this matter and look forward to hearing back from you. If you have any questions or concerns, please contact me at 314-977-6885.

Sincerely,

Mark Haenchen, M.S., J.D.
Executive Director, Environmental Health and Safety
and Radiation Safety Officer

cc: Paul M. Loewenstein, Chairman, Radiation Safety Committee
Matthew Christian, Associate Vice President for Research, Saint Louis University
Kevin Ferguson, Associate Radiation Safety Officer

enclosure:
Saint Louis University, St. Mary's Health Center – 1027 Building – Decommissioning Final Status Survey Report

Saint Louis University
St. Mary's Health Center – 1027 Building
Final Status Survey Report

Work Performed Under:
Saint Louis University
NRC License Number 24-00196-07

June 30, 2018

Prepared:	Stefan Herold **Stefan Herold**	**Radiological Specialist**	**Date:**	**11/23/18**
Reviewed:	Dustin Miller **Dustin G. Miller**	**Certified Health Physicist**	**Date**	**11/23/18**
Approved:	Dave Culp **Dave Culp**	**Field Services Manager**	**Date**	**11/23/18**

Prepared by:
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APPENDICES

ACRONYMS

ALARA	As Low As Reasonably Achievable
CFR	Code of Federal Regulations
$DCGL_W$	Derived Concentration Guideline Level – Wilcoxon Rank Sum
DQA	Data Quality Assessment
DQO	Data Quality Objective
DSV	Default Screening Value
FSS	Final Status Survey
HSA	Historical Site Assessment
LBGR	Lower Bound of the Gray Region
LSC	Liquid Scintillation Counter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
NRC	U.S. Nuclear Regulatory Commission
NIST	National Institute of Standards and Technology
QA	Quality Assurance
SLU	Saint Louis University
SMH	St. Mary's Health Center – 1027 Building
TEDE	Total Effective Dose Equivalent

1 INTRODUCTION

Saint Louis University (SLU) has decided to release for unrestricted use laboratory suite 110 located at St. Mary's Health Center – 1027 Building (SMH) in St. Louis, Missouri. See Appendix A for a site satellite photo. The Laboratory was designated as a radioactive materials usage area under the Saint Louis University US Nuclear Regulatory Commission (NRC) radioactive materials license #24-00196-07. In preparation for reassigning suite 110 for non-radiological use, radiological closeout surveys were performed by SLU personnel. Licensed radioactive materials used in dispersible forms consisted of H-3 and S-35. Considering the half-life of S-35, quantities used, and time since last usage any residual S-35 would have decayed to undetectable levels; therefore, H-3 is the only nuclide of concern for decommissioning. However, Chase designed final status surveys to include measurements to verify no other long-lived nuclides were present.

SLU contracted Chase Environmental Group, Inc. (Chase) to perform MARSSIM-based surveys of laboratory suite 110. These independent, third party surveys are statistically sound and support that the impacted laboratory suite meets the unrestricted release criteria for residual radioactive materials. On-site activities were conducted on June 19, 2018.

This Report was developed using the guidance provided in NUREG 1757, "*Consolidated NMSS Decommissioning Guidance*" and NUREG 1575, "*Multi-Agency Radiation Survey and Site Investigation Manual*" (MARSSIM); and provides the approach, methods, and techniques for radiological surveys of impacted areas of the facilities within the scope of the project. Final status surveys were designed to implement the protocols and guidance provided in MARSSIM to ensure that technically defensible data was generated to demonstrate that structures met the release criteria for unrestricted use specified in 10CFR20.1402: "*Radiological criteria for unrestricted use*". The criteria are that residual radioactivity that is distinguishable from background radiation does not result in a Total Effective Dose Equivalent (TEDE) to an average member of the critical group in excess of 25 mrem per year and that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA).

In addition, Chase established conservative ALARA goals. Specifically, the following surface contamination limits were applied:

- 5,000 dpm/100 cm^2 total surface contamination
- 1,000 dpm/100 cm^2 removable surface contamination

This report presents sufficient data to support the conclusion that the facilities surveyed meet the NRC's release criteria for unrestricted use. Radiological surveys demonstrate that building structural surfaces and systems included in the scope of this report are below release criteria and are suitable for unrestricted release. All final status surface radioactivity measurements were a small fraction of the NRC screening values. Based on the Building Occupancy Scenario of NRC DandD dose modeling software Version 2.1, **the Total Effective Dose Equivalent (TEDE) to an average member of the critical group would be 2.3E-5 mrem/year (<1E-5% of the release criterion of 25 mrem/yr)**.

2 SITE DESCRIPTION AND HISTORY

The 1,364ft^2 laboratory suite 110 consists of four rooms and is located inside the Women's Health Building located at 1027 Bellevue Ave. St. Louis, MO 63117. A floor plan is provided in Appendix B.

The laboratory room has vinyl and terracotta flooring, painted sheetrock walls, steel casework, composite lab benchtops and stainless steel sinks. The room contains one capped duct above the location of a removed fume hood.

Suite 110 was decommissioned on May 10, 2005. SLU provided Chase with a list of the nuclides known to be used in dispersible form within lab 110. Total usage consisted of 23 mCi of S-35, and 11 mCi of H-3.

3 RELEASE CRITERIA

The release criteria for unrestricted use are contained in NRC 10 CFR 20 Subpart E. Specifically, buildings were surveyed in accordance with the guidance contained in MARSSIM to demonstrate compliance with the criteria of 10 CFR 20.1402: *"Radiological criteria for unrestricted use: A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA)."*

4 DERIVED CONCENTRATION GUIDELINE LEVELS (DCGLs)

The NRC has published default screening values (DSVs) in NUREG 1757, Volume 1, Appendix B for commonly used radionuclides. The DSVs are the average concentrations of residual radioactivity that would equate to 25 mrem/yr to an average member of the critical group using default parameter values in the DandD dose modeling software. Structural surface DSVs for the nuclides of concern are presented in the following table. Although Carbon-14 was not authorized for use in the suite, direct beta surveys were designed to detect C-14 as a quality measure to verify no other long-lived nuclides were present.

Table 4-1: NRC Screening Values

Nuclide	Half-Life (yr)	Half-Life < 120 days?	Radiation Type	Default Screening Value (dpm/100cm^2)
C-14	5.7E+03	No	Low Energy Beta	3.7E+06
H-3	1.2E+01	No	Low Energy Beta	1.2E+08

DSVs are the basis for developing Derived Concentration Guideline Levels for building structural surfaces. The DCGL is the radionuclide-specific surface area concentration that could result in a dose equal to the release criterion. DCGL$_W$ is the concentration limit if the residual activity is essentially evenly distributed over a large area. For this project, DCGL$_W$ is equal to the DSV. An important assumption of the dose model is that removable

radioactivity is <10% of total surface radioactivity. Smear surveys were taken to verify this assumption and compared to a removable DCGL equal to 10% of the total DCGL.

Because H-3 cannot be efficiently detected by direct methods, it was evaluated by removable contamination measurements only. Considering the extremely conservative ALARA goals, the H-3 dose contribution is an insignificant component of the total calculated dose

5 ALARA GOALS (INVESTIGATION LEVELS)

Investigation levels are used to flag locations that require special attention and further investigation to ensure areas are properly classified and adequate surveys are performed. These locations are marked and receive additional surveys to determine the concentration, area, and extent of contamination. SLU established conservative investigation levels for ALARA purposes based on the release criteria for equipment and materials specified in NUREG 1556, Volume 7, Table Q.2, "Acceptable Surface Contamination Levels for Equipment," Specifically, the following surface contamination goals were used:

- 5,000 dpm/100 cm^2 total beta-gamma surface contamination (averaged over 1m^2)
- 15,000 dpm/100 cm^2 maximum total beta-gamma surface contamination (limited to 100 cm^2)
- 1,000 dpm/100 cm^2 removable beta-gamma surface contamination

Data Quality Objectives (DQOs) were designed to ensure instrument detection sensitivities are below the ALARA goals. Because of the conservatism of these ALARA goals, they were applied on a gross measurement basis and the unity rule was not applied. The number of measurements required by MARSSIM to demonstrate compliance with the release criteria was calculated using the DCGLs.

6 ALARA ANALYSIS

Due to the low doses associated with residual radioactivity at or below the ALARA goals, an explicit quantitative ALARA analysis is not required per NUREG 1757, Volume 2, Appendix N.

7 SURVEY INSTRUMENTATION

7.1 Instrument Calibration

Radiation detection instruments were calibrated within the previous year with National Institute of Standards and Technology (NIST) traceable sources and to radiation emission types and energies that provided detection capabilities similar to the isotopes of concern. Field instruments had an efficiency determined by a licensed calibration facility using NIST traceable sources. The liquid scintillation counter successfully completed its internal calibration procedure using NIST traceable C-14 and H-3 sources prior to and after

counting each set of samples. Calibration records for field instruments are provided in Appendix C.

7.2 Datalogging

Structural surface scans and static measurements were performed using datalogging instrumentation. While scanning, in addition to the surveyor listening to the audible output, integrated counts were recorded. Logged data were downloaded and processed using data management software to perform data analyses and reporting. Reporting includes graphical (4-plot) presentation of scan data as well as summary statistics functions. The 4-Plot is described in the NIST e-Handbook of Statistical Methods (http://www.itl.nist.gov/div898/handbook/index.htm).

A 4-plot consists of the following:

- A run **sequence plot** presents logged data in chronological order, providing a time history of the survey data.
- A **lag plot** checks whether a data set or time series is random or not. Random data should not exhibit any identifiable structure in the lag plot. Non-random structure in the lag plot indicates that the underlying data are not random.
- A **histogram plot** graphically summarizes the distribution of a univariate data set, showing center (i.e., the location) of the data, spread (i.e., the scale) of the data, skewness of the data, presence of outliers, and presence of multiple modes.
- A **probability plot** is a goodness-of-fit test used to verify the distributional model. The normal probability plot is a graphical technique for assessing whether or not a data set is approximately normally distributed. The data are plotted against a theoretical normal distribution in such a way that the points should form an approximate straight line. Departures from this straight line indicate departures from normality.

7.3 Functional Checks

Instrument functional checks were performed at least daily when in use. The background, source check, and field measurement count times for radiation detection instrumentation were specified by procedure to ensure measurements were statistically valid. Background readings were taken as part of the daily instrument check and compared with the acceptance range for instrument and site conditions.

7.4 Counting Times and Minimum Detectable Concentrations (MDCs)

Minimum counting times for background determinations and measurement of total and removable contamination were chosen to provide MDCs that met the survey Data Quality Objectives (DQOs). MARSSIM equations relative to building surfaces have been modified to convert to units of dpm/100 cm^2. Count times and scanning rates were determined using the following equations:

7.4.1 Static Counting MDC

Static counting MDC at a 95% confidence level was calculated using the following equation, which is an expansion of NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{static} = \frac{3 + 3.29\sqrt{B_R \cdot t_S \cdot (1 + \frac{t_S}{t_B})}}{t_S \cdot E_{tot} \cdot \frac{A}{100}}$$

Where:

MDC_{static}	=	minimum detectable concentration (dpm/100 cm^2)
B_R	=	background count rate (counts per minute)
t_B	=	background count time (minutes)
t_S	=	sample count time (minutes)
E_{tot}	=	total detector efficiency for radionuclide emission of interest (cpm/dpm)
A	=	detector probe area (cm^2)

A typical static MDC calculation for C-14 using the Ludlum Model 43-68 gas flow proportional detector is shown below:

$$MDC_{STATIC} = \frac{3 + 3.29\sqrt{(500)(.1)\left(1 + \frac{0.1}{0.1}\right)}}{(0.1)(0.075)\frac{126}{100}} = 3{,}799 \text{ dpm}/100\,\text{cm}^2$$

7.4.2 Ratemeter Scanning MDC

Scanning MDC at a 95% confidence level was calculated using the following equation, which is a combination of MARSSIM equations 6-8, 6-9, and 6-10:

$$MDC_{scan} = \frac{d'\sqrt{b_i}\left(\frac{60}{i}\right)}{\sqrt{p} \cdot E_{tot} \cdot \frac{A}{100cm^2}}$$

Where:

MDC_{scan}	=	minimum detectable concentration (dpm/100 cm^2)
d'	=	desired performance variable (1.38)
b_i	=	background counts during the residence interval (counts)
i	=	residence interval (seconds)
p	=	surveyor efficiency (0.5)
E_{tot}	=	total detector efficiency for radionuclide emission of interest (cpm/dpm)
A	=	detector probe area (cm^2)

A typical MDC_{scan} calculation for the Ludlum 43-37 gas flow proportional detector is shown below (the actual MDC was calculated using instrument-specific parameter values for each measurement):

$$i = 13.3\,\text{cm} \cdot \frac{\text{inch}}{2.54\,\text{cm}} \cdot \frac{\text{sec}}{20\,\text{inch}} \cdot = 0.262\,\text{sec}$$

$$b_i = 0.262\,\text{sec} \cdot \frac{1500\,\text{counts}}{\text{minute}} \cdot \frac{\text{minute}}{60\,\text{sec}} = 6.55\,\text{counts}$$

$$MDC_{SCAN} = \frac{1.38\sqrt{6.55}\left(\frac{60}{0.262}\right)}{\left(\sqrt{0.5}\right)(0.075)\left(\frac{584}{100}\right)} = 2{,}612\ \text{dpm}/100\text{cm}^2$$

7.4.3 Smear Counting MDC

Smear counting MDC at a 95% confidence level was calculated using the following equation, which is an expansion of NUREG 1507, Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{SMEAR} = \frac{3 + 3.29\sqrt{B_R \cdot t_s \cdot \left(1 + \frac{t_s}{t_b}\right)}}{t_s \cdot E}$$

Where:

MDC_{smear}	=	minimum detectable concentration (dpm/100cm^2)
B_R	=	background count rate (counts per minute)
t_b	=	background count time (minutes)
t_s	=	sample count time (minutes)
E_{tot}	=	instrument efficiency for radionuclide emission of interest (cpm/dpm)

The liquid scintillation counter (LSC) at the Chase office in Lenoir City, TN was setup to count samples in three channels as described in Section 10.7. The MDC calculation for each LSC channel using conservative parameters is shown below. Channel 3 results were used qualitatively.

$$^3\text{H MDC}_{\text{SMEAR}} = \frac{3 + 3.29\sqrt{(15)(1)\left(1 + \frac{1}{1}\right)}}{(1)(0.60)} = 35\ \text{dpm}$$

$$^{14}\text{C MDC}_{\text{SMEAR}} = \frac{3 + 3.29\sqrt{(25)(1)\left(1+\frac{1}{1}\right)}}{(1)(0.80)} = 33 \text{ dpm}$$

Because the counting efficiency is different for each LSC measurement depending on quench characteristics, and in consideration of the errors associated with wipe counting (i.e., area wiped, wiping pressure, etc.), the a priori estimates of smear MDCs calculated above are applied to all removable contamination measurements.

7.5 Uncertainty

The uncertainty for each measurement was calculated using equation 6-15 from MARSSIM:

$$\sigma = 1.96\sqrt{\frac{C_{s+b}}{T_{s+b}^{\ 2}} + \frac{C_b}{T_b^{\ 2}}}$$

Where:

σ	=	Uncertainty
1.96	=	multiplier to achieve a 95% confidence level
C_{s+b}	=	gross sample counts
T_{s+b}	=	sample count time (min.)
C_b	=	gross background counts
T_b	=	background count time (min.)

Uncertainties presented with total surface activity results are additionally corrected for detection efficiency and probe area for presentation in the same units as total surface activity results.

7.6 Instrumentation Specifications

The instrumentation used for facility closeout surveys is summarized in the following tables. The first table lists the standard features of each instrument such as probe size and efficiency. The second table lists the typical operational parameters such as scan rate, count time, and the associated Minimum Detectable Concentrations (MDC). These parameters are typical of the instrumentation, actual instrument-specific parameter values were used for each measurement to verify that DQOs were met.

Table 7-1: Instrumentation Specifications

Detector Model	Detector Type	Detector Area	Detector Width	Meter Model	Window Thickness	Typical Efficiency
Ludlum 43-68	Gas Flow Proportional	126 cm^2	8.8 cm	Ludlum 2221-3	0.8 mg/cm^2	7.5% (C-14)
Ludlum 43-37	Gas Flow Proportional	584 cm^2	13.3 cm	Ludlum 2221-3	0.8 mg/cm^2	7.5% (C-14)
LSC	Liquid Scintillation	N/A	N/A	N/A	N/A	60% (H-3) 80% (C-14)

Table 7-2: Instrumentation Operating Parameters

Measurement Type	Detector Model	Scan Rate	Count Time	Background (cpm)	MDC ($dpm/100cm^2$)
Gross Beta Surface Scans	Ludlum 43-68	5 in/sec	N/A	500	4,297
Gross Beta Surface Scans	Ludlum 43-37	20 in/sec	N/A	1,500	2,612
Gross Beta Total Surface Activity	Ludlum 43-68	N/A	6 sec.	500	3,799
Gross Beta Total Surface Activity	Ludlum 43-37	N/A	6 sec.	1,500	1,370
Removable Activity	LSC	N/A	60 sec.	15 (H-3) 25 (C-14)	35 (H-3) 33 (C-14)

7.7 Efficiency Determination

Field instruments for determination of total surface activity by scanning and static measurements had efficiencies determined by a licensed calibration facility using NIST traceable sources. ISO 7503-1 methods were used to determine field concentrations for final status data and calculation of resultant doses from residual radioactivity. Efficiencies for total surface activity measurements were determined by multiplying the 2-pi C-14 calibration efficiency by a surface efficiency of 0.25.

8 CHARACTERIZATION SURVEYS

Radiological characterization was designed to identify areas of elevated activity that required remediation. Characterization consisted primarily of surface scans and smears for building structural surfaces, and total activity measurements and removable activity measurements on system internal surfaces. Judgmental static measurements and smears were taken on vertical surfaces as part of the Class 3 final status survey protocols described in section 9.6.2. Characterization surveys were designed to meet the same data quality objectives as final surveys. No areas of elevated activity were identified during characterization.

8.1 Building Structural Surfaces

The survey protocol for building surfaces consisted of performing the scanning portion of the final status survey protocol. No areas of elevated activity were identified during scan surveys, verifying that H-3 is the only nuclide of concern.

8.2 Building Systems

The characterization survey protocol for building systems consisted of removable contamination measurements of internal surfaces of the drain, and ventilation systems. 100% of accessible openings in ventilation and drain systems were surveyed. The small geometry of the openings of drain system inlets made direct measurements impossible, so only removable activity measurements were performed.

9 FINAL STATUS SURVEYS

Final status surveys (FSS) demonstrated that no residual radioactivity was present in the survey unit and it satisfied the predetermined criteria for release. The FSS was conducted by performing the appropriate combination of scan surveys, total activity measurements, and removable activity measurements as discussed further in this section. All final status surveys were performed according to written instructions. Survey data was documented on survey maps and/or associated data information sheets. Characterization survey data was used as FSS data to the maximum extent possible.

9.1 Background Determination

Reference background areas or paired background comparisons were not necessary for this survey design. Material and ambient background levels were not significant in comparison to the DCGLs. Ambient background was determined to calculate the actual survey MDCs and associated counting errors.

For total surface activity measurements, ambient background levels were determined by performing a timed count with the probe at waist level and away from survey unit surfaces. Ambient background was subtracted from each total activity gross measurement. Material background, the contribution from naturally-occurring radioactivity in building structural materials, was not accounted for (subtracted) since it was a small fraction of the DCGL.

9.2 Data Quality Objectives (DQO)

The Data Quality Objective process as described in MARSSIM was used throughout the design and implementation of closeout surveys. The following is a list of the DQOs for the survey design:

- Static measurements of structural surfaces were taken to achieve an MDC_{static} of less than the ALARA goal of 5,000 dpm/100 cm^2
- Scanning of structural surfaces was conducted at a rate to achieve an MDC_{scan} of less than the ALARA goal of 5,000 dpm/100 cm^2

- Removable contamination measurements were counted to achieve an MDC_{smear} of less than the ALARA goal of 1,000 dpm/100 cm^2 in each channel.
- Individual measurements were made to a 95% confidence interval.
- Decision error probability rates were set at 0.05 for both α and β.
- The null hypothesis (H_0) and alternative hypothesis (H_A) were that of NUREG 1505 scenario A:
  - H_0 was that the survey unit does not meet the release criteria
  - H_A was that the survey unit meets the release criteria
- Quality assurance surveys (duplicative measurements on building structural surfaces) were conducted at a rate of 5%.
- Characterization surveys were conducted under the same quality assurance criteria as FSSs such that the data may be used as FSS data to the maximum extent possible.

9.3 Area Classifications

Based on the facility operational history and previous survey results, facility areas were classified as impacted areas or non-impacted areas.

9.3.1 Non-Impacted Areas

Non-impacted areas are areas without residual radioactivity from licensed activities and were not surveyed during final status surveys. The following areas were classified as non-impacted:

- Structural surfaces above a two-meter height
- Internal surfaces of positively pressurized systems (air, gas, water, etc.)

Based on historical operations, a potential existed for residual contamination from spills or cross-contamination on surfaces less than a two-meter height. Thorough surveys of impacted room entrances/exits and ventilation exhausts were conducted during characterization to provide adequate assurance that any potential residual radioactivity was contained within impacted areas.

9.3.2 Impacted Areas

Impacted areas are those areas that had potential residual radioactivity from licensed activities. The laboratory suite was initially classified as Class 3. Class 3 areas are areas that meet the following criteria: (1) impacted; (2) little or no potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

9.4 Survey Units

A survey unit is a geographical area of specified size and shape for which a separate decision was made whether or not that area met the release criteria. Survey units were homogeneous in construction, contamination potential, and contamination distribution.

The number of discrete sampling locations needed to determine if a uniform level of residual radioactivity existed within a survey unit did not depend on the survey unit size. However, the sampling density reflected the potential for small elevated areas of residual radioactivity. Survey units were sized according to the potential for small elevated areas of residual radioactivity. Recommended maximum survey unit sizes for building structures, based on floor area, is Class 1: up to 100 m^2, Class 2: 100 m^2 to 1000 m^2 and Class 3: no limit.

The laboratory was designated as a single survey unit and was assigned a unique alpha-numeric identifier consisting of the building number followed by a dash and then a four-character code consisting of the elevation, classification, and a two-digit identifier as follows:

Survey Unit Designations
Building Number – Elevation/Classification/Numerical Identifier
The default numeric identifier is 01

Elevations:
1=1st Floor

Example:
SMH-1301 is St. Mary's Health Center, first floor, class 3

Building structural surfaces survey unit is presented in the table below.

Table 10-1: Building Structural Survey Unit

Survey Unit Number	Class	Floor Area (GSF)
SMH-1301	3	1,364

Building systems survey units were arranged by building and system type. There were three types of systems: ventilation, drain and vacuum. Each system survey unit encompassed all of a certain type within the impacted area i.e., all drains are grouped into survey unit SMH-DR01. The four-digit identifier for systems surveys consisted of the first digit for the system code, and the fourth digit as a numerical identifier.

Survey Unit Designations
System codes are DR=Drain, VE=Ventilation, VA=Vacuum
The default numeric identifier is 01.

The building system survey units are presented in the following table.

Table 10-2: Building Systems Survey Units

Building	Systems Survey Unit		
	Drain	Ventilation	Vacuum
SMH	SMH-DR01	SMH-VE01	SMH-VA01

9.5 Surface Scans

Scanning was used to identify locations that exceed the investigation levels. Scan surveys were conducted by moving the detector probe at a distance of about $^1/_8$ inch from the surface at the prescribed scan rate and listening for an increase in the audible response. While scanning, in addition to the surveyor listening to the audible output, integrated counts were recorded every second by datalogging instrumentation.

Even though tritium cannot be detected by a gas flow proportional detector, beta scans were performed as a quality measure to verify no other long-lived nuclides were used. Additionally, the number of sample locations were doubled for the FSS since tritium cannot be detected during scans.

9.6 Total Surface Activity Measurements

Total surface activity (static) measurements were taken at each identified sample location. Scaler count times were determined to achieve the detection sensitivities stated in the DQOs. Field measurements were converted to an activity concentration using the following equation:

$$\text{Activity}\,(\text{dpm}/100\text{cm}^2) = \frac{cpm_{sample} - cpm_{background}}{E_{total} \cdot \frac{A}{100cm^2}}$$

Where:

cpm_{sample}	=	sample count rate in counts per minute
$cpm_{background}$	=	background count rate in counts per minute
E_{tot}	=	total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and surface efficiency)
A	=	Active area of the detector in cm^2

Static measurements for total surface activity were performed by conducting a timed count on the surface to be measured. Static measurements were used for survey unit statistical analyses and to determine compliance with release criteria. Due to small geometry, drain and vacuum system internals were inaccessible and no direct measurements were performed.

9.6.1 Determination of the Number of Samples Required for the Sign Test

The minimum number of samples required for the Sign Test was calculated using equations in Section 5 of MARSSIM. An estimate of the standard deviation of total surface activity measurements was used for calculations. The Lower Bound Gray Region was set at one half of the DCGL. The calculation performed to determine the required number of samples in accessible areas is provided below.

Determination of the Relative Shift

The number of required samples depended on the ratio involving the activity level measured relative to the variability in the concentration. This ratio is called the Relative Shift, Δ/σ_S and is defined in MARSSIM as:

$$\Delta / \sigma_S = \frac{DCGL - LBGR}{\sigma_S}$$

Where:

DCGL = derived concentration guideline level
LBGR = concentration at the lower bound of the gray region. The LBGR is the average concentration to which the survey unit should be cleaned in order to have an acceptable probability of passing the test
σ_S = an estimate of the standard deviation of the residual radioactivity in the survey unit

The calculation is provided below using the structural surface survey unit standard deviation, because H-3 cannot be detected by direct methods, the removable surface activity DCGL is used:

$$\frac{\Delta}{\sigma_s} = \frac{1.2\,E7 - 6.0E6}{10} = 6.0E5$$

Since MARRSIM Table 5.5 does not include relative shifts above 3 and the number of samples required decreases with an increasing relative shift, the relative shift was conservatively set at 3.

Determination of Acceptable Decision Errors

A decision error is the probability of making an error in the decision on a survey unit by passing a unit that should fail (α decision error) or failing a unit that should pass (β decision error). Decision error rates were selected in accordance with the established DQOs at 0.05 for both α and β errors.

Determination of Number of Samples

For the purposes of the final status survey it was assumed that the contaminant was not present in background at significant levels compared to the DCGLs. Using this methodology, the Sign Test was chosen for the statistical evaluation of survey data.

The number of total surface activity measurements for a particular survey unit, employing the Sign Test, was determined from MARSSIM Table 5.5, which is based on the following equation (MARSSIM equation 5-2):

$$N = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{4\left(SignP - 0.5\right)^2}$$

Where:

N	= number of samples needed in the survey unit
$Z_{1-\alpha}$	= percentile represented by the decision error α
$Z_{1-\beta}$	= percentile represented by the decision error β
SignP	= estimated probability that a random measurement will be less than the DCGL when the survey unit median is actually at the LBGR

Note: SignP is determined from MARSSIM Table 5.4

MARSSIM recommends increasing the calculated number of measurements by 20% to ensure sufficient power of the statistical tests and to allow for possible data losses. MARSSIM Table 5.5 values include this additional 20%. The following calculations were made to determine this number:

$$N = \frac{\left(1.645 + 1.645\right)^2}{4\left(0.998650 - 0.5\right)^2} = 11$$

$Z_{1-\alpha}$ and $Z_{1-\beta}$ are equal to 1.645 using the error rate of 0.05 from MARSSIM Table 5.2. SignP is equal to 0.998650 from MARSSIM Table 5.4. Adding an additional 20% to account for data losses resulted in a value of 14.

Therefore, the determined number of samples per survey unit for the final status surveys was **14**. With H-3 as the nuclide of concern, and with no viable scanning option, the number of sample locations was doubled to 28 for this survey.

9.6.2 Determination of Sample Locations

Class 3 survey units generally consist of multiple rooms. The process to identify, map and locate measurement coordinates in survey units with many rooms is complicated due to the noncontiguous nature of the survey unit once walls are "folded-out". Therefore, the MARSSIM sample measurement locations (i.e., random static and wipe measurements) were determined only on horizontal surfaces with the highest probability for residual contamination (floors, benchtops, fume hood working surfaces, etc.). The appropriate percentage of all survey unit surfaces (including vertical surfaces) was scanned according to the survey unit classification. In laboratory areas, permanent counter tops and other horizontal surfaces that block floor surfaces were included as a replacement to the blocked floor surface. Internal surfaces of permanent furnishings (i.e., drawer or cabinetry interior surfaces) were not included in the systematic measurement location placement. However, these surfaces were included in the scan surveys. Additional

total surface activity measurements were collected at each area of elevated activity identified during the scan surveys.

As part of characterization, the survey technician judgmentally selected locations with the highest probability of contamination on vertical surfaces for a static measurement and smear, such as light switches, door knobs, door pulls, push plates, and other locations. These measurements were in addition to and were not included in the statistical analysis of the locations selected by MARSSIM protocols.

Sampling locations were established in a unique pattern beginning with the random start location and the determined sample spacing. After determining the number of samples needed in the survey unit, sample spacing is determined from MARSSIM equation 5-8:

$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Where:

L = sample spacing interval
A = the survey unit area
N = number of samples needed in the survey unit

Maps were generated of the survey unit's permanent horizontal surfaces included in the statistical tests. A random starting point was determined using computer-generated random numbers coinciding with the x and y coordinates of the total survey unit. A grid was plotted across the survey unit surfaces based on the random start point and the determined sample spacing. A measurement location was plotted at each intersection of the grid plot. Survey location maps are presented in Appendix D.

9.7 Removable Activity Measurements

Removable surface activity measurements were collected by wiping an area of approximately 100 cm^2 using paper smears or cotton swabs. The smears/swabs were counted to achieve the detection sensitivities stated in the DQOs. The liquid scintillation counter (LSC) was setup for triple channel counting as follows:

Channel 1 (H-3): 0– 18.6 keV
Channel 2 (C-14): 18.6 – 156 keV
Channel 3 (open): 0 – 2,000 keV

Removable surface activity measurements (smears) were collected on building structural surfaces at each sample location. Additionally, removable activity measurements were collected for building system internals. An area of approximately 100 cm^2 was wiped. LSC results are reported in net dpm/100 cm^2.

9.8 Surveys of Building Mechanical System Internals

Surveys of various building system components were required. Survey design for these systems is out of the scope of MARSSIM. For the purposes of identifying potential residual contamination within these systems (ventilation, vacuum, and drain), removable contamination surveys were taken at system inlets. Direct measurements were not possible inside drain and vacuum system openings due to geometry. System survey requirements are summarized in the table below.

Table 10-3: System Survey Coverage

Structure	Coverage
Exhaust duct inlets	100%
Drain Openings/Traps	100%
Vacuum Nozzles	100%

9.9 Investigation Levels

Investigation levels were used to flag locations that required special attention and further investigation to ensure areas were properly classified and adequate surveys were performed. Investigation levels were established at the ALARA Goals and are summarized in the table below.

Table 10-4: Survey Investigation Levels

Survey Unit Classification	Flag Static Measurement Result When: (dpm/100cm^2)	Flag Scanning Measurement Result When: (dpm/100cm^2)	Flag Removable Measurement Result When: (dpm/100cm^2 in any channel)
3	>5,000	>MDC	>1,000

10 SURVEY DOCUMENTATION AND DATA MANAGEMENT

10.1 Survey Packages

The survey unit was surveyed under a survey package approved by the Project Manager and specifying the survey protocol to be followed. The survey package contained the following elements to ensure the DQOs were met:

- Survey protocol instructions such as the number of samples, sample spacing, sample locations, areas to be scanned, etc.
- Random number generations to determine survey locations
- Instrumentation to be used
- Scan rates, static count times, and/or minimum sample volumes
- Scaled survey unit maps
- Checklists for the survey technician

10.2 Location Codes

To ensure proper data management and organization, each static and removable activity measurement location was assigned a unique alpha-numeric location code consisting of a sequence of identifiers to indicate specific information about that location, such as the building, survey unit, structural surface, structural material, and a numerically sequenced location number within the survey unit. This system was used so that survey data could be properly entered and organized in the Survey Database. A breakdown of the location code and specific code components are provided in the table below.

Table 11-1: Location Code Description

A unique location code was assigned to each individual survey location to ensure proper data management of the survey results. The following format was used to ensure consistency throughout the final status survey process: **BBB-RRRR-SS-M-LLL** Where:		
BBB:	=	Building Code. This field represents the building number. (3 characters) SMH: St. Mary's Health Center
RRRR:	=	Survey Unit Number. This is the assigned survey unit number. (4 characters)
SS:	=	Structural Surface Code. This field represents the structural surface such as floor, wall, ceiling, etc. (2 characters) B1 = Benchtop F1 = Floor D2 = Floor Drain D3 = Sink Drain D4 = Other Drain E1 = Fume Hood Duct E2 = General Ventilation V1 = Vacuum Nozzle
M:	=	Structural Material Code. This field represents the type of structural material on which a particular measurement is taken. (1 character) M = Miscellaneous (wood, plastic, metal) V = Vinyl Floor Covering T = Terracotta Tile
LLL:	=	Numerical Identifier. This field represents the survey location number. The field "001" means survey point location number 1. Numerical identifiers are unique within a survey unit. (3-characters)

11 DATA QUALITY ASSESSMENT (DQA)

The statistical guidance contained in Section 8 of MARSSIM was used to determine if areas were acceptable for unrestricted release, and whether additional surveys or sample measurements were needed.

11.1 Data Validation

Field data was reviewed and validated to ensure:

- Completeness of forms.
- The type of survey was correctly assigned to the survey unit.
- The MDCs for measurements met the established data quality objectives.
- Independent calculations were performed for a representative sample of data sheets and survey areas.
- Instrument calibrations and daily functional checks were performed accurately and at the required frequency.

Additionally, all final status survey data was entered into the Survey Database. This provided the means to sort survey data, verify activity calculations, and to compute the associated MDC and counting errors. Once data entry for a survey unit was complete, a verification report was printed and compared to original data sheets to ensure correct data entry.

The final status database reports for building structural surfaces and systems are provided in Appendix F and Appendix G, respectively.

11.2 Preliminary Data Review

A preliminary data review was performed for each survey unit to identify any patterns, relationships or potential anomalies. Additionally, measurement data was reviewed and compared with the DCGLs and investigation levels to identify areas of elevated activity and confirm the correct classification of survey units.

The following preliminary data reviews were performed for each survey unit:

- Calculations of the survey unit mean median, maximum, minimum, and standard deviation for each type of reading.
- Comparison of the actual standard deviation to the assumed standard deviation used for calculating the number of measurements to ensure a sufficient number of samples was obtained.
- Comparison of survey data with applicable investigation levels.
- Review of graphical outputs

The data management software produced 4-plot graphical output of scan data to enhance data visualization.

11.3 Review of 4 Plots

A 4-Plot of scan data was produced for each survey instrument used within the survey unit. 4-Plot graphs indicate a bimodal distribution because measurements are not corrected for naturally-occurring radioactivity in building materials. A portion of the floor consisted of terracotta tiles that contain elevated levels of natural radioactivity. The tiles have a mean of approximately 2,500 dpm/100 cm^2 while other structural surfaces have a mean of approximately zero. As a result, a bimodal distribution is evident in the 4-plot. All dataloged scan results were less than the investigation level

The survey unit 4-Plot graph is presented in Appendix E.

11.4 Data Summary Tables

Static measurement and smear data are presented below. The total activity results had a slight positive bias due to the naturally occurring radioactivity in building structural materials.

Table 12-1: Structural Surfaces Total Beta Surface Activity (Static Measurements)

Survey Unit	# of Sample Locations	Mean	MDC	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 5,000?
		(dpm/100 cm^2)					
SMH-1301	28	1,085	2,375	1,107	-313	3,237	NO

Table 12-2: Building Structural Surfaces Removable H-3 Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 1,000?
		(dpm/100 cm^2)				
SMH-1301	28	11	10	0	30	NO

Table 12-3: Building Structural Surfaces Removable C-14 Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 1,000?
		(dpm/100 cm^2)				
SMH-1301	28	4	4	0	12	NO

Table 12-4: Building Structural Surfaces Removable Channel 3 Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 1,000?
		(cpm/100 cm²)				
SMH-1301	28	11	8	0	26	NO

Table 12-5: Building Systems Total Beta Surface Activity (Static Measurements)

Survey Unit	# of Sample Locations	Mean	MDC	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 5,000?
		(dpm/100 cm²)					
SMH-VE01	10	-533	2,643	272	-940	0	NO

Table 12-6: Building Systems Removable H-3 Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 1,000?
		(dpm/100 cm²)				
SMH-DR01	9	6	7	0	19	NO
SMH-VA01	4	8	10	0	20	NO
SMH-VE01	10	8	12	0	39	NO

Table 12-7: Building Systems Removable C-14 Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 1,000?
		(dpm/100 cm²)				
SMH-DR01	9	3	2	0	7	NO
SMH-VA01	4	3	2	0	5	NO
SMH-VE01	10	6	5	0	13	NO

Table 12-8: Building Systems Removable Channel 3 Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 1,000?
		(cpm/100 cm²)				
SMH-DR01	9	8	5	0	13	NO
SMH-VA01	4	10	5	5	16	NO
SMH-VE01	10	11	8	0	24	NO

11.5 Determining Compliance for Building Structural Surfaces and Structures

Removable contamination measurements were compared directly to the applicable investigation levels and DCGLs. No contingency was established for elevated removable contamination. All removable contamination measurements collected during the final status surveys were less than the applicable investigation level and significantly less than the removable DCGL.

All total surface activity measurements were compared directly to the investigation level to determine if an area required further surveillance. All total surface activity measurements collected were less than the investigation levels and significantly less than the DCGL, verifying that no long-lived beta emitters were present and that H-3 is the only nuclide of concern for decommissioning.

Because H-3 cannot be detected by direct measurements, compliance is determined based on removable activity measurements assuming a removable fraction of 10%. The Sign Test is not performed in this survey design because the removable activity DCGL is used as a maximum. If all measurements are less than the DCGL, performance of the Sign test is not necessary because the survey units will pass the Sign Test. Therefore, the null hypothesis can be rejected and the survey units meet the release criteria and are suitable for release for unrestricted use.

The results of the data quality assessment and calculations of the dose from each structural surface survey unit are presented in the table below.

Table 12-9: Structural Surfaces Total Beta Surface Activity Dose Calculations

Survey Unit	Standard Deviation (dpm/100 cm^2)	# Samples Required	Actual # of Samples	Adequate # of Samples?	Mean (dpm/100 cm^2)	Calculated Annual TEDE [1] (mrem/yr)
SMH-1301	10	11	28	YES	11	2.3E-5

11.6 Mechanical System Survey Data Analysis

Results of ventilation, vacuum, and drain system removable activity measurements were compared directly with the investigation level and removable DCGL. Direct measurements were not possible due to the small geometry of drain and vacuum system internals. All removable activity measurements were less than the investigation level and removable DCGL, therefore the systems meet the release criterion and are suitable for release.

[1] The TEDE shown is calculated by multiplying 25 mrem/yr by the ratio of the mean removable surface activity to the H-3 removable surface activity DCGL of 1.2E7 dpm/100 cm^2.

12 QUALITY ASSURANCE SURVEYS

Quality Assurance (QA) measurements were performed according to the quality assurance requirements of the plan and consisted of duplicating the final status survey protocol for building structural surfaces at a rate of 5% to include scans, static measurements, and smears. The Project Manager implemented QA surveys by re-performing judgmentally selected survey locations as survey unit QA01. The locations of QA survey total and removable surface activity measurements are presented in the table below.

Table 13-1: QA Survey Locations

QA Survey Location	FSS Location
SMH-QA01-B1-M-001	SMH-1301-B1-M-014
SMH-QA01-F1-V-002	SMH-1301-F1-V-022

The conclusions reached based on QA surveys were the same as those based on the initial surveys. QA survey results are presented in Appendix H and are summarized in the tables below.

Table 13-2: QA Structural Surfaces Total Activity Summary

Survey Unit	# of Sample Locations	Mean	MDC	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 5,000?
		(dpm/100 cm^2)					
SMH-QA01	2	-107	2,652	151	-214	0	NO

Table 13-3: QA Structural Surfaces Removable H-3 Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 1,000?
		(dpm/100 cm^2)				
SMH-QA01	2	16	11	8	24	NO

Table 13-4: QA Structural Surfaces Removable C-14 Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 1,000?
		(dpm/100 cm^2)				
SMH-QA01	2	8	6	3	12	NO

Table 13-5: QA Structural Surfaces Removable Open Channel Summary

Survey Unit	# of Sample Locations	Mean	Standard Deviation	Min.	Max.	Any Result Exceeding Investigation Level of 1,000?
		(cpm/100 cm^2)				
SMH-QA01	2	18	8	12	24	NO

13 CONCLUSION

Radiological surveys demonstrate that building structural surfaces and systems included in the scope of this report are below release criteria and are suitable for unrestricted release. A sufficient number of samples was taken in the survey unit and all total and removable surface activity results were less than the investigation levels and significantly less than the applicable DCGL, so no further statistical tests are required.

Conclusion: *The null hypothesis is rejected; all survey units pass the statistical tests and are suitable for release for unrestricted use.*

All final status surface radioactivity measurements were a small fraction of the DCGLs. Based on the Building Occupancy Scenario of NRC DandD dose modeling software Version 2.1, the Total Effective Dose Equivalent (TEDE) to an average member of the critical group is 2.3E-5 mrem/year (<1E-5% of the release criterion of 25 mrem/yr).

14 REFERENCES

1. NRC Regulations
2. NRC Radioactive Materials License #24-00196-07
3. NUREG-1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," August 2000
4. NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," June 1998
5. NUREG 1757, Volume 1, Revision 2, "Consolidated NMSS Decommissioning Guidance, Decommissioning Process for Materials Licensees," September, 2006
6. ISO-7503-1, "Evaluation of Surface Contamination – Part 1: Beta Emitters and Alpha Emitters." 1988

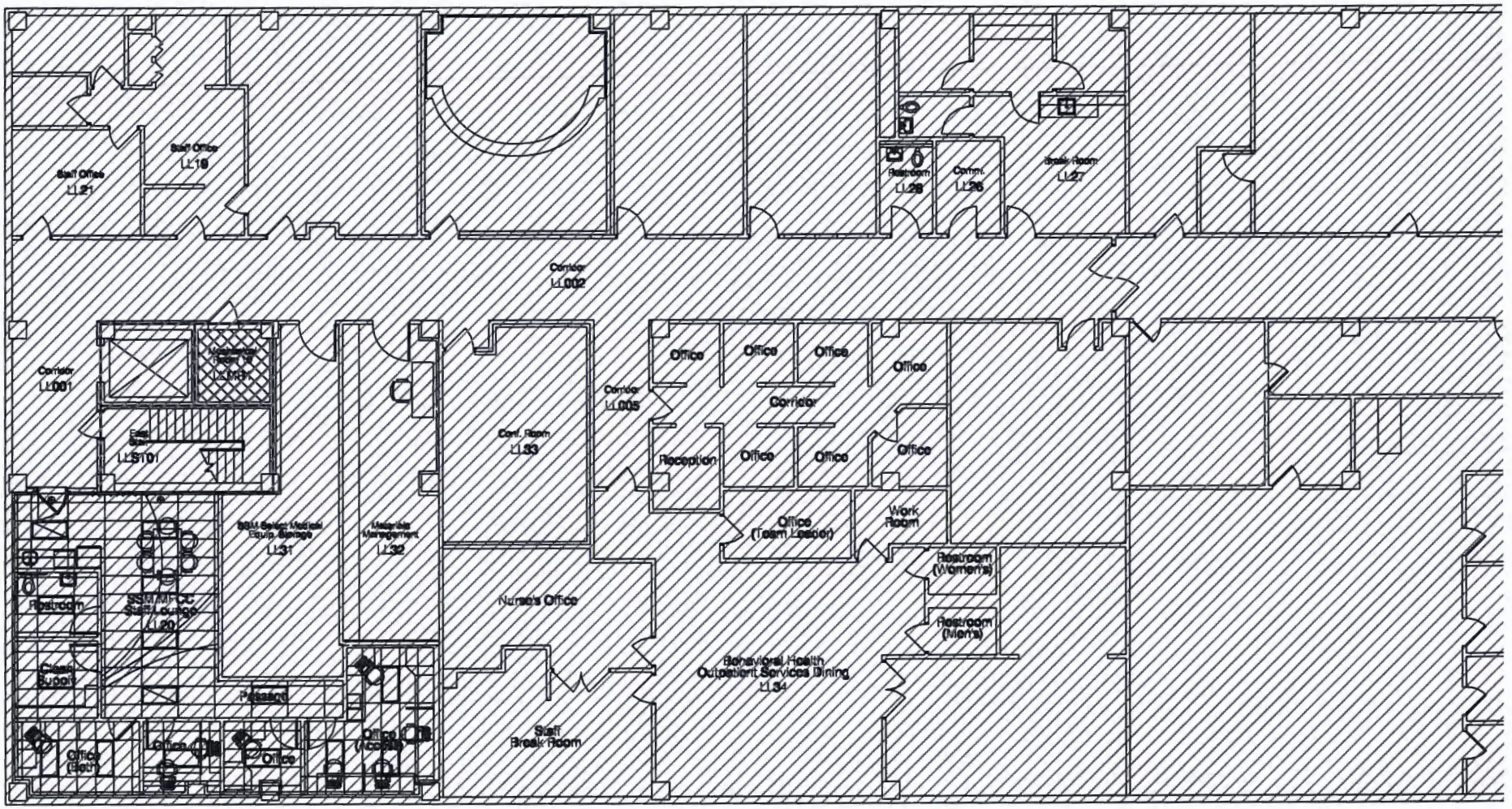
Appendix A

Site Satellite Photo


St. Mary's Health Center
1027 Building
Seminary Terrace
Founders Ln
Founders Way
Seminary Pl
Oak Knoll Park
Ridgemoor Dr
Broadview Dr
Seminary Rd
Concordia Ln
St Rita Ave
Moorlands Dr
Claytonia Terrace
Commodore Dr
Painters Alley
Hoover Ave
Mabel Ave

Appendix B

Building Floor Plan


Staff Office
LL21
Staff Office
LL19
Corridor
LL002
Restroom
LL28
Comm.
LL26
Break Room
LL27
Corridor
LL001
Maintenance Room
LL003
East Stair
LLS101
Conf. Room
LL33
Corridor
LL005
Office
Office
Office
Office
Corridor
Reception
Office
Office
Office
Work Room
Office (Team Leader)
Restroom (Women's)
Restroom (Men's)
SSM Senior Medical Equip. Storage
LL31
Medical Gas Management
LL32
Restroom
SSM MFCU Staff Lounge
LL20
Nurse's Office
Behavioral Health Outpatient Services Dining
LL34
Clean Supply
Passage
Staff Break Room
Office (Staff)
Office
Office
Office (Visitor)

SMH-1301

Appendix C

Instrument Calibration Records

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

SEC Corporate
2800 Solway Road
Knoxville, TN 37931

Model 2241-3 CALIBRATION FORM

Serial number : 267161 **Customer Name :** Chase

Previous due date : 1/13/2018 **P.O Number :**

Date : 12/29/2017 **Technician :** Noah Keebler

Reason For Calibration : DUE FOR CALIBRATION

INSTRUMENT(S) USED DURING CALIBRATION					
Model Number:	500-2	**Serial Number:**	268940	**Calibration Due date:**	4/20/2018
Model Number:		**Serial Number:**		**Calibration Due date:**	

Instrument Condition	
As Found	As Left
OK	OK

Threshold	
As Found	As Left
3.2	4.0

Battery Indicator
SAT

SCA/RATE Switch
SAT

	Set Voltage		High Voltage Range	
Detector #	As Found	As Left	As Found	As Left
1	1697	1700	SAT	SAT
2	1828	1825	SAT	SAT
3	1179	1175	SAT	SAT
4	1372	1375	SAT	SAT

Digital Scaler				
Target	As Found	%Error	As Left	%Error
250	250	0.04%	250	0.04%
2,500	2,502	0.08%	2,502	0.08%
25,000	25,010	0.04%	25,010	0.04%
250,000	250,100	0.04%	250,100	0.04%

Reproducability		
x.1 or x1 Scale		
250	250	250
x1 or x10 Scale		
2500	2500	2500
x10 or x100 Scale		
25K	25K	25K
x100 or x1000 Scale		
250K	250K	250K

OK	Is the As Found Data within 20% of the set point?	OK	Audio Response
OK	Are the Individual counts within 10% of the average?	OK	Push Buttons
OK	Fast / Slow response switch functions properly?	OK	RESET
OK	Does Instrument meet final Acceptance Criteria?	OK	Audio Switch
OK	Calibration sticker attached?	OK	Light

Married with:	**1700V**	**DET 1**	**Model:**	43-68	**Serial Number:**	PR289347
	1825V	**DET 2**	**Model:**	43-37	**Serial Number:**	PR148503
	1175V	**DET 3**	**Model:**	43-68	**Serial Number:**	PR289347
Comments :	**1375V**	**DET 4**	**Model:**	43-37	**Serial Number:**	PR148503

Instrument calibrated per SEC-IS-423.

5 foot cable used for the 43-68

10 foot cable used for the 43-37

Date instrument is due for next calibration : 12/29/2018

Performed by: _____ Date: _____ Reviewed by: _____ Date: 1/3/18

Printed name : Noah Keebler

Safety and Ecology Corporation

SEC PROCEDURE # SEC-IS-417 Rev 4

2800 Solway Road, Knoxville, TN 37931

1/2/2018

Calibration Certificate

Calibration Certificate for 43-68,Serial # PR289347, Bar Code # Purple,Property # Chase99

Date: 12/29/17 Date Last Cal. Expires: 01/13/18 Technician: Noah Keebler

Location: 999999, Reason For Calibration: Due for Calibration

EQUIPMENT USED DURING CALIBRATION MODEL: 2241-3 SERIAL #: 267161 CAL DUE 12/29/18

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4078-02	Pu-239	16998 dpm	8,639 cpm	1/3/2017
	4064-02	Th-230	27399 dpm	13,899 cpm	1/3/2017
	4073-02	Tc-99	30500 dpm	19,100 cpm	1/3/2017
	4065-02	Sr-90	15059 dpm	10,547 cpm	1/3/2017

Efficiencies from last calibration

Pu-239: 18.67 %
Tc-99: 21.48 %
Th-230: 16.46 %
SrY-90: 33.23 %

AS FOUND DATA

AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1175 V HV (Beta): 1700 V Threshold: mV

	Alpha		Beta		AF 4 πEfficiencies
Back ground:	2	CPM	240	CPM	
Pu-239:	3358	CPM	N/A		19.74%
Tc-99:	N/A		8036	CPM	25.56%
Th-230:	4690	CPM	N/A		17.11%
SrY-90:	N/A		5629	CPM	35.79%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1175 V HV (Beta): 1700 V Threshold: 4 mV

	Alpha		Beta		AL 4 π Efficiencies
Back ground:	2	CPM	240	CPM	
Pu-239:	3358	CPM	N/A		19.74%
Tc-99:	N/A		8036	CPM	25.56%
Th-230:	4690	CPM	N/A		17.11%
SrY-90:	N/A		5629	CPM	35.79%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Tc-99 8036 7924 8189 Average: 8049.7 ☑ Are the individual counts within 10% of the average?

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 PI Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	38.85%	40.82%	33.73%	51.10%

Comments: Married as a set with: Model: 2241-3 Serial #: 267161 Bar Code #: Purple

Calibrated with plastic standoffs attached while using a 5' cable. AF-punctured mylar. AL-replaced mylar and calibrated.

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 12/29/18

Performed by: _____ Reviewed by: _____ Date: 1/3/18

Printed Name: Noah Keebler

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-68 **Customer Name :** Chase Environmental

Probe Serial Number : PR289347 **Technician :** Noah Keebler

Date of Calibration : 12/29/2017

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	267161	Calibration Due Date:	12/29/2018
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat

High Voltage: 1700

Background: 240

C-14 Count: 7944

2π Efficiency: 29.72%

4π Efficiency: 11.36%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 267161

Calibrated with plastic standoffs attached while using 5' cable.

Date instrument is due for next calibration : 12/29/2018

Performed by : _____ Reviewed by : _____ Date : 1/3/18

Printed Name : Noah Keebler

Entered in computer inventory by: _____ Date : _____

Calibration Certificate for 43-37,Serial # PR148503, Bar Code # Purple,Property # Chase100

Date: 12/29/17 Date Last Cal. Expires: 01/13/18 Technician: Noah Keebler
Location: 999999, Reason For Calibration: Due for Calibration

EQUIPMENT USED DURING CALIBRATION MODEL: 2241-3 SERIAL #: 267161 CAL DUE 12/29/18

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4078-02	Pu-239	16998 dpm	8,639 cpm	1/3/2017
	4064-02	Th-230	27399 dpm	13,899 cpm	1/3/2017
	4073-02	Tc-99	30500 dpm	19,100 cpm	1/3/2017
	4065-02	Sr-90	15059 dpm	10,547 cpm	1/3/2017

Efficiencies from last calibration
Pu-239: 20.24 %
Tc-99: 24.09 %
Th-230: 17.78 %
SrY-90: 35.98 %

AS FOUND DATA

AS FOUND Instrument Condition: SAT
Calibration Setpoints
HV (Alpha): 1375 V HV (Beta): 1825 V Threshold: 4 mV

	Alpha		Beta		AF 4 πEfficiencies
Background:	27	CPM	1013	CPM	
Pu-239:	3721	CPM	N/A		21.73%
Tc-99:	N/A		8933	CPM	25.97%
Th-230:	5422	CPM	N/A		19.69%
SrY-90:	N/A		6583	CPM	36.99%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT DATA after repair, HV adjust or Plateau

AS LEFT Instrument Condition: SAT
HV (Alpha): 1375 V HV (Beta): 1825 V Threshold: 4 mV

	Alpha		Beta		AL 4 π Efficiencies
Background:	6	CPM	1013	CPM	
Pu-239:	3721	CPM	N/A		21.86%
Tc-99:	N/A		8933	CPM	25.97%
Th-230:	5422	CPM	N/A		19.77%
SrY-90:	N/A		6583	CPM	36.99%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Tc-99 8933 9029 8975 Average: 8979.0 ☑ Are the individual counts within 10% of the average?

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Pu-239

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	43.00%	41.47%	38.97%	52.81%

Comments: Married as a set with: Model: 2241-3 Serial #: 267161 Bar Code #: Purple

Calibrated with plasic standoffs attached while using a 10' cable. AF-mylar torn/punctured, high alpha background due to dirty screen AL-mylar replaced, cleaned screen.

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 12/29/18

Performed by: _____ Reviewed by: _____ Date: 1/2/18
Printed Name: Noah Keebler

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-37 **Customer Name :** Chase Environmental

Probe Serial Number : PR148503 **Technician :** Noah Keebler

Date of Calibration : 12/29/2017

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	267161	Calibration Due Date:	12/29/2018
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

		Activity(s)				
	Source S/N	Emission Rate	2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat

High Voltage: 1825

Background: 1013

C-14 Count: 8778

2π Efficiency: 29.96%

4π Efficiency: 11.45%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 267161

Calibrated with plastic standoffs attached while using a 10' cable.

Date instrument is due for next calibration : 12/29/2018

Performed by : Reviewed by : Date : 1/3/18

Printed Name : Noah Keebler

Entered in computer inventory by: Date :

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

SEC Corporate
2800 Solway Road
Knoxville, TN 37931

Model 2241-3 CALIBRATION FORM

Serial number : 267138 **Customer Name :** Chase
Previous due date : 4/27/2018 **P.O Number :**
Date : 4/26/2018 **Technician :** Noah Keebler
Reason For Calibration : Due for Calibration

INSTRUMENT(S) USED DURING CALIBRATION					
Model Number:	500-2	**Serial Number:**	153622	**Calibration Due date:**	4/20/2018
Model Number:		**Serial Number:**		**Calibration Due date:**	

Instrument Condition	
As Found	As Left
OK	OK

Threshold	
As Found	As Left
4.1	4.0

Battery Indicator
SAT

SCA/RATE Switch
SAT

	Set Voltage		High Voltage Range	
Detector #	As Found	As Left	As Found	As Left
1	1672	1675	SAT	SAT
2	1801	1800	SAT	SAT
3	1253	1250	SAT	SAT
4	1278	1275	SAT	SAT

Digital Scaler				
Target	As Found	%Error	As Left	%Error
250	250	0.00%	250	0.00%
2,500	2,500	0.00%	2,500	0.00%
25,000	25,010	0.04%	25,010	0.04%
250,000	250,100	0.04%	250,100	0.04%

Reproducability		
x.1 or x1 Scale		
250	250	250
x1 or x10 Scale		
2500	2500	2500
x10 or x100 Scale		
25K	25K	25K
x100 or x1000 Scale		
250K	250K	250K

OK	Is the As Found Data within 20% of the set point?	OK	Audio Response
OK	Are the individual counts within 10% of the average?	OK	Push Buttons
OK	Fast / Slow response switch functions properly?	OK	RESET
OK	Does Instrument meet final Acceptance Criteria?	OK	Audio Switch
OK	Calibration sticker attached?	OK	Light

Married with:						
	1675V	**DET 1**	**Model:**	43-68	**Serial Number:**	PR285699
	1800V	**DET 2**	**Model:**	43-37	**Serial Number:**	PR286832
	1250V	**DET 3**	**Model:**	43-68	**Serial Number:**	PR285699
Comments :	**1275V**	**DET 4**	**Model:**	43-37	**Serial Number:**	PR286832

Instrument calibrated per SEC-IS-423.

Date instrument is due for next calibration : 4/26/2019

Performed by : Date: Reviewed by: Date: 4.26.18

Printed name : Noah Keebler

Calibration Certificate

Calibration Certificate for 43-68,Serial # PR285699, Bar Code # ,Property # Chase79

Date: 04/26/18 Date Last Cal. Expires: 04/27/18 Technician: Noah Keebler

Location: 999999, Reason For Calibration: Due for Calibration

EQUIPMENT USED DURING CALIBRATION MODEL: 2241-3 SERIAL #: 267138 CAL DUE 04/26/19

Efficiencies from last calibration

Pu-239: 19.30 %
Tc-99: 23.50 %
Th-230: 16.85 %
SrY-90: 33.87 %

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4071-02	Th-230	40297 dpm	20,499 cpm	3/5/2018
	4079-02	Pu-239	28994 dpm	14,697 cpm	3/5/2018
	4072-02	Tc-99	28299 dpm	17,700 cpm	3/5/2018
	4076-02	Sr-90	10225 dpm	7,174 cpm	3/5/2018

AS FOUND DATA

AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1250 V HV (Beta): 1675 V Threshold: 4 mV

	Alpha		Beta		AF 4 πEfficiencies
Background:	0	CPM	216	CPM	
Pu-239:	6786	CPM	N/A		23.40%
Tc-99:	N/A		8055	CPM	27.70%
Th-230:	9129	CPM	N/A		22.65%
SrY-90:	N/A		4234	CPM	39.30%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1250 V HV (Beta): 1675 V Threshold: 4 mV

	Alpha		Beta		AL 4 π Efficiencies
Background:	0	CPM	216	CPM	
Pu-239:	6786	CPM	N/A		23.40%
Tc-99:	N/A		8055	CPM	27.70%
Th-230:	9129	CPM	N/A		22.65%
SrY-90:	N/A		4234	CPM	39.30%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Tc-99 8055 8109 8063 Average: 8075.7 ☑ Are the individual counts within 10% of the average?

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	46.17%	44.29%	44.53%	56.01%

Comments: Married as a set with: Model: 2241-3 Serial #: 267138 Bar Code #:

Calibrated using 5' cable.

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 04/26/19

Performed by: _____ Reviewed by: _____ Date: 4/26/18

Printed Name: Noah Keebler

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-68 **Customer Name :** Chase

Probe Serial Number : PR285699 **Technician :** Carl Hall

Date of Calibration : 5/3/2018

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	267138	Calibration Due Date:	4/26/2019
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat

High Voltage: 1675

Background: 216

C-14 Count: 8095

2π Efficiency: 30.40%

4π Efficiency: 11.62%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 267138

Calibrated with plastic standoffs attached while using a 5' cable.
Set calibration due date to match other calibration certificates.

Date instrument is due for next calibration : 4/26/2019

Performed by : Carl Hall Reviewed by : Date : 5-3-18

Printed Name : Carl Hall

Entered in computer inventory by: Date :

Calibration Certificate for 43-37,Serial # PR286832, Bar Code # ,Property # Chase101

Date: 04/26/18 Date Last Cal. Expires: 04/27/18 Technician: Noah Keebler
Location: 999999, Reason For Calibration: Due for Calibration

EQUIPMENT USED DURING CALIBRATION MODEL: 2241-3 SERIAL #: 267138 CAL DUE 04/26/19

NIST TRACEABLE SOURCES USED	SOURCE	ISOTOPE	ACTIVITY	2π	ASSAY DATE
	4071-02	Th-230	40297 dpm	20,499 cpm	3/5/2018
	4079-02	Pu-239	28994 dpm	14,697 cpm	3/5/2018
	4072-02	Tc-99	28299 dpm	17,700 cpm	3/5/2018
	4076-02	Sr-90	10225 dpm	7,174 cpm	3/5/2018

Efficiencies from last calibration

Pu-239:	17.60 %
Tc-99:	22.93 %
Th-230:	15.20 %
SrY-90:	31.01 %

AS FOUND DATA

AS FOUND Instrument Condition: SAT

Calibration Setpoints

HV (Alpha): 1275 V HV (Beta): 1800 V Threshold: 4 mV

	Alpha		Beta		AF 4 πEfficiencies
Back ground:	7	CPM	715	CPM	
Pu-239:	5561	CPM	N/A		19.16%
Tc-99:	N/A		7518	CPM	24.04%
Th-230:	6714	CPM	N/A		16.64%
SrY-90:	N/A		4125	CPM	33.35%

☑ Is the As Found Data within 20% of the efficiency from the last cal.?

AS LEFT Instrument Condition: SAT

AS LEFT DATA after repair, HV adjust or Plateau

HV (Alpha): 1275 V HV (Beta): 1800 V Threshold: 4 mV

	Alpha		Beta		AL 4 π Efficiencies
Back ground:	7	CPM	715	CPM	
Pu-239:	5561	CPM	N/A		19.16%
Tc-99:	N/A		7518	CPM	24.04%
Th-230:	6714	CPM	N/A		16.64%
SrY-90:	N/A		4125	CPM	33.35%

"AF" in the AL Efficiency fields means to refer to the AF Efficiencies in the AS FOUND DATA Section

Reproducibility : Isotope: Tc-99 7518 7562 7627 Average: 7569.0 ☑ Are the individual counts within 10% of the average?

If the As Found data (even after repair) is within 10% of the last calibration, then the technician may N/A Plateau Data and go directly to Comments. Geometry of source = flush to surface, except gas proportional probes = 1/8" from surface unless otherwise specified.

PLATEAU DATA

Alpha Source: Th-230

HV (Alpha)	Response CPM A ch.	Background CPM A ch.	Net 4π Eff.
N/A			

Beta Source: Tc-99

HV (Beta)	Response CPM B ch.	Background CPM B ch.	Net 4π Eff.
N/A			

2 Pi Efficiencies:	Pu-239	Tc-99	Th-230	SrY-90
	37.79%	38.44%	32.72%	47.53%

Comments: Married as a set with: Model: 2241-3 Serial #: 267138 Bar Code #:

Calibrated using 10' cable.

☑ Does Instrument Meet Final Acceptance Criteria? ☑ Calibration Sticker Attached?

Date Instrument is Due For Next Calibration: 04/26/19

Performed by: _____ Reviewed by: _____ Date: 4.26.18

Printed Name: Noah Keebler

SEC INSTRUMENTATION SERVICES

10512 Lexington Drive
Suite 200
Knoxville, TN 37932

C-14 SOURCE CALIBRATION FORM

Probe Model Number : 43-37 **Customer Name :** Chase

Probe Serial Number : PR286832 **Technician :** Carl Hall

Date of Calibration : 5/3/2018

Instruments used during calibration					
Model Number:	2241-3	Serial Number:	267138	Calibration Due Date:	4/26/2019
Model Number:		Serial Number:		Calibration Due Date:	

NIST Traceable Source(s) used :

	Source S/N	Emission Rate	Activity(s) 2 Pi (cpm)	uCi	4Pi (dpm)	Assay Date
1> C-14	DX 295	432	25,920	0.0305405	67,800	5/3/1994

Data

Instrument condition : Sat

High Voltage: 1800

Background: 715

C-14 Count: 9489

2π Efficiency: 33.85%

4π Efficiency: 12.94%

Calibration sticker attached? Yes

Comments : **Married as a set with :** **Model :** 2241-3 **Serial # :** 267138

Calibrated with plastic standoffs attached while using a 10' cable.
Set calibration due date to match other calibration certificates.

Date instrument is due for next calibration : 4/26/2019

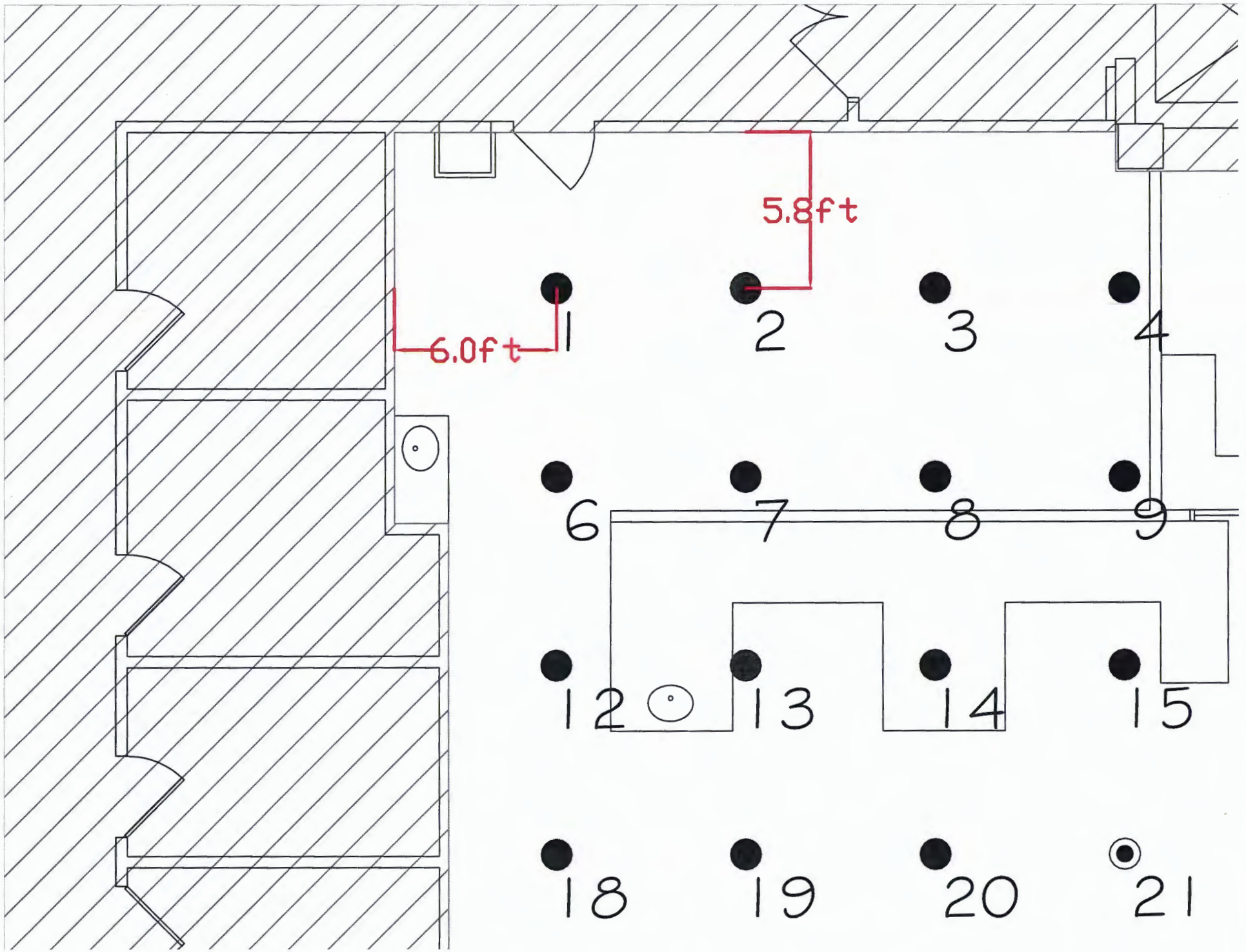
Performed by : _____ Reviewed by: _____ Date : 5-3-18

Printed Name : Carl Hall

Entered in computer inventory by: _____ Date : _____

Appendix D

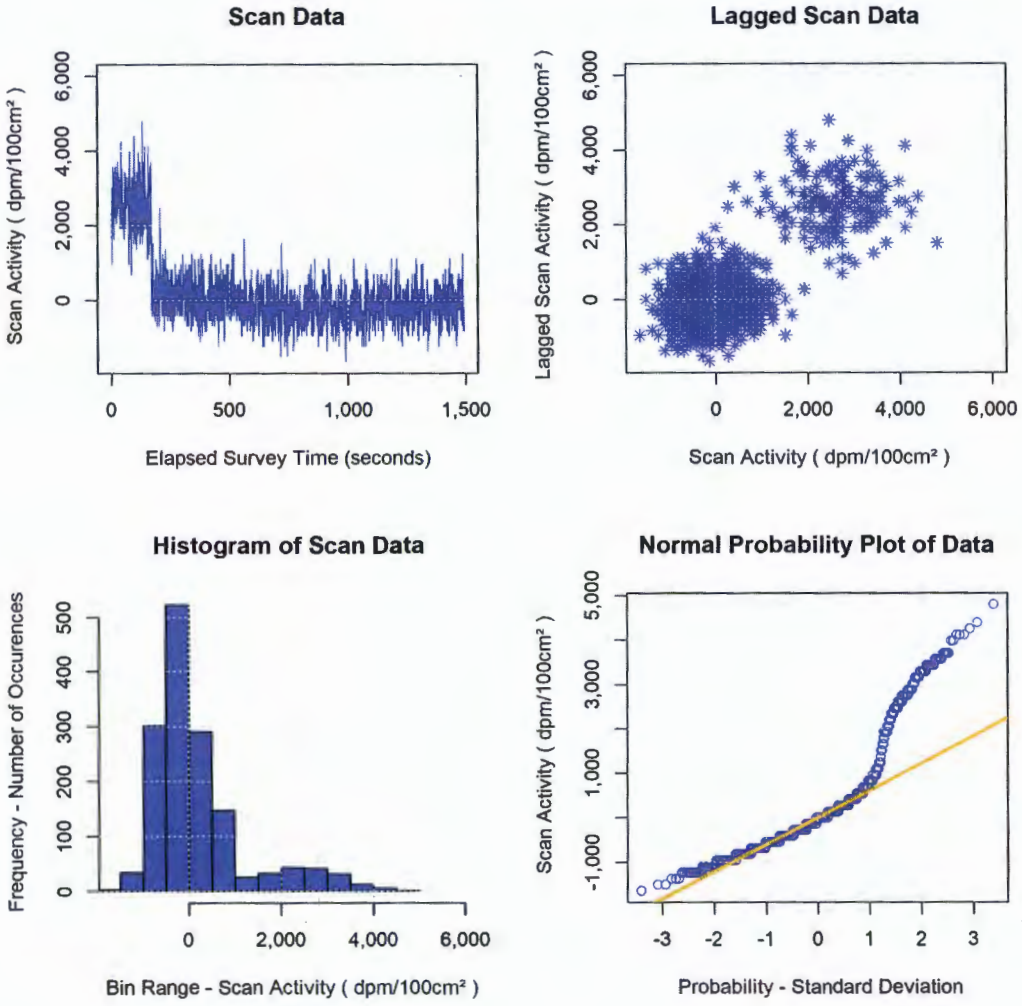
Survey Location Maps


5.8ft
6.0ft
1
2
3
4
6
7
8
9
12
13
14
15
18
19
20
21

Appendix E

4-Plot Graphs

Survey Unit: SMH-1301 Probe: PR148503 (43-37)



Appendix F

Structural Surfaces Survey Results

Survey Results

Building: SMH Survey Unit: 1301 Survey Type: Structural Class: 3

	Total Activity Measurements		Removable Activity Measurements					
Location Code	Activity	MDC	H-3	MDC	C-14	MDC	CH3	MDCR
SMH-1301-F1-T-001	**2,402** +/- 1,572	2,375	17	35	4	33	21	36
SMH-1301-F1-T-002	**2,402** +/- 1,572	2,375	4	35	12	33	14	36
SMH-1301-F1-T-003	**2,820** +/- 1,625	2,375	0	35	6	33	0	36
SMH-1301-F1-T-004	**2,820** +/- 1,625	2,375	7	35	10	33	15	36
SMH-1301-F1-V-005	1,253 +/- 1,418	2,375	7	35	0	33	0	36
SMH-1301-F1-T-006	2,089 +/- 1,532	2,375	25	35	4	33	14	36
SMH-1301-F1-T-007	**3,237** +/- 1,675	2,375	4	35	6	33	5	36
SMH-1301-F1-T-008	**3,237** +/- 1,675	2,375	30	35	3	33	17	36
SMH-1301-F1-T-009	**2,506** +/- 1,585	2,375	7	35	6	33	22	36
SMH-1301-F1-V-010	418 +/- 1,294	2,375	5	35	8	33	11	36
SMH-1301-F1-V-011	418 +/- 1,294	2,375	18	35	9	33	14	36
SMH-1301-F1-V-012	940 +/- 1,373	2,375	28	35	8	33	26	36
SMH-1301-F1-V-013	313 +/- 1,278	2,375	18	35	1	33	15	36
SMH-1301-B1-M-014	418 +/- 1,294	2,375	0	35	3	33	0	36
SMH-1301-F1-V-015	418 +/- 1,294	2,375	0	35	6	33	4	36
SMH-1301-F1-V-016	0 +/- 1,228	2,375	0	35	8	33	7	36
SMH-1301-F1-V-017	835 +/- 1,358	2,375	11	35	1	33	16	36
SMH-1301-F1-V-018	0 +/- 1,228	2,375	3	35	0	33	2	36
SMH-1301-F1-V-019	418 +/- 1,294	2,375	10	35	0	33	5	36
SMH-1301-F1-V-020	313 +/- 1,278	2,375	8	35	3	33	9	36
SMH-1301-F1-V-021	522 +/- 1,311	2,375	10	35	0	33	6	36
SMH-1301-F1-V-022	-313 +/- 1,176	2,375	15	35	11	33	24	36
SMH-1301-F1-V-023	522 +/- 1,311	2,375	0	35	0	33	0	36
SMH-1301-F1-V-024	418 +/- 1,294	2,375	22	35	1	33	16	36
SMH-1301-F1-V-025	1,044 +/- 1,388	2,375	16	35	3	33	14	36
SMH-1301-F1-V-026	522 +/- 1,311	2,375	0	35	0	33	0	36
SMH-1301-F1-V-027	731 +/- 1,342	2,375	27	35	0	33	10	36

Total activity results are reported in net dpm/100 cm².
H-3 and C-14 removable results are reported in net dpm/100 cm².CH3 removable results are reported in net cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 = 0-18.6 keV, C-14 = 18.6-156 keV, CH3 = 0-2,000 keV.

Survey Results

SMH-1301-B1-M-028	-313 +/- 1,176	2,375	21	35	4	33	11	36	

Static Count	28	**Sample Count**	28	28	28
Average	1,085		11	4	11
Minimum	-313		0	0	0
Maximum	3,237		30	12	26
Standard Deviation	1,107		10	4	8

Total activity results are reported in net dpm/100 cm².
H-3 and C-14 removable results are reported in net dpm/100 cm².CH3 removable results are reported in net cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 = 0-18.6 keV, C-14 = 18.6-156 keV, CH3 = 0-2,000 keV.

Appendix G

Building Systems Survey Results

Survey Results

Building: SMH Survey Unit: DR01 Survey Type: System Class: System

	Total Activity Measurements		Removable Activity Measurements					
Location Code	Activity	MDC	H-3	MDC	C-14	MDC	CH3	MDCR
SMH-DR01-D2-M-001	+/-		8	35	4	33	13	36
SMH-DR01-D2-M-002	+/-		0	35	4	33	0	36
SMH-DR01-D3-M-003	+/-		5	35	7	33	12	36
SMH-DR01-D3-M-004	+/-		15	35	0	33	11	36
SMH-DR01-D4-M-005	+/-		0	35	5	33	10	36
SMH-DR01-D2-M-006	+/-		0	35	4	33	11	36
SMH-DR01-D2-M-007	+/-		7	35	1	33	7	36
SMH-DR01-D3-M-008	+/-		19	35	5	33	12	36
SMH-DR01-D3-M-009	+/-		1	35	0	33	0	36
Static Count	0	**Sample Count**	9		9		9	
Average			6		3		8	
Minimum			0		0		0	
Maximum			19		7		13	
Standard Deviation			7		2		5	

Total activity results are reported in net dpm/100 cm².
H-3 and C-14 removable results are reported in net dpm/100 cm².CH3 removable results are reported in net cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 = 0-18.6 keV, C-14 = 18.6-156 keV, CH3 = 0-2,000 keV.

Survey Results

Building: SMH Survey Unit: VA01 Survey Type: System Class: System

	Total Activity Measurements		Removable Activity Measurements					
Location Code	Activity	MDC	H-3	MDC	C-14	MDC	CH3	MDCR
SMH-VA01-V1-M-001	+/-		12	35	4	33	13	36
SMH-VA01-V1-M-002	+/-		0	35	1	33	6	36
SMH-VA01-V1-M-003	+/-		0	35	5	33	5	36
SMH-VA01-V1-M-004	+/-		20	35	0	33	16	36
Static Count	0	**Sample Count**	4		4		4	
Average			8		3		10	
Minimum			0		0		5	
Maximum			20		5		16	
Standard Deviation			10		2		5	

Total activity results are reported in net dpm/100 cm².
H-3 and C-14 removable results are reported in net dpm/100 cm².CH3 removable results are reported in net cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 = 0-18.6 keV, C-14 = 18.6-156 keV, CH3 = 0-2,000 keV.

Survey Results

Building: SMH Survey Unit: VE01 Survey Type: System Class: System

	Total Activity Measurements		Removable Activity Measurements					
Location Code	Activity	MDC	H-3	MDC	C-14	MDC	CH3	MDCR
SMH-VE01-E2-M-001	-731 +/- 1,278	2,643	0	35	5	33	5	36
SMH-VE01-E2-M-002	-627 +/- 1,294	2,643	18	35	9	33	19	36
SMH-VE01-E2-M-003	-418 +/- 1,326	2,643	0	35	0	33	0	36
SMH-VE01-E2-M-004	-522 +/- 1,311	2,643	8	35	9	33	11	36
SMH-VE01-E2-M-005	0 +/- 1,388	2,643	0	35	8	33	11	36
SMH-VE01-E2-M-006	-418 +/- 1,326	2,643	0	35	1	33	10	36
SMH-VE01-E2-M-007	-940 +/- 1,245	2,643	0	35	0	33	0	36
SMH-VE01-E2-M-008	-522 +/- 1,311	2,643	3	35	10	33	12	36
SMH-VE01-E2-M-009	-835 +/- 1,262	2,643	**39**	35	0	33	20	36
SMH-VE01-E1-M-010	-313 +/- 1,342	2,643	8	35	13	33	24	36

Static Count	10	**Sample Count**	10	10	10
Average	-533		8	6	11
Minimum	-940		0	0	0
Maximum	0		39	13	24
Standard Deviation	272		12	5	8

Total activity results are reported in net dpm/100 cm².
H-3 and C-14 removable results are reported in net dpm/100 cm².CH3 removable results are reported in net cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 = 0-18.6 keV, C-14 = 18.6-156 keV, CH3 = 0-2,000 keV.

Appendix H

Quality Assurance Survey Results

Survey Results

Building: SMH Survey Unit: QA01 Survey Type: QA Class: QA

	Total Activity Measurements		Removable Activity Measurements					
Location Code	Activity	MDC	H-3	MDC	C-14	MDC	CH3	MDCR
SMH-QA01-B1-M-001	-214 +/- 1,357	2,652	24	35	12	33	24	36
SMH-QA01-F1-V-002	0 +/- 1,389	2,652	8	35	3	33	12	36
Static Count	2	Sample Count	2		2		2	
Average	-107		16		8		18	
Minimum	-214		8		3		12	
Maximum	0		24		12		24	
Standard Deviation	151		11		6		8	

Total activity results are reported in net dpm/100 cm².
H-3 and C-14 removable results are reported in net dpm/100 cm².CH3 removable results are reported in net cpm/100 cm².
Results above MDC are in bold print. Results above Investigation Levels are in red bold print.
Removable Activity: H-3 = 0-18.6 keV, C-14 = 18.6-156 keV, CH3 = 0-2,000 keV.

ORIGIN ID:CPSA (314) 977-6885
MARK HAENCHEN
SAINT LOUIS UNIVERSITY
1402 SOUTH GRAND BLVD
ROOM C305
SAINT LOUIS, MO 63104
UNITED STATES US

SHIP DATE: 08FEB19
ACTWGT: 1.00 LB
CAD: 104618722/INET4100

BILL SENDER

TO **MICHAEL LAFRANZO / REGION III**
U.S. NUCLEAR REGULATORY COMMISSION
2443 WARRENVILLE ROAD

RECEIVED FEB 11 2019

LISLE IL 60532
(630) 515-1259 REF: 1-24705
INV:
PO: DEPT:

565J20E3D/23AD

FedEx Express

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MON - 11 FEB 3:00P
STANDARD OVERNIGHT

TRK# 0201 **7744 3137 6298**

XH ENLA

60532
IL-US **ORD**

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1. Use the 'Print' button on this page to print your label to your laser or inkjet printer.
2. Fold the printed page along the horizontal line.
3. Place label in shipping pouch and affix it to your shipment so that the barcode portion of the label can be read and scanned.

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