

Final Report

Indiana University-Bloomington, IN
Swain Hall West
Radiological Remediation

January 2017



Prepared by:

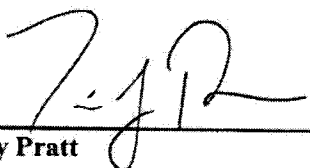


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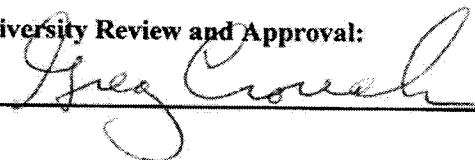
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Attachments

Attachment 1: Final Status Survey Unit Overview Maps
Attachment 2: Final Status Survey Measurement Results
Attachment 3: Verification Soil Samples Analytical Report
Attachment 4: Completed Final Status Survey Packages

Abbreviations and Acronyms

ALARA	As Low As Reasonably Achievable
Ameriphysics	Ameriphysics, LLC
cpm	counts per minute
DAC	Derived Air Concentration
DCGL	Derived Concentration Guideline Level
dpm	disintegration per minute
DQO	Data Quality Objective
HSA	Historical Site Assessment
NIST	National Institute of Standards and Technology
LBGR	Lower Bound of the Gray Region
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
NRC	Nuclear Regulatory Commission
RAM	Radioactive Material
TEDE	Total Effective Dose Equivalent

1. EXECUTIVE SUMMARY

Indiana University contracted Ameripysics LLC to perform the removal of residual radioactive contamination from specific locations within Swain Hall West in order to meet the requirements for unrestricted release of these locations so additional demolition and remodeling of the facility can be accomplished without radiological controls. This included the removal of specific building system components such as drain piping and ductwork. It also included the remediation of room surfaces in six rooms (Rooms 243, 244, 301, 302, 330 and 331) to meet the project release criteria. All work was accomplished using the Ameripysics Nuclear Regulatory Commission (NRC) radioactive materials license number 41-35264-01.

Ameripysics developed a Remediation Work Plan that was submitted to the NRC. The Plan 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). It provided the approach, methods, and techniques for the radiological D&D of impacted areas of the facility. Final status surveys were designed to implement the protocols and guidance provided in MARSSIM to demonstrate compliance with the established derived concentration guideline levels (DCGLs) for the site. These methods ensure technically defensible data were generated to aid in determining whether or not the facility met the release criteria for unrestricted use specified in 10 CFR 20, Subpart E of 25 mrem/yr total effective dose equivalent (TEDE).

Onsite work included performing free release surveys of equipment obstructing building surfaces; characterization of the building surfaces; remediation; packaging, manifesting and shipment of radioactive waste for disposal; and final status surveys of the six impacted rooms.

Following the scopes of work performed and discussed in this report, specific drain piping located below the basement level including below the concrete slab in the subbasement Machine Shop is known or suspected to be internally contaminated above the release criteria. The removal of this piping could not be completed during this phase. This piping will be addressed at a later time.

This report demonstrates that building structural surfaces remaining in the six rooms included in the scope of this report are well below release criteria and are suitable to release for unrestricted use. Based on the results of the surface and structure final status surveys, the TEDE to a maximally exposed individual based on the occupational scenario of the NRC's dose modelling software, DandD Version 2.1, is <2.74 mrem/year. Since the average total activity levels were less than their applicable minimum detection concentration (MDC) values, this dose is based on the highest MDC values for gross beta-gamma.

2. HISTORICAL RADIONUCLIDES OF CONCERN

Table 2-1 includes a listing of all the radionuclides known to be possessed in Swain Hall West. This listing is based on what might have been authorized (such as by the old AEC license) and more recent (1970 to present) facility records.

Table 2-1: Potential Radionuclides

Radionuclide	Half Life
Bi-207	32.9 y
C-14	5.73E3 y
Cl-36	3.01E5 y
Co-60	5.27 y
Cs-137	30.1671 y
Eu-152	13.537 y
Eu-154	8.593 y
H-3	12.32 y
Ni-63	100.1 y
Pb-210	22.2 y
Ra-226	1600 y
Sr-90	28.79 y
Th-232	1.41E+10 y
Tl-204	3.78 y
U-235	7.04E+08 y
U-238	4.47E+09 y

Based on the radionuclides that were possessed in unsealed form, a comprehensive radiological survey of the impacted areas within the scope of this plan is required. The methodology described in NUREG 1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), is used to design these surveys.

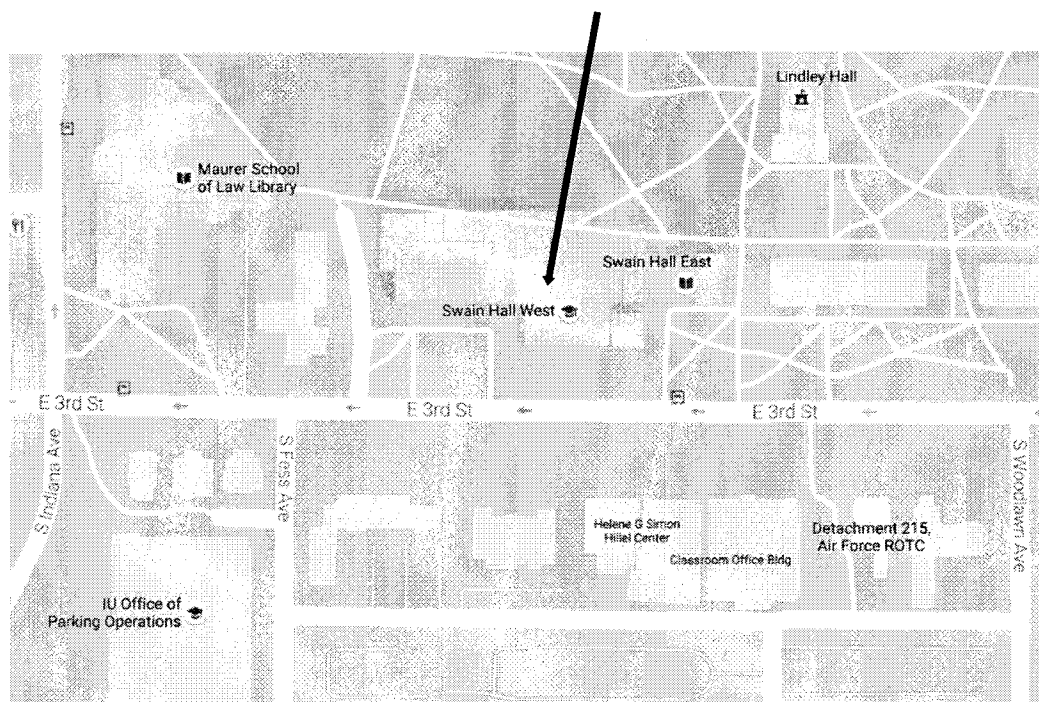
3. FACILITY DESCRIPTION

Originally built in 1940, Swain Hall West at the IU Bloomington Campus houses the university's physics department. With its last major renovations occurring in 1973, the building is currently in the process of a new renovation. Construction is currently in progress within adjacent areas of the building to those described in this plan. Upon approval of this report the rooms and areas included in this report will be renovated as well.

3.1. Site Location and Description

Swain Hall is located at 727 E. 3rd Street, in Bloomington, IN. Figure 3-1 provides a detailed street view with Swain Hall indicated. The Map was obtained online from Google.

Figure 3-1: Location of Swain Hall



4. PROJECT RELEASE CRITERIA

The criteria for releasing equipment and materials that interfere with performance of the MARSSIM-based decommissioning survey are those specified in NRC Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors*. Acceptable Surface Contamination Levels are provided in Table 1 of this guide.

Based on the radionuclides identified, the alpha total activity release limit is 100 dpm/100 cm² and the beta-gamma total activity release limits is 5,000 dpm/100 cm². Removable activity limits for alpha and beta-gamma emitters are 20 dpm/100 cm² and 1,000 dpm/100 cm², respectively.¹

¹ It should be noted that beta/gamma release limits are based on the standard beta/gamma emitter limits from Table 1. In order for the lower limits of Sr-90 to apply, Sr-90 is in its pure form where the Y-90 daughter has been chemically stripped away. Even if Sr-90 was once possessed in this form, in the time that has elapsed, the Y-90 would have grown back in.

Radiological requirements for license termination are described in Title 10 of the Code of Federal Regulations, Part 20, Subpart E, Radiological Criteria for License Termination, which states that a site will be considered acceptable for unrestricted release if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 millirem per year (mrem/yr), and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA).

The NRC has published default screening values in units of dpm/100 cm² corresponding to this limit in NUREG 1757, Volume 2, Appendix H. Table H.1 of NUREG provides acceptable surface contamination screening values for commonly used radionuclides. Where possible, these default screening values are used to provide the basis for developing the derived concentration guideline levels (DCGLs) corresponding to the release criteria for the project. The DCGL is the term MARSSIM uses to describe a radionuclide specific surface area concentration limit that could result in a dose equal to the release criterion. The DCGL is the concentration limit if the residual activity is essentially evenly distributed over a large area. For the purposes of this plan, where NUREG 1757 list a default screening value, the value is used as the project DCGL for the corresponding radionuclide. Note that although MARSSIM provides a means for allowing small areas of elevated activity that exceed the DCGL to remain (not be remediated), this process was not applied to this project. Rather, any contamination exceeding the DCGL was remediated.

The values in NUREG 1757 were derived using the DandD Modeling Code. The table in NUREG 1757 only lists common radionuclides, and Indiana University possessed several radionuclides not listed. In these instances, the RESRAD-BUILD code, Ver. 3.5, is used to determine DCGLs corresponding to the twenty-five (25) millirem per year limit. The RESRAD-BUILD Version 3.5 was used using the default parameters. The RESRAD-BUILD summary reports for the radionuclides of concern not listed in Table H.1 are provided in Attachment 2 of the Remediation Work Plan.

These DCGLs correspond to total contamination (fixed and removable) and published default screening values are based on the assumption that no more than 10% of the contamination is removable. Consequently, a removal activity limit equal to 10% of the total activity DCGL is implemented to confirm this important assumption.

Table 4-1 shows the radionuclide specific DCGLs for this project. DCGL screening values listed are based on the equivalent screening values from NUREG 1757, or for unlisted radionuclides, the RESRAD-BUILD summary reports provided in the Remediation Work Plan. This is reflected by the note following the table.

Table 4-1: DCGLs for Nuclides of Concern at 25 mrem/yr

Radionuclide	Half Life	Primary Radiation Type	DCGL - Total Activity Limit (dpm/100cm ²)	Removable Activity Limit (dpm/100cm ²)
Bi-207 ²	32.9 y	EC/Beta+	34,000	3,400
C-14 ¹	57E3 y	Beta	3,700,000	370,000
Cl-36 ¹	3.01E5 y	Beta	500,000	50,000
Co-60 ¹	5.2713 y	Beta	7,100	710
Cs-137 ¹	30.1671 y	Beta	28,000	2,800
Eu-152 ²	13.537 y	Beta	40,000	4,000
Eu-154 ²	8.593 y	Beta	37,500	3,750
H-3 ¹	12.32 y	Beta	120,000,000	12,000,000
Ni-63 ^{1, 3}	100.1 y	Beta	1,800,000	180,000
Pb-210 ^{2, 3}	22.2 y	Beta	2,200	220
Ra-226 ²	1600 y	Alpha	4,110	411
Sr-90 ¹	28.79 y	Beta	8,700	870
Tl-204 ²	3.78 y	Beta	5,800,000	580,000
U-235 ²	7.04E+08 y	Alpha	480	48
U-238 ²	4.468E9 y	Alpha	508	51

¹ DCGL Listed in NUREG 1757 Vol. 1, Rev. 2

² DCGL determined using the RESRAD-BUILD Ver.3.5 code

³ Ni-63 and Pb-210 are not detected by standard field instruments with any reasonable efficiency. These radionuclides were evaluated by liquid scintillation counting only.

⁴ Although Th-232 was identified as a potential radionuclide of concern, it was not detected in any of the samples collected and analyzed by the off-site laboratory analysis and thus has been removed as a nuclide of concern for total and removable activity measurements.

The field instruments used to collect survey data are not equipped to distinguish between radionuclides. The measurements analyze for gross alpha and gross beta/gamma only. Therefore, the gross activity DCGLs were based on the most limiting release criteria for both alpha and beta/gamma. The alpha gross activity DCGL is most limited by U-235 at 480 dpm/100cm² and the beta/gamma gross activity DCGL is most limited by Co-60 at 7,100 dpm/100cm².

5. PROJECT ACTIVITIES

The project activities are outlined in the following sections. Detailed instructions for completing technical aspects of the project are provided in Section 7, Final Status Survey Design.

5.1. Characterization Surveys

A characterization survey was performed to verify the boundaries and initial conditions in the six impacted rooms within Swain Hall. The characterization included obtaining a sample of the contamination from the concrete surfaces. The sample was sent to GEL Laboratories in Charleston, SC for gamma spectroscopy, alpha spectroscopy and Sr-90 analyses. Surface

scanning, total surface activity (static) measurements, and removable activity measurements (smears) were performed to determine the activities and extent of contamination requiring remediation.

Where elevated activity was identified, a static measurement and smear are taken at the location of highest activity identified during the scan. Where elevated activity is identified that exceeds the release criteria, the boundary of the elevated area was marked to aid the remedial actions.

5.1.1. Room 243

Contamination exceeding the release criteria was detected on approximately nine square meters of surfaces in Room 243. The maximum total activity measurement was 84,637 dpm/100 cm² beta and <MDC alpha (<105 dpm/100 cm²). No removable contamination exceeding MDC for alpha or beta was detected.

5.1.2. Room 244

Contamination exceeding the release criteria was detected on approximately seven square meters of surfaces in Room 244. The maximum total activity measurement was 261,350 dpm/100 cm² beta and <MDC alpha (<105 dpm/100 cm²). No removable contamination exceeding MDC for alpha or beta was detected.

5.1.3. Room 301

Contamination exceeding the release criteria was detected on approximately five square meters of surfaces in Room 301. The maximum total activity measurement was 59,854 dpm/100 cm² beta and <MDC alpha (<105 dpm/100 cm²). No removable contamination exceeding MDC for alpha or beta was detected.

5.1.4. Room 302

Contamination exceeding the release criteria was detected on approximately twenty-one square meters of surfaces in Room 302. The maximum total activity measurement was 761,614 dpm/100 cm² beta and <MDC alpha (<105 dpm/100 cm²). No removable contamination exceeding MDC for alpha or beta was detected.

5.1.5. Room 330

Contamination exceeding the release criteria was detected on approximately thirty-six square meters of surfaces in Room 330. The maximum total activity measurement was 14,155,193 dpm/100 cm² beta and 1,193 dpm/100 cm² alpha. The maximum removable contamination measurement was 3,413 dpm/100 cm² beta and <MDC alpha (<10 dpm/100 cm²).

5.1.6. Room 331

Contamination exceeding the release criteria was detected on approximately six square meters of surfaces in Room 331. The maximum total activity measurement was 36,297 dpm/100 cm² beta and <MDC alpha (<105 dpm/100 cm²). No removable contamination exceeding MDC for alpha or beta was detected.

5.2. Remediation

Various components and rooms required remediation within Swain Hall West to meet the project release criteria. Specific building systems (ventilation ductwork and drain lines) that were internally contaminated required removal. Surface decontamination was performed in the six rooms discussed in the previous section. The remediation activities are further discussed in the following sections.

5.2.1. Incinerator Flue Ductwork Removal

The remaining incinerator flue ductwork that previously served an incinerator in the subbasement level required removal and disposal as radioactive waste. The removal process began in the Attic Level above the 3rd Floor and was removed in manageable sections down to the basement level. It had been removed from the incinerator up to that point during a previous remediation effort.

Surveys were performed on the flue duct as it was removed. Each cut was performed inside a glove bag. Surveys were performed on the duct openings for total activity and removable activity prior to sealing the ends and removal of the glove bag. The highest total activity measurement was 23,558 dpm/100 cm² beta, no detectable alpha total activity. Removable activity was <MDC alpha and beta (<103 dpm/100 cm² beta and <10 dpm/100 cm² alpha). Confirmatory surveys were performed of the surrounding surfaces to verify that no contamination was spread from the activities.

Each section of flue duct was transferred to a radioactive material storage area in the High Bay. Approximately 88-feet of flue ducting was removed during this process.

5.2.2. Room S12 (Incinerator Room) Supply Duct Removal

It was determined during surveys performed during the Incinerator Room remediation that the supply air duct was contaminated. This duct is a galvanized duct extending approximately 40 feet from Room S12, across a hallway, and through Room S17.

Surveys were performed on the supply duct as it was removed. Each cut was performed inside a glove bag. Surveys were performed on the duct openings for total activity and removable activity prior to sealing the ends and removal of the glove bag. The highest total activity measurement was 7,049 dpm/100 cm² beta, no detectable alpha total activity. Removable activity was <MDC

alpha and beta (<106 dpm/100 cm² beta and <10 dpm/100 cm² alpha). Confirmatory surveys were performed of the surrounding surfaces to verify that no contamination was spread from the activities.

Each section of duct was transferred to a radioactive material storage area in the High Bay. Approximately 30-feet of ducting was removed during this process.

5.2.3. Room S18 Fume Hood Exhaust Duct Removal

Contamination was known to exist in the remaining fume hood exhaust duct in Room S18. The galvanized duct extended 65 feet from the overhead in S18 via S17 and a vertical chase to the second-floor rooftop fan. Removal of the fume hood duct began in Room S18 and continued up to the rooftop fan unit.

Surveys were performed on the duct as it was removed. Each cut was performed inside a glove bag. Surveys were performed on the duct openings for total activity and removable activity prior to sealing the ends and removal of the glove bag. The highest total activity measurement was 23,270 dpm/100 cm² beta, no detectable alpha total activity. Removable activity was $<$ MDC alpha and beta (<106 dpm/100 cm² beta and <10 dpm/100 cm² alpha). Confirmatory surveys were performed of the surrounding surfaces to verify that no contamination was spread from the activities.

Each section of duct was transferred to a radioactive material storage area in the High Bay. Approximately 65 feet of ducting was removed during this process.

5.2.4. Attic Fume Hood Exhaust Ventilation Stack Removal

Contamination was known to exist in the remaining fume hood exhaust stack that originally serviced Room 330. The galvanized stack extended approximately four feet up through the Attic roof. The stack was removed in two sections.

Surveys were performed on the stack as it was removed. A cut was performed inside a glove bag on the attic level. Surveys were performed on the duct openings for total activity and removable activity prior to sealing the ends and removal of the glove bag. The highest total activity measurement was 5,646 dpm/100 cm² beta, no detectable alpha total activity. Removable activity was $<$ MDC alpha and beta (<100 dpm/100 cm² beta and <10 dpm/100 cm² alpha). Confirmatory surveys were performed of the surrounding surfaces to verify that no contamination was spread from the activities.

Each section of duct was transferred to a radioactive material storage area in the High Bay. Approximately four feet of ducting was removed during this process.

5.2.5. Drain Systems Removal

Several drain systems were removed as part of this scope of work. This includes drain lines from Rooms 243/244, 301/302, 330 and the sub-slab drain lines from Room S18. The drain lines were primarily cast iron pipes.

The pipes from the 2nd and 3rd floors were cut into manageable sections and removed down to the basement level. This required some demolition of the walls to access the piping.

Surveys were performed on the piping as it was removed. Each cut or break was performed inside a glove bag. Surveys were performed on the pipe openings for total activity and removable activity prior to sealing the ends and removal of the glove bag. The highest total activity measurement in any of the 2nd and 3rd floors piping was 207,526 dpm/100 cm² beta, no detectable alpha total activity. Removable activity was <MDC alpha and beta (<103 dpm/100 cm² beta and <10 dpm/100 cm² alpha). Confirmatory surveys were performed of the surrounding surfaces to verify that no contamination was spread from the activities.

The piping from Room S18 and the adjacent hallway was accessed by cutting/removing concrete slab sections and excavation of the pea gravel and soils surrounding the piping. Sufficient soils were removed to allow plastic sheeting to be placed below the pipe prior to cutting or breaking. Surveys were performed on the pipe openings for total activity and removable activity prior to sealing the ends and removal sections. The highest total activity measurements was 179,753 dpm/100 cm² beta, no detectable alpha total activity. Removable activity was <MDC beta (<106 dpm/100 cm²). Confirmatory surveys were performed of the surrounding surfaces to verify that no contamination was spread from the activities.

In addition, soil samples were collected at ten locations below the areas where the breaks in the piping were made. It should be noted that there was no evidence of leaks in the piping prior to removal. No activity for any radionuclides other than naturally occurring radionuclides was detected in the samples. A map showing the location of these samples is included in Attachment 1. The laboratory results for these samples are provided in Attachment 3.

Each section of piping was transferred to a radioactive material storage area in the High Bay. Approximately 185 feet of piping was removed during this process.

5.2.6. Room Remediation Activities

Remediation of the building surfaces in the six rooms was accomplished using a combination of concrete scarifying and ing chipping hammers. Personnel performing these activities were in full anti-contamination clothing and powered air purifying respirators (PAPRs).

Dusts were controlled using the equipment in conjunction with a HEPA vacuum. During the process, no visible dust was created. Air samples were performed in accordance with the Remediation Work Plan. All air sample results were <0.1 Derived Air Concentration (DAC). The air

samples were evaluated against the most restrictive radionuclides of concern. These were the Sr-90 DAC of 8.00 E-09 $\mu\text{Ci}/\text{ml}$ for beta and the U-238 DAC of 2.00E-11 $\mu\text{Ci}/\text{ml}$ for alpha.

5.2.7. Radioactive Waste Management

Radioactive wastes generated as a result of remediation were transported to EnergySolutions Bear Creek Facility in Oak Ridge, TN for processing and disposal.

5.2.7.1. Waste Shipment

A 20-foot sealand waste container was prepared, loaded, and manifested by personnel who have satisfied the training requirements of Title 49 of the Code of Federal Regulations (CFR) Part 172, Subpart H. The shipment was performed on 1/17/2017. Shipping papers reflected Indiana University as the generator.

5.2.8. Remaining Contaminated Systems

Some removal efforts were not completed during this phase of work. There are still some remaining contaminated embedded piping from the basement level down and below the subbasement Machine Shop. The Machine Shop is currently in use and activities won't cease until at least April 2017. The additional removal activities of this contaminated piping will continue at that time.

5.3. Final Status Survey

Final status surveys collect the statistical information needed to demonstrate that residual radioactivity satisfies the predetermined criteria for unrestricted release. Surveys were designed using MARSSIM and the DQO process it describes. Final status survey design is presented in greater detail in Section 7.

6. SURVEY INSTRUMENTATION

Based on potential contaminants, their associated radiations, and the types of residual contamination categories to be evaluated, the detection sensitivities of various instruments and techniques were evaluated for use. Instruments were evaluated for use during surface scans, direct measurements, and analysis of removable contamination wipes.

6.1. Instrument Calibration

Laboratory and portable field instruments were calibrated at least annually with National Institute of Standards and Technology (NIST) traceable sources and to radiation emission types and energies that provide detection capabilities similar to the nuclides of concern.

6.2. Daily Response Checks

For radiological instruments operated by Ameriphsics, a reference source was measured prior to use each day. The result is considered accurate if it falls within $\pm 20\%$ of originally determined values. This is consistent with the guidance in Section 6.5.4 of MARSSIM, Instrument Calibration. Background readings were taken as part of the daily response checks and compared with the acceptance range for instrument and site conditions. During the course of the project, no instruments failed their daily response checks.

6.3. Determination of Counting Times and Minimum Detectable Concentrations

Minimum counting times for background determinations and counting times for measurement of total and removable contamination are chosen to provide minimum detectable concentrations (MDCs) that meet the DQOs specified in this plan. MARSSIM equations relative to building surfaces are modified to convert to units of dpm/100cm². Count times and scanning rates are determined using the equations in the following sections.

6.3.1. Static Counting

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):

$$MDC_{static} = \frac{3 + 3.29 \sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E_{tot} \cdot \frac{A}{100cm^2}}$$

Where:

- MDC_{static} = minimum detectable concentration level in dpm/100cm²
- B_r = background count rate in counts per minute
- t_b = background count time in minutes
- t_s = sample count time in minutes
- E_{tot} = total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and surface efficiency)¹
- A = detector probe area in cm²

¹. Surface efficiency applied will be in accordance with the recommended values of 0.25 for alpha and beta emitters <400keV max and 0.5 for all others.

Static MDCs were calculated for the Ludlum 43-68 detector based on the highest background values used for final status surveys (window slate – 319 cpm beta, 1 cpm alpha). For all other background values, the static MDC would be lower than that calculated below.

Maximum beta static MDC:

$$Beta\ MDC_{static} = \frac{3 + 3.29 \sqrt{319 \cdot 1 \cdot (1 + \frac{1}{1})}}{1 \cdot 0.3237 \cdot \frac{126}{100cm^2}} = 845\ dpm/100cm^2$$

Maximum alpha static MDC:

$$Alpha\ MDC_{static} = \frac{3 + 3.29 \sqrt{1 \cdot 1 \cdot (1 + \frac{1}{1})}}{1 \cdot 0.3147 \cdot \frac{126}{100cm^2}} = 77\ dpm/100cm^2$$

6.3.2. Ratemeter Scanning

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 level in dpm/100 cm²
- d' = desired performance variable (1.38)
- b_i = background counts during the residence interval
- i = residence interval
- p = surveyor efficiency (0.5)
- E_{tot} = total detector efficiency for radionuclide emission of interest
(includes combination of instrument efficiency and surface efficiency¹)
- A = detector probe area in cm²

¹. Surface efficiency applied will be in accordance with the recommended values of 0.25 for alpha and beta emitters <400 keV max and 0.5 for all others.

Beta Scan MDCs were calculated for the 43-37 detectors based on the highest background value used for final status surveys. For all other background values, the scan MDC would be lower than that calculated below.

Beta scan MDC for the 43-37 based on the maximum background of 1,574 cpm beta - window slate:

$$MDC_{scan} = \frac{1.38\sqrt{70.31} \text{ counts} \left(\frac{60}{2.68 \text{ sec.}} \right)}{\sqrt{0.5 \cdot 0.2878} \cdot \frac{584}{100 \text{ cm}^2}} = 871 \text{ dpm}/100 \text{ cm}^2$$

From MARSSIM, Section 6.7.7.2, Scanning for Alpha Emitters:

"Scanning for alpha emitters differs significantly from scanning for beta and gamma emitters in that the expected background response of most alpha detectors is very close to zero. Since the time a contaminated area is under the probe varies and the background count rate of some alpha instruments is less than 1 cpm, it is not practical to determine a fixed MDC for alpha scanning. Instead, it is more useful to determine the probability of detecting an area of contamination at a predetermined DCGL for given scan rates."

For alpha survey instrumentation with backgrounds of no more than three counts per minute, a single count provides a surveyor sufficient cause to stop and investigate further. Given a known scan rate and a surface contamination DCGL, the probability of detecting a single count while passing over a contaminated area from MARSSIM Equation 6-12 is:

$$P(n \geq 1) = 1 - e^{-\frac{GE d}{60v}}$$

Where:

- $P(n \geq 1)$ = probability of observing a single count
- G = contamination activity (dpm)
- E = detector efficiency (total efficiency)
- d = width of detector in direction of scan (cm)
- v = scan speed (cm/s)

Once a count is recorded and the guideline level of contamination is suspected the surveyor stops and waits (dwell time) until the probability of getting another count is at least 90%. This time interval was calculated using Equation 6.13 from MARSSIM:

$$t = \frac{13,800}{CAE}$$

Where:

t	=	time period for static count or dwell time
C	=	contamination guideline (dpm/100 cm ²)
A	=	physical detector area (cm ²)
E	=	detector efficiency (4π)

The instrument used for alpha scans was the Ludlum 43-37 detector paired with the Ludlum 2360 meter. Table 6-1 provides the scan rate, probability rate, and dwell time determined based on a maximum alpha background of 1 cpm.

Table 6-1: Alpha Instrument Scan Probability and Dwell Time

Detector Model	Scan Rate	Maximum Background (cpm)	Physical Detector Area	Width of detector	4π Efficiency	Limiting Release Criterion	Probability of Detection	Dwell Time
Ludlum 43-37	5 cm/sec.	1	584 cm ²	13.4 cm	15.98%	480 dpm/100 cm ²	96.75%	0.31 sec.

6.3.3. Removable Contamination Measurement Counting

Removable contamination measurement (smear) counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{static} = \frac{3 + 3.29 \sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E \cdot \frac{A}{100cm^2}}$$

Where:

MDC_{smear}	=	minimum detectable concentration level in dpm/smear
B_r	=	background count rate in counts per minute
t_b	=	background count time in minutes
t_s	=	sample count time in minutes
E	=	instrument efficiency for radionuclide emission of interest
A	=	physical area of the smear in cm ²

Static MDCs were calculated for the Ludlum 3030E meter with a Ludlum 43-10-1 detector based on the highest background values used for final status surveys (69 cpm beta, 0 cpm alpha).

Maximum beta static MDC:

$$Beta MDC_{static} = \frac{3 + 3.29 \sqrt{69 \cdot 1 \cdot (1 + \frac{1}{1})}}{1 \cdot 0.1481 \cdot \frac{100}{100 cm^2}} = 281 dpm/100 cm^2$$

Maximum alpha static MDC:

$$Alpha MDC_{static} = \frac{3 + 3.29 \sqrt{0 \cdot 1 \cdot (1 + \frac{1}{1})}}{1 \cdot 0.2973 \cdot \frac{100}{100 cm^2}} = 10 dpm/100 cm^2$$

6.4. Counting Uncertainty

The counting uncertainty for both total and removable measurements was calculated using equation 6-15 from MARSSIM:

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

Where:

- σ_R = uncertainty
- C_{s+b} = gross counts of the sample
- T_{s+b} = Sample time (minutes)
- C_b = Gross background counts
- T_b = Background count time (minutes)

6.5. Uncertainty Propagation and Confidence Interval

Because calculations to determine the final static measurement results are based on dividing the net count rate by total efficiency, the uncertainty propagation formula is as follows (MARSSIM Section 6.8.3):

$$\sigma_A = u \sqrt{\left(\frac{\sigma_{R_b}}{R_b}\right)^2 + \left(\frac{\sigma_E}{E}\right)^2}$$

Where:

- σ_A = Measurement propagated error or total uncertainty
- u = Final result in dpm/100 cm²

σ_{Rb}	=	Standard deviation or statistical counting uncertainty of the net count rate
R_b	=	Net count rate
σ_E	=	Standard deviation of the instrument efficiency
E	=	Total efficiency

Referring to MARSSIM Table 6.9, a k value of ± 1.96 represents a confidence interval equal to 95 percent about the mean of a normal distribution. All total activity measurements are presented as the final result in $\text{dpm}/100 \text{ cm}^2 \pm \text{total uncertainty } (\sigma_A)$ as provided in Attachment 2.

6.6. Instrumentation Specifications

The instrumentation used for facility decommissioning surveys is summarized in the following tables. Table 6-2 lists the standard features of each instrument such as probe size and efficiency. Table 6-3 lists the operational parameters such as scan rate, count time, and the associated MDCs.

Table 6-2: Instrumentation Specifications

Detector Model	Detector Type	Detector Area	Meter Model	Window Thickness	Total Efficiency
Ludlum 43-68	Alpha/Beta Gas Proportional	126 cm^2	Ludlum 2360	0.8 mg/cm^2	8.09% (C-14) - Beta 7.87% (Th-230) - Alpha
Ludlum 43-37	Alpha/Beta Gas Proportional	584 cm^2	Ludlum 2360	0.8 mg/cm^2	7.20% (C-14) - Beta 15.98% (Th-230) - Alpha
Ludlum 43-10-1	Alpha/Beta Scintillation	100 cm^2	Ludlum 3030	0.4 mg/cm^2	14.81% - Beta (C-14) 29.73% - Alpha (Th-230)

Table 6-3: Typical Instrument Operating Parameters and Sensitivities

Measurement Type	Detector Model	Meter Model	Scan Rate	Count Time	Background (cpm)	MDC ($\text{dpm}/100\text{cm}^2$)
Total Surface Activity	43-68	Ludlum 2360	N/A	60 sec.	350 - Beta 1 - Alpha	845 - Beta 77 - Alpha
Surface Scans ¹	43-37	Ludlum 2360	3 $\text{cm}/\text{sec.}$	N/A	700 - Beta 2 - Alpha	871 - Beta N/A - Alpha
Removable Beta Activity	Ludlum 43-10-1	Ludlum 3030	N/A	60 sec. ¹	69 - Beta 0 - Alpha	281 - Beta 10 - Alpha

¹ All surface scans were performed with the Ludlum 43-37.

6.7. Background Determination

The use of reference background areas or paired background comparisons is not necessary for the purposes of this plan since the radionuclides of concern do not exist in background or they exist at very small fractions of the DCGLs. It was determined that there were significant background variations in the building materials encountered in the impacted rooms. Material

specific background measurements were performed in a couple of the non-impacted rooms on the 2nd and 3rd Floors of Swain Hall West. These backgrounds were applied to their applicable measurement locations in determining the net activity levels. The background values used are provided in Table 6-4.

Table 6-4: Material Specific Background Values

Material	43-68 Background (cpm)	43-37 Background (cpm)	Material Code	Location Collected
Bare concrete	220	1050	C	Room 203
Painted Concrete	270	1500	P	Room 203
Wood	155	805	W	Room 203
Glass	135	750	G	Room 203
Slate – Window Thresholds	319	1574	S	Room 307
Painted Drywall	148	850	D	Room 307

Alpha background were similar on all materials. An average alpha background value of 1 cpm was used for all materials.

7. FINAL STATUS SURVEY DESIGN AND IMPLEMENTATION

Final status surveys were performed to demonstrate that residual radioactivity in each survey unit satisfies the predetermined criteria for release for unrestricted use. The final status surveys were conducted using the DQO process.

Final status surveys were conducted by performing required scan surveys, total direct surveys, and removable contamination measurements as discussed further in this section. All survey data was documented on survey maps and associated data information sheets.

7.1. Data Quality Objectives

The process of designing a final status survey begins with development of DQOs. On the basis of these objectives and the known or anticipated radiological conditions at the site, the numbers and locations of measurement and sampling points used to demonstrate compliance with the release criterion are then determined. Finally, survey techniques appropriate to develop adequate data are selected and implemented.

Survey results, obtained in accordance with the MARSSIM guidelines, are used to select between one condition of the environment (the null hypothesis, H_0) and an alternative condition (the alternative hypothesis, H_a). The null hypothesis is treated like a baseline condition that is assumed to be true in the absence of strong evidence to the contrary. Acceptance or rejection of the null hypothesis depends upon whether or not the particular survey results are consistent with the hypothesis.

A decision error occurs when the decision maker rejects the null hypothesis when it is true, or accepts the null hypothesis when it is false. These two types of decision errors are classified as Type I and Type II decision errors.

A Type I decision error occurs when the null hypothesis is rejected when it is true, and is sometimes referred to as a false positive error. The probability of making a Type I decision error, or the level of significance, is denoted by alpha (α). Alpha reflects the amount of evidence the decision maker would like to see before abandoning the null hypothesis, and is also referred to as the size of the test.

A Type II decision error occurs when the null hypothesis is accepted when it is false. This is sometimes referred to as a false negative error. The probability of making a Type II decision error is denoted by beta (β). The term $(1 - \beta)$ is the probability of rejecting the null hypothesis when it is false, and is also referred to as the power of the test.

The null hypothesis for this decommissioning project was that the residual radioactivity concentrations exceed the release criterion. Acceptable decision error probabilities for testing the hypothesis were set at $\alpha = 0.05$ and $\beta = 0.05$.

7.2. Area Classification

Classification is a critical step in the survey design process. The working hypothesis of MARSSIM is that all impacted areas being evaluated for release have a potential for radioactive contamination above the DCGL. This initial assumption means that all areas are initially considered Class 1 areas unless some basis for reclassification as Class 2, Class 3 or non-impacted is provided. Consistent with this approach, Class 1 areas have the greatest potential for contamination and, therefore, receive the highest degree of survey effort, followed by Class 2 and then Class 3 areas.

Areas that have no reasonable potential for residual contamination do not need any level of survey coverage and are designated as non-impacted areas. These areas have no radiological impact from site operations and are typically identified during the Historical Site Assessment (HSA).

As discussed previously, impacted areas are areas that have some potential for containing contaminated material. They can be subdivided into three classes:

- Class 1 areas: Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination. Examples of Class 1 areas include site areas previously subjected to remedial actions, locations where leaks or spills are known to have occurred, former burial or disposal sites, waste storage sites, and areas with contaminants in discrete solid pieces of material high specific activity.

- Class 2 areas: These areas have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the DCGL. To justify changing an area's classification from Class 1 to Class 2, the existing data (from the HSA, scoping surveys, or characterization surveys) should provide a high degree of confidence that no individual measurement would exceed the DCGL. Examples of areas that might be classified as Class 2 include locations where radioactive materials were present in an unsealed form, potentially contaminated transport routes, upper walls and ceilings of rooms subjected to airborne radioactivity, areas where low concentrations of radioactive materials were handled, and areas on the perimeter of former contamination control areas.
- Class 3 areas: Any impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the DCGL, based on site operating history and previous radiological surveys. Examples of areas that might be classified as Class 3 include buffer zones around Class 1 or Class 2 areas, and areas with very low potential for residual contamination but insufficient information to justify a non-impacted classification.

The working hypothesis of MARSSIM is that all impacted areas being evaluated for release have a potential for radioactive contamination above the DCGL. This initial assumption means that all areas are initially considered Class 1 areas unless some basis for reclassification as Class 2, Class 3 or non-impacted is provided. Consistent with this approach, Class 1 areas have the greatest potential for contamination and, therefore, receive the highest degree of survey effort, followed by Class 2 and then Class 3 areas.

Based on the current process knowledge and prior survey data, all six of the rooms where remediation was planned were classified as Impacted Class 1.

7.3. Survey Unit Identification

A survey unit is a physical area consisting of structures or land areas of specified size and shape for which a separate decision is made as to whether or not that area exceeds the release criterion. As this decision is made as a result of the final status survey, the survey unit is the primary entity for demonstrating compliance with the release criterion.

Each of the six rooms was designated as a Class 1 survey unit that included all surfaces; floor, walls, and ceiling. The survey units were designated by the building and room number; SHW-243, SWH-244, SWH-301, SWH-302, SWH-330, and SWH-331.

MARSSIM states that survey units should be limited in size based on classification, exposure pathway modeling assumptions, and site-specific conditions. MARSSIM also suggests size limitations, which for Class 1 structural surfaces is 100 m² or less (floor area). Survey units were established so the recommended size limit of 100 m² was not exceeded.

7.4. Surface Scans

Scan surveys were performed for gross alpha and for gross beta/gamma. For the purposes of the final status survey, all survey units received a 100% scan survey of all accessible surfaces. During the final status surveys, no elevated activity was detected during the scan surveys. Remediation was conducted to eliminate all elevated activity prior to the final status survey.

7.5. Determining the Number of Sample Locations

For situations where the contaminant is not present in background, or is present at such a small fraction of the DCGL as to be considered insignificant, a background reference area is not necessary. Instead, the contaminant levels are compared directly with the DCGL value. A one-sample Sign test was used to statistically demonstrate compliance with the release criterion.

The lower bound of the gray region (LBGR) was selected to be one-half the DCGL and was used as an arbitrary starting point for developing an acceptable survey design along with target values of 0.05 for α and β . The width of the gray region, equal to DCGL minus the LBGR, is a parameter that is central to the Sign test. This parameter is also referred to as the shift, Δ .

The absolute size of the shift is actually of less importance than the relative shift, Δ/σ , where σ is an estimate of the standard deviation of the measured values in the survey unit. Values estimated for σ include both the real spatial variability in the quantity being measured and the precision of the chosen measurement system. The relative shift, Δ/σ , is an expression of the resolution of the measurements in units of measurement uncertainty.

The importance of choosing appropriate values for σ must be emphasized. If the value is grossly underestimated, the number of data points will be too few to obtain the desired power level for the test and a resurvey may be recommended. Therefore, in the interest of conservatism a larger value is selected even though the number of data points determined is increased.

The shift (Δ) is equal to the width of the gray region (DCGL - LBGR), and the relative shift is defined as Δ/σ , where σ is an estimate of the standard deviation in the survey unit. Since an actual value for σ is not known, it is preliminarily assumed to be no more than thirty percent of the DCGL. This important assumption is confirmed during characterization. Using this estimate of σ , the relative shift is calculated using a LBGR of fifty percent of the DCGL ($\Delta = 1 \times \text{DCGL} - 0.5 \times \text{DCGL}$). This calculation is shown below.

$$\text{Relative shift} = \frac{\Delta}{\sigma} = \frac{1 - 0.5}{0.3} = 1.6$$

Table 5.5 of MARSSIM provides a list of the number of data points used to demonstrate compliance using the Sign test for selected values of α , β , and Δ/σ .

The value extracted from the table using the expected site-specific parameters is seventeen (17) and represents the minimum number of measurements performed in each survey unit. The values were calculated using the methodology presented in MARSSIM and increased by 20% to account for missing or unusable data.

Following data collection, the MARSSIM DQO process requires a retrospective assessment of the selected LBGR and σ values to confirm that an adequate number of data points were obtained for final evaluation. This was performed for each survey unit. The LBGR was set to the survey unit mean or the minimum detectable concentration, whichever was greater. The actual standard deviation of the survey unit data was used. Based on this evaluation, a sufficient number of data point were collected in each survey unit. No additional points were required. These evaluations are provided in Table 7-1.

Table 7-1: Verification of Sufficient Number of Samples for Statistical Tests

Survey Unit	Class	MDC	Survey Unit Mean	Standard Deviation	DCGL	Number of Samples Collected	Relative Shift	Required Number of Samples
		dpm/100 cm ²						
SHW-243	1	779	-212	740	7,100	21	8.54	14
SHW-244	1	779	-212	421	7,100	20	15.01	14
SHW-301	1	779	-151	363	7,100	18	17.41	14
SHW-302	1	779	-129	566	7,100	22	11.17	14
SHW-330	1	779	17	784	7,100	27	8.06	14
SHW-331	1	779	103	482	7,100	32	13.11	14

7.6. Determination of Sampling Locations

For each survey unit, the sampling locations were established in a unique pattern beginning with a random start location and the determined sample spacing. After determining the number of samples needed in the survey units, sample spacing was 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 surfaces included in the statistical tests (floors, walls, and ceilings) and folded out in a 2-dimensional view. 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.

Final status survey design maps for the six survey units are provided in Attachment 1.

7.7. Total Surface Activity Measurements

Total surface contamination measurements for gross beta were taken at statistically determined sample locations. Scaler count times were based on achieving detection sensitivity below the DCGL.

All alpha and beta total activity measurement results are provided in Attachment 2.

7.8. Removable Contamination Measurements

Removable contamination measurements (smears) were collected on building surfaces and structures at each total activity sample location to determine the potential removable contamination. Smears were taken for gross alpha/beta and for liquid scintillation counting (LSC). An area of approximately 100 cm² was wiped. All removable contamination measurements were less than their applicable MDC.

All smear sample results for alpha and beta are provided in Attachment 2. LSC smear results are provided in the completed Survey Design Packages, Attachment 4.

7.9. Survey 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 investigations to determine the concentration, area, and extent of the contamination. The survey investigation levels for each type of measurement are listed by classification in Table 7.2.

Table 7-2: Survey Investigation Levels

Survey Unit Classification	Flag Direct Measurement Result When:	Flag Scanning Measurement Result When:	Flag Removable Measurement Result When:
Class 1	>75% of DCGL	>75% of DCGL	>200 dpm/100cm ² Beta >15 dpm/100cm ² Alpha

No investigation levels were exceeded during the final status surveys.

7.10. Survey Documentation

A survey package was developed for each survey unit containing the following:

- Survey Instruction Sheets
- General survey requirements
- Instrument requirements with associated MDCs, count times and scan rates
- Survey Maps
- Overview maps detailing survey locations and placement methodology
- Survey sub-unit maps with additional sample location information, as needed
- Survey Data Sheets
- Signature of Data Collector and Reviewer

The completed final status survey packages are provided in Attachment 4.

8. INTERPRETATION OF SURVEY RESULTS

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

8.1. Data Validation

Field data was reviewed by the Project Manager and validated to ensure:

- Completeness of Forms
- Proper types of surveys were performed
- The MDCs for measurements met the established data quality objectives
- Independent calculations were performed on a representative sample of data for each survey unit in accordance with the QAP
- Satisfactory instrument calibrations and daily functionality checks were performed as required

8.2. Evaluating Survey Results

In addition to simply comparing the data against the release criteria, basic statistical quantities were calculated for the data obtained from the survey units. First, the average of the data set and the standard deviation are calculated. The average of the data is compared to the DCGL to get a preliminary indication of the survey unit status. Where remediation is inadequate, this comparison may readily reveal that a survey unit contains excess residual radioactivity - even before applying statistical tests. For example, if every measurement in the survey unit is below the DCGL, the survey unit clearly meets the release criterion.

The value of the sample standard deviation is especially important. If the value is too large compared to that assumed during the survey design, this may indicate an insufficient number of samples were collected to achieve the desired power of the statistical test.

The median is the middle value of the data set when the number of data points is odd, and is the average of the two middle values when the number of data points is even. Thus 50% of the data points are above the median, and 50% are below the median. Large differences between the average and the median are an early indication of skewness in the data. Ideally, the difference between the average and the mean should be a small fraction of the sample standard deviation.

Examining the minimum, maximum, and range of the data may provide additional useful information. The range should not be unusually large. When there are 30 or fewer data points, values of the range much larger than about 4 to 5 standard deviations are considered unusual. For larger data sets the range might be wider.

Comparisons of the survey unit mean activities were compared to the DCGL and the means were less than MDC and well below the release criteria of 7,100 dpm/100 cm² beta and 480 dpm/100 cm² alpha. No individual static measurement exceeded the release criteria. No removable activity result exceed MDC.

These basic statistical quantities are provided for each survey unit in Attachment 2.

8.3. Total Effective Dose Equivalent Calculations

In all cases, the random-systematic measurement locations for each survey unit were less than the applicable release criterion. As a result, all survey units satisfy the criterion and no further statistical evaluation is necessary. The null hypothesis is rejected, and the survey units meet the established criteria.

Calculations were performed for individual survey units based on the survey unit average or the instrument MDC, whichever was greater. The ratio of the average (or MDC) to the DCGL is multiplied by 25 mrem/year to determine the TEDE. Individual survey unit exposure calculation results are provided in Table 8-1.

Table 8-1: Calculated TEDE by Survey Unit Results

Survey Unit	Class	Highest MDC	Survey Unit Mean	Standard Deviation	DCGL	TEDE (mrem/year)	Calculated Based On
		dpm/100 cm ²					
SHW-243	1	779	-212	740	7,100	2.74	MDC
SHW-244	1	779	-212	421	7,100	2.74	MDC
SHW-301	1	779	-151	363	7,100	2.74	MDC
SHW-302	1	779	-129	566	7,100	2.74	MDC
SHW-330	1	779	17	784	7,100	2.74	MDC
SHW-331	1	779	103	482	7,100	2.74	MDC

9. CONCLUSIONS

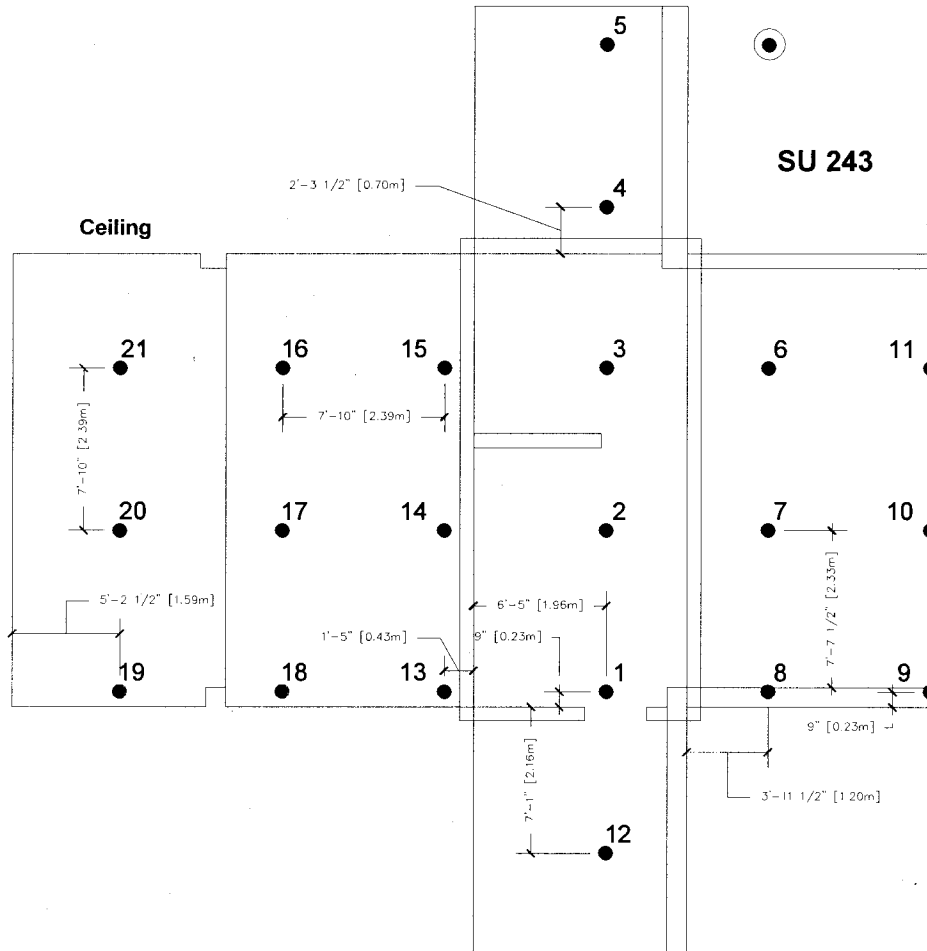
The elements of the Remediation Work Plan for the Swain Hall West building have been executed. The results of surveys and sampling are provided in Attachment 2. The TEDE corresponding to residual radioactivity in each of the six survey units is tabulated in Table 8-1, and demonstrates a maximum dose of <2.74 mrem in the first year. Subsequent years will result in lower doses due to decay; thus, the site satisfies the dose-based criterion reflected in 10 CFR 20 Subpart E.

10. REFERENCES

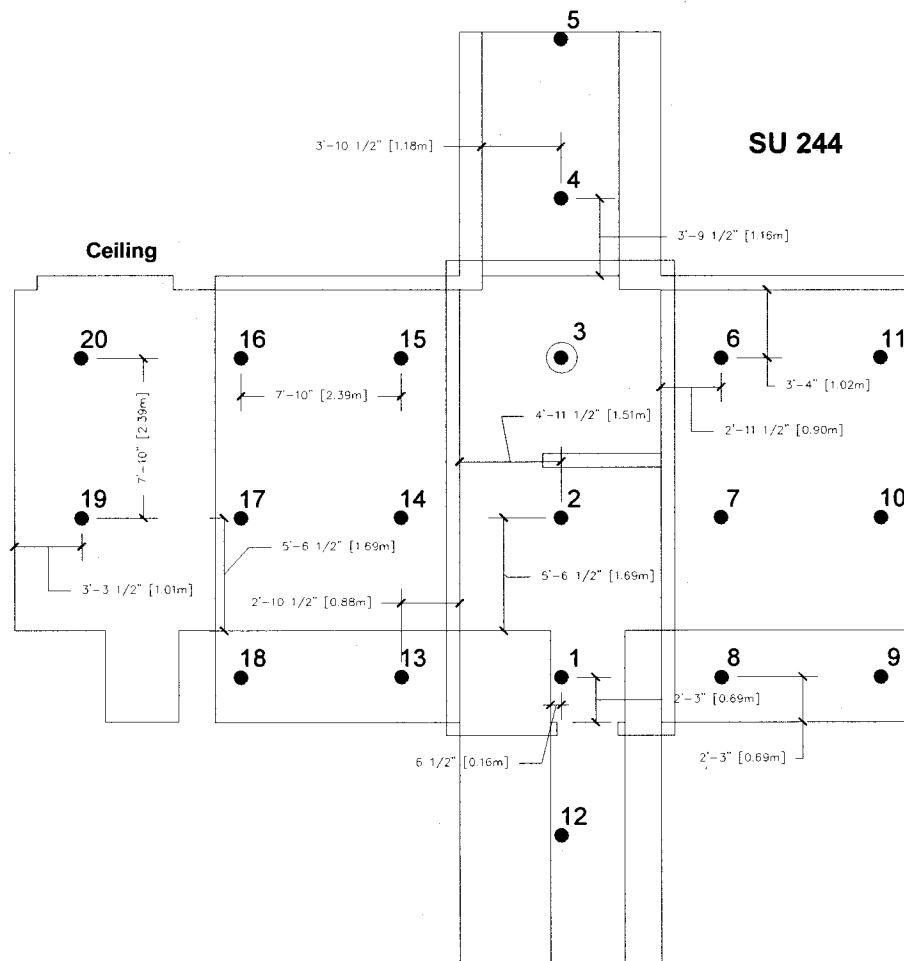
1. NUREG 1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM)
2. NUREG 1505, "A Nonparametric Statistical Methodology for the Design and Analysis of Final Decommissioning Surveys"
3. NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions"
4. NUREG 1757, Volume 1 "Consolidated NMSS Decommissioning Guidance," Appendix B
5. NUREG 1757, Volume 2 "Consolidated NMSS Decommissioning Guidance,"
6. 10 CFR 20 Subpart E, "Radiological Criteria for License Termination"
7. Ameriphsysics Radiological Control Procedure Manual and associated Procedures.
8. Handbook of Health Physics and Radiological Health, Third Edition.
9. Remediation Work Plan for Indiana University Swain Hall West

Attachment 1
Final Status Survey Unit Overview Maps

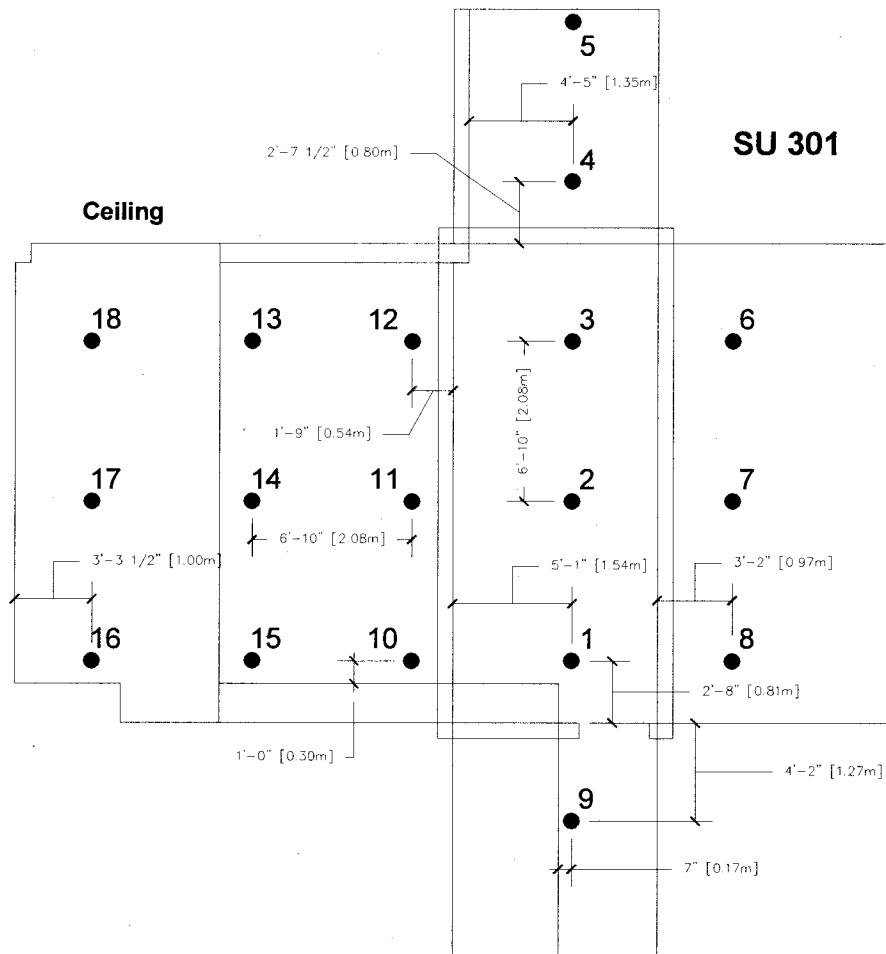
Survey Unit SHW-243



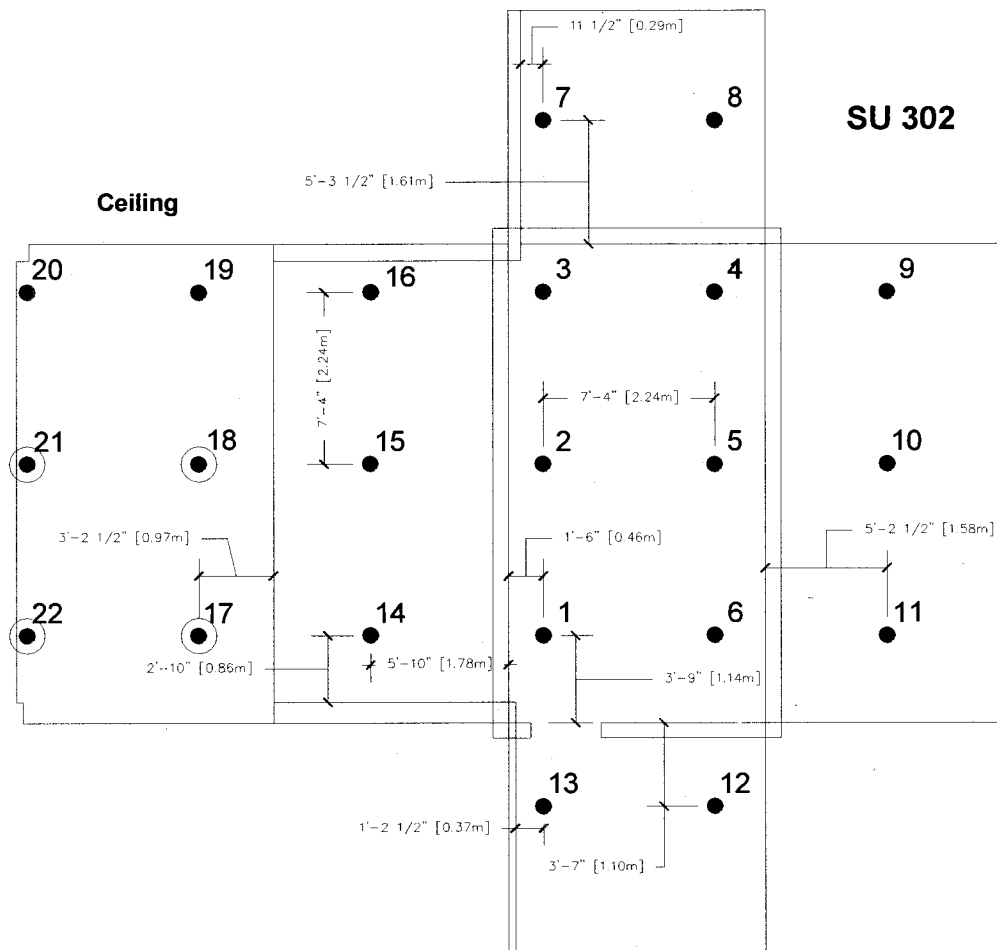
Survey Unit SHW-244



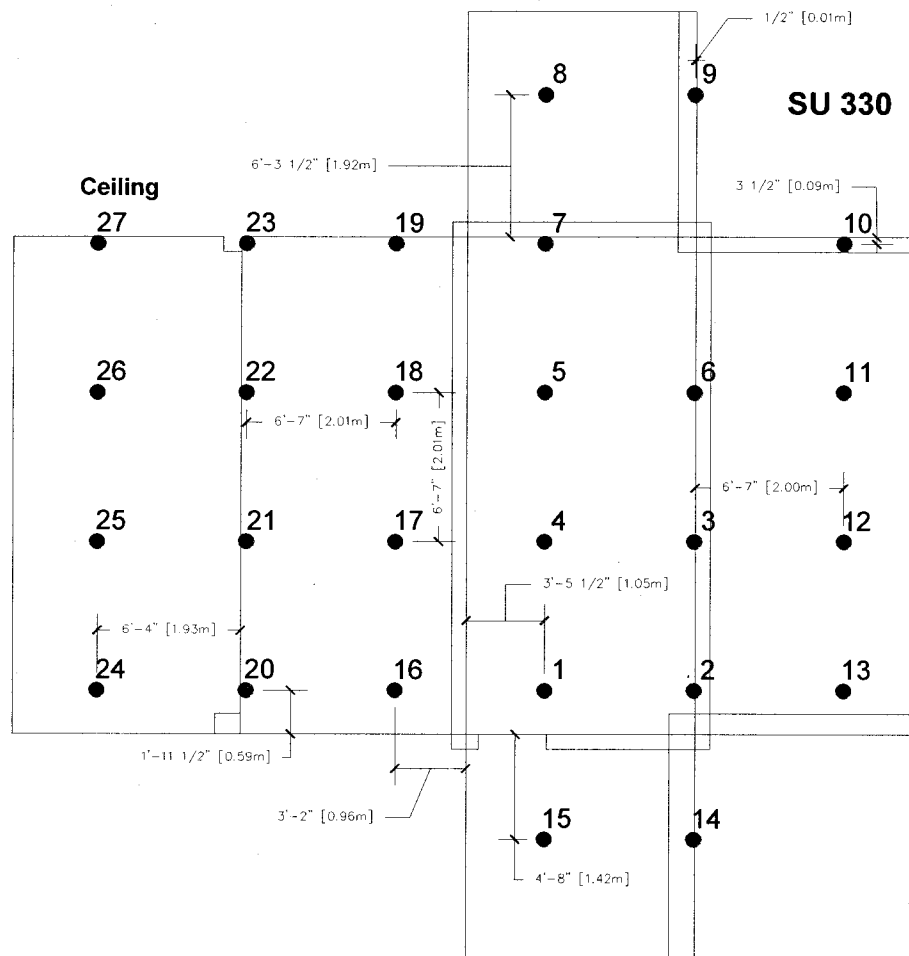
Survey Unit SHW-301



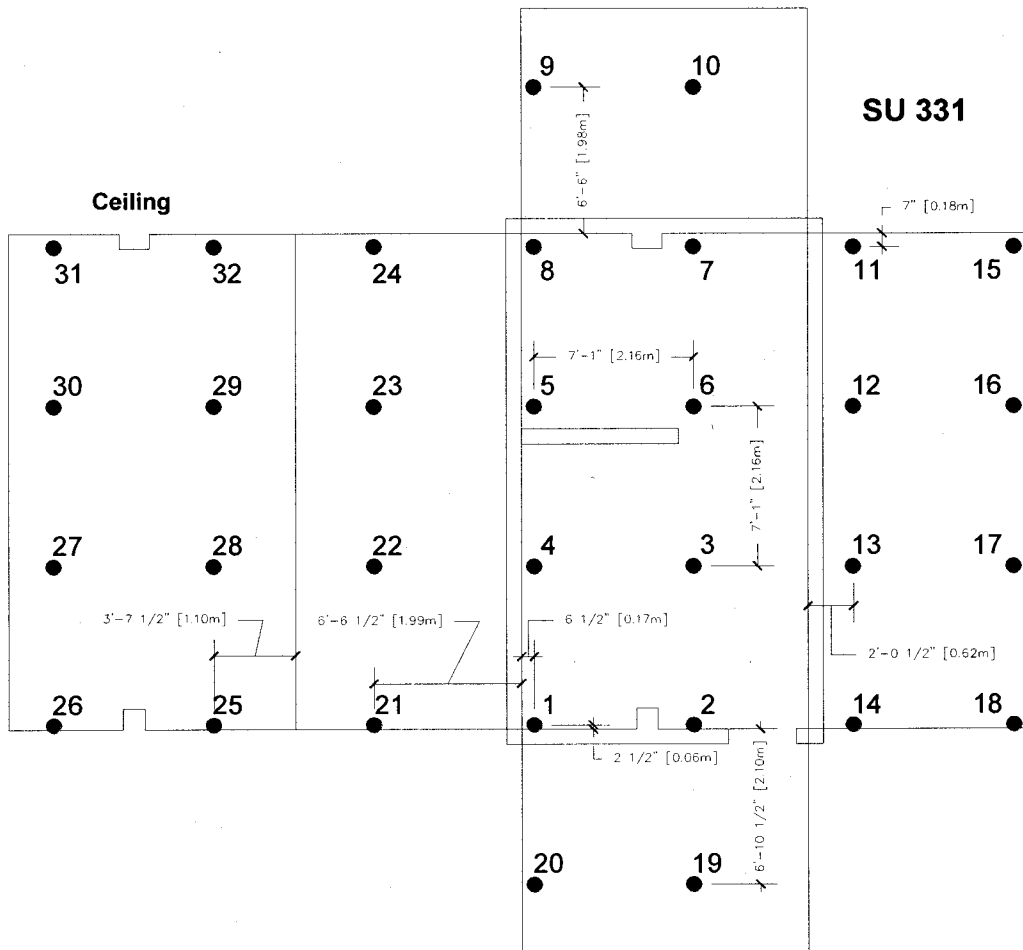
Survey Unit SHW-302



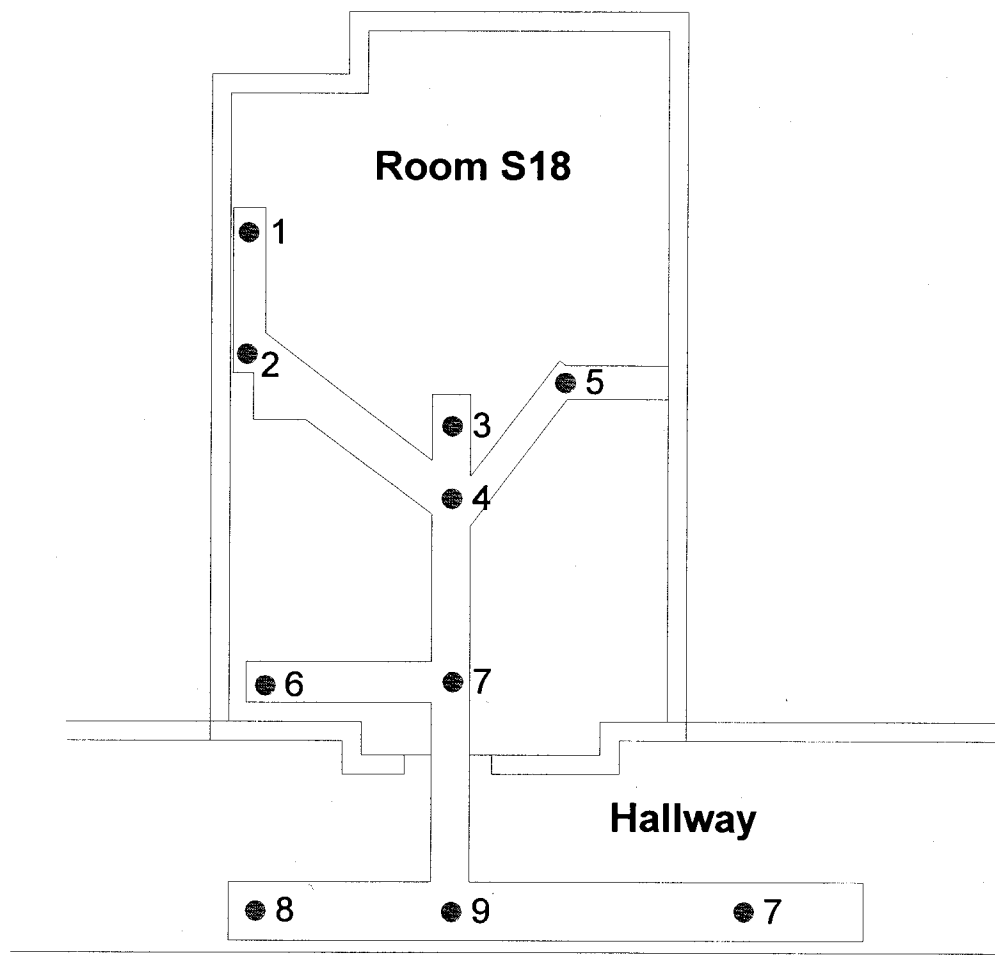
Survey Unit SHW-330



Survey Unit SHW-331



Room S18 and Adjacent Hallway Sub-Surface Soil Sample Locations



Attachment 2
Final Status Survey Measurement Results

Indiana University -Swain Hall West Survey Results

Survey Unit: SHW-243

Class 1

Total Activity Measurement Results

Removable Activity Measurement Results

Location Code	Beta		Alpha		Beta		Alpha	
	dpm/100cm ²	MDC	dpm/100cm ²	MDC	dpm/100cm ²	MDC	dpm/100cm ²	MDC
SHW-243-F-C-1	1736 ± 586	706	46.5 ± 92	77	61 ± 161	281	0.0 ± 0	10
SHW-243-F-C-2	-275 ± 394	706	-7.4 ± 15	77	61 ± 161	281	0.0 ± 0	10
SHW-243-F-C-3	-255 ± 394	706	-6.8 ± 23	77	88 ± 164	281	0.0 ± 0	10
SHW-243-W-P-4	-177 ± 441	779	-4.7 ± 16	77	74 ± 162	281	0.0 ± 0	10
SHW-243-W-P-5	-294 ± 438	779	-7.9 ± 16	77	47 ± 160	281	0.0 ± 0	10
SHW-243-W-P-6	736 ± 498	779	19.7 ± 67	77	101 ± 165	281	0.0 ± 0	10
SHW-243-W-P-7	147 ± 454	779	3.9 ± 13	77	142 ± 169	281	0.0 ± 0	10
SHW-243-W-P-8	-667 ± 438	779	-17.9 ± 35	77	149 ± 170	281	0.0 ± 0	10
SHW-243-W-P-9	-1030 ± 449	779	-27.6 ± 77	77	34 ± 158	281	0.0 ± 0	10
SHW-243-W-P-10	-1030 ± 449	779	-27.6 ± 77	77	-34 ± -153	281	0.0 ± 0	10
SHW-243-W-P-11	-883 ± 443	779	-23.7 ± 66	77	149 ± 170	281	0.0 ± 0	10
SHW-243-W-P-12	-1010 ± 448	779	-27.1 ± 92	77	108 ± 166	281	0.0 ± 0	10
SHW-243-W-P-13	69 ± 450	779	1.8 ± 5	77	81 ± 163	281	0.0 ± 0	10
SHW-243-W-P-14	-147 ± 442	779	-3.9 ± 11	77	41 ± 159	281	0.0 ± 0	10
SHW-243-W-P-15	88 ± 451	779	2.4 ± 8	77	108 ± 166	281	0.0 ± 0	10
SHW-243-W-P-16	353 ± 467	779	9.5 ± 32	77	88 ± 164	281	0.0 ± 0	10
SHW-243-W-P-17	29 ± 448	779	0.8 ± 4	77	115 ± 166	281	0.0 ± 0	10
SHW-243-W-P-18	952 ± 520	779	25.5 ± 71	77	20 ± 157	281	0.0 ± 0	10
SHW-243-C-P-19	-991 ± 447	779	-26.6 ± 90	77	101 ± 165	281	0.0 ± 0	10
SHW-243-C-P-20	-834 ± 442	779	-22.3 ± 44	77	135 ± 168	281	3.4 ± 7	10
SHW-243-C-P-21	-971 ± 446	779	-26.0 ± 51	77	81 ± 163	281	0.0 ± 0	10
Average	-212		-6		83		0.2	
Median	-255		-7		88		0.0	
Minimum	-1030		-28		-34		0.0	
Maximum	1736		47		149		3.4	
Standard Deviation	740		20		46		0.7	

Indiana University -Swain Hall West Survey Results

Survey Unit: SHW-244

Class 1

Total Activity Measurement Results

Removable Activity Measurement Results

Location Code	Beta			Alpha			Beta			Alpha		
	dpm/100cm ²	MDC		dpm/100cm ²	MDC		dpm/100cm ²	MDC		dpm/100cm ²	MDC	
SHW-244-F-C-1	618 ± 448	706		17 ± 46	77		115 ± 161	272		0.0 ± 0	10	
SHW-244-F-C-2	-353 ± 393	706		-9 ± 32	77		47 ± 154	272		0.0 ± 0	10	
SHW-244-F-C-3	-20 ± 402	706		-1 ± 2	77		108 ± 160	272		3.4 ± 7	10	
SHW-244-W-G-4	-284 ± 304	560		-8 ± 26	77		108 ± 160	272		0.0 ± 0	10	
SHW-244-W-P-5	-1069 ± 451	779		-29 ± 80	77		7 ± 150	272		0.0 ± 0	10	
SHW-244-W-P-6	-167 ± 441	779		-4 ± 9	77		41 ± 153	272		0.0 ± 0	10	
SHW-244-W-P-7	118 ± 452	779		3 ± 6	77		142 ± 164	272		0.0 ± 0	10	
SHW-244-W-P-8	29 ± 448	779		1 ± 2	77		95 ± 159	272		0.0 ± 0	10	
SHW-244-W-P-9	-10 ± 446	779		0 ± 1	77		-20 ± 148	272		0.0 ± 0	10	
SHW-244-W-P-10	-510 ± 436	779		-14 ± 76	77		34 ± 23	272		0.0 ± 0	10	
SHW-244-W-P-11	-167 ± 441	779		-4 ± 9	77		108 ± 67	272		3.4 ± 7	10	
SHW-244-W-P-12	-147 ± 442	779		-4 ± 11	77		128 ± 60	272		0.0 ± 0	10	
SHW-244-W-P-13	-20 ± 446	779		-1 ± 1	77		135 ± 59	272		0.0 ± 0	10	
SHW-244-W-P-14	49 ± 449	779		1 ± 3	77		7 ± 2	272		0.0 ± 0	10	
SHW-244-W-P-15	108 ± 452	779		3 ± 6	77		0 ± 0	272		0.0 ± 0	10	
SHW-244-W-P-16	-314 ± 438	779		-8 ± 2	77		0 ± 0	272		0.0 ± 0	10	
SHW-244-W-P-17	324 ± 465	779		9 ± 17	77		128 ± 60	272		0.0 ± 0	10	
SHW-244-W-P-18	-795 ± 440	779		-21 ± 42	77		61 ± 412	272		0.0 ± 0	10	
SHW-244-C-P-19	-863 ± 442	779		-23 ± 46	77		115 ± 63	272		0.0 ± 0	10	
SHW-244-C-P-20	-765 ± 440	779		-21 ± 40	77		74 ± 167	272		3.4 ± 7	10	
Average	-212			-6			72			0.5		
Median	-157			-4			85			0.0		
Minimum	-1069			-29			-20			0.0		
Maximum	618			17			142			3.4		
Standard Deviation	421			11			53			1.2		

Indiana University -Swain Hall West Survey Results

Survey Unit: SHW-301

Class 1

Total Activity Measurement Results

Removable Activity Measurement Results

Location Code	Beta			Alpha			Beta			Alpha		
	dpm/100cm ²	MDC		dpm/100cm ²	MDC		dpm/100cm ²	MDC		dpm/100cm ²	MDC	
SHW-301-F-C-1	-10 ± 403	706		0 ± 1	77		135 ± 163	272		0.0 ± 0	10	
SHW-301-F-C-2	39 ± 406	706		1 ± 4	77		115 ± 161	272		0.0 ± 0	10	
SHW-301-F-C-3	-157 ± 408	706		-4 ± -9	77		95 ± 159	272		0.0 ± 0	10	
SHW-301-W-P-4	-353 ± 484	779		-9 ± 33	77		34 ± 153	272		0.0 ± 0	10	
SHW-301-W-P-5	-1079 ± 779	779		-29 ± 59	77		108 ± 160	272		3.4 ± 7	10	
SHW-301-W-P-6	-520 ± 533	779		-14 ± 78	77		230 ± 174	272		0.0 ± 0	10	
SHW-301-W-P-7	108 ± 456	779		3 ± 10	77		149 ± 165	272		0.0 ± 0	10	
SHW-301-W-P-8	-69 ± 446	779		-2 ± 4	77		74 ± 157	272		0.0 ± 0	10	
SHW-301-W-P-9	255 ± 484	779		7 ± 24	77		122 ± 162	272		3.4 ± 7	10	
SHW-301-W-P-10	-785 ± 638	779		-21 ± 73	77		108 ± 160	272		0.0 ± 0	10	
SHW-301-W-P-11	-520 ± 533	779		-14 ± 78	77		81 ± 157	272		0.0 ± 0	10	
SHW-301-W-P-12	-88 ± 446	779		-2 ± 8	77		41 ± 153	272		0.0 ± 0	10	
SHW-301-W-D-13	10 ± 331	585		0 ± 1	77		7 ± 150	272		0.0 ± 0	10	
SHW-301-W-D-14	177 ± 358	585		5 ± 10	77		47 ± 154	272		0.0 ± 0	10	
SHW-301-W-D-15	206 ± 365	585		6 ± 11	77		61 ± 155	272		0.0 ± 0	10	
SHW-301-C-D-16	137 ± 349	585		4 ± 13	77		169 ± 167	272		0.0 ± 0	10	
SHW-301-C-D-17	-39 ± 329	585		-1 ± 2	77		142 ± 164	272		0.0 ± 0	10	
SHW-301-C-D-18	-29 ± 330	585		-1 ± 2	77		-34 ± 147	272		0.0 ± 0	10	
Average	-151			-4			94			0.4		
Median	-34			-1			102			0.0		
Minimum	-1079			-29			-34			0.0		
Maximum	255			7			230			3.4		
Standard Deviation	363			10			63			1.1		

Indiana University -Swain Hall West Survey Results

Survey Unit: SHW-302

Class 1

Total Activity Measurement Results

Removable Activity Measurement Results

Location Code	Beta		Alpha		Beta		Alpha	
	dpm/100cm ²	MDC	dpm/100cm ²	MDC	dpm/100cm ²	MDC	dpm/100cm ²	MDC
SHW-302-F-C-1	-78 ± 400	706	-2 ± 4	77	68 ± 156	272	0.0 ± 0	10
SHW-302-F-C-2	-383 ± 392	706	-10 ± 20	77	27 ± 152	272	0.0 ± 0	10
SHW-302-F-C-3	10 ± 404	706	0 ± 0	77	20 ± 152	272	0.0 ± 0	10
SHW-302-F-C-4	-373 ± 392	706	-10 ± 28	77	7 ± 150	272	0.0 ± 0	10
SHW-302-F-C-5	-402 ± 392	706	-11 ± 21	77	95 ± 159	272	0.0 ± 0	10
SHW-302-F-C-6	-510 ± 392	706	-14 ± 38	77	95 ± 159	272	0.0 ± 0	10
SHW-302-W-P-7	-69 ± 444	779	-2 ± 6	77	142 ± 164	272	0.0 ± 0	10
SHW-302-W-G-8	-206 ± 306	560	-6 ± 11	77	176 ± 168	272	0.0 ± 0	10
SHW-302-W-P-9	461 ± 475	779	12 ± 24	77	88 ± 158	272	0.0 ± 0	10
SHW-302-W-P-10	373 ± 468	779	10 ± 28	77	61 ± 155	272	0.0 ± 0	10
SHW-302-W-P-11	844 ± 509	779	23 ± 45	77	41 ± 153	272	0.0 ± 0	10
SHW-302-W-P-12	-383 ± 437	779	-10 ± 28	77	81 ± 157	272	0.0 ± 0	10
SHW-302-W-W-13	-1246 ± 461	779	-33 ± 66	77	108 ± 160	272	0.0 ± 0	10
SHW-302-W-P-14	677 ± 493	779	18 ± 62	77	74 ± 157	272	0.0 ± 0	10
SHW-302-W-P-15	775 ± 502	779	21 ± 41	77	122 ± 162	272	0.0 ± 0	10
SHW-302-W-P-16	157 ± 454	779	4 ± 14	77	47 ± 154	272	0.0 ± 0	10
SHW-302-C-M-17	-78 ± 300	540	-2 ± 4	77	101 ± 159	272	0.0 ± 0	10
SHW-302-C-M-18	147 ± 314	540	4 ± 8	77	74 ± 157	272	0.0 ± 0	10
SHW-302-C-C-19	-1060 ± 407	706	-28 ± 56	77	81 ± 157	272	3.4 ± 7	10
SHW-302-C-C-20	-1118 ± 411	706	-30 ± 59	77	81 ± 157	272	3.4 ± 7	10
SHW-302-C-M-21	-226 ± 293	540	-6 ± 21	77	68 ± 156	272	0.0 ± 0	10
SHW-302-C-M-22	-157 ± 296	540	-4 ± 12	77	41 ± 153	272	0.0 ± 0	10
Average	-129		-3		77		0.3	
Median	-118		-3		78		0.0	
Minimum	-1246		-33		7		0.0	
Maximum	844		23		176		3.4	
Standard Deviation	566		15		40		1.0	

Indiana University -Swain Hall West Survey Results

Survey Unit: SHW-330

Class 1

Total Activity Measurement Results

Removable Activity Measurement Results

Location Code	Beta			Alpha			Beta			Alpha		
	dpm/100cm ²	MDC		dpm/100cm ²	MDC		dpm/100cm ²	MDC		dpm/100cm ²	MDC	
SHW-330-F-C-1	1050 ± 495	706		28 ± 55	77		101 ± 159	272		3.4 ± 7	10	
SHW-330-F-C-2	-147 ± 397	706		-4 ± 8	77		54 ± 155	272		0.0 ± 0	10	
SHW-330-F-C-3	-304 ± 393	706		-8 ± 28	77		74 ± 157	272		0.0 ± 0	10	
SHW-330-F-C-4	510 ± 438	706		14 ± 38	77		115 ± 161	272		0.0 ± 0	10	
SHW-330-F-C-5	981 ± 486	706		26 ± 89	77		115 ± 161	272		0.0 ± 0	10	
SHW-330-F-C-6	324 ± 423	706		9 ± 13	77		122 ± 162	272		0.0 ± 0	10	
SHW-330-F-C-7	2227 ± 661	706		60 ± 118	77		54 ± 155	272		0.0 ± 0	10	
SHW-330-W-G-8	441 ± 352	560		12 ± 23	77		-81 ± 143	272		0.0 ± 0	10	
SHW-330-W-P-9	-726 ± 439	779		-19 ± 29	77		88 ± 158	272		0.0 ± 0	10	
SHW-330-W-P-10	-883 ± 443	779		-24 ± 47	77		20 ± 152	272		0.0 ± 0	10	
SHW-330-W-P-11	697 ± 495	779		19 ± 23	77		41 ± 153	272		0.0 ± 0	10	
SHW-330-W-P-12	863 ± 511	779		23 ± 64	77		7 ± 150	272		6.7 ± 5	10	
SHW-330-W-P-13	-893 ± 443	779		-24 ± 81	77		74 ± 157	272		0.0 ± 0	10	
SHW-330-W-P-14	-716 ± 439	779		-19 ± 65	77		27 ± 152	272		3.4 ± 4	10	
SHW-330-W-W-15	-69 ± 335	598		-2 ± 5	77		155 ± 165	272		0.0 ± 0	10	
SHW-330-W-P-16	98 ± 451	779		3 ± 9	77		155 ± 165	272		0.0 ± 0	10	
SHW-330-W-P-17	481 ± 476	779		13 ± 25	77		54 ± 155	272		0.0 ± 0	10	
SHW-330-W-P-18	-304 ± 438	779		-8 ± 28	77		149 ± 165	272		0.0 ± 0	10	
SHW-330-W-P-19	-471 ± 436	779		-13 ± 35	77		-7 ± 149	272		0.0 ± 0	10	
SHW-330-W-P-20	530 ± 480	779		14 ± 48	77		14 ± 151	272		0.0 ± 0	10	
SHW-330-W-P-21	69 ± 450	779		2 ± 5	77		47 ± 154	272		0.0 ± 0	10	
SHW-330-W-P-22	118 ± 452	779		3 ± 11	77		209 ± 172	272		0.0 ± 0	10	
SHW-330-W-P-23	88 ± 451	779		2 ± 13	77		122 ± 162	272		0.0 ± 0	10	
SHW-330-C-P-24	-697 ± 438	779		-19 ± 37	77		155 ± 165	272		0.0 ± 0	10	
SHW-330-C-P-25	-500 ± 436	779		-13 ± 37	77		-7 ± 149	272		0.0 ± 0	10	
SHW-330-C-P-26	-883 ± 443	779		-24 ± 47	77		74 ± 157	272		0.0 ± 0	10	
SHW-330-C-P-27	-1432 ± 474	779		-38 ± 131	77		108 ± 160	272		0.0 ± 0	10	
Average	17			0			76			0.5		
Median	69			2			74			0.0		
Minimum	-1432			-38			-81			0.0		
Maximum	2227			60			209			6.7		
Standard Deviation	784			21			64			1.5		

Indiana University -Swain Hall West Survey Results

Survey Unit: SHW-331

Class 1

Total Activity Measurement Results

Removable Activity Measurement Results

Location Code	Beta			Alpha			Beta			Alpha		
	dpm/100cm ²	MDC		dpm/100cm ²	MDC		dpm/100cm ²	MDC		dpm/100cm ²	MDC	
SHW-331-F-C-1	-49 ± 401	706		-1 ± 3.7	77		41 ± 153	272		0.0 ± 0	10	
SHW-331-F-C-2	-118 ± 398	706		-3 ± 11	77		243 ± 176	272		0.0 ± 0	10	
SHW-331-F-C-3	-128 ± 398	706		-3 ± 9.5	77		196 ± 170	272		3.4 ± 7	10	
SHW-331-F-C-4	-265 ± 394	706		-7 ± 24	77		-7 ± -149	272		0.0 ± 0	10	
SHW-331-F-C-5	-461 ± 392	706		-12 ± 69	77		182 ± 169	272		0.0 ± 0	10	
SHW-331-F-C-6	726 ± 459	706		19 ± 38	77		81 ± 157	272		0.0 ± 0	10	
SHW-331-F-C-7	2423 ± 693	706		65 ± 128	77		122 ± 162	272		0.0 ± 0	10	
SHW-331-F-C-8	20 ± 404	706		1 ± 1.8	77		74 ± 157	272		0.0 ± 0	10	
SHW-331-W-G-9	-78 ± 312	560		-2 ± 7.2	77		142 ± 164	272		0.0 ± 0	10	
SHW-331-W-P-10	49 ± 449	779		1 ± 3.7	77		95 ± 159	272		0.0 ± 0	10	
SHW-331-W-P-11	-39 ± 445	779		-1 ± 2.9	77		122 ± 162	272		0.0 ± 0	10	
SHW-331-W-P-12	49 ± 449	779		1 ± 2.6	77		162 ± 166	272		0.0 ± 0	10	
SHW-331-W-P-13	108 ± 452	779		3 ± 9.8	77		142 ± 164	272		0.0 ± 0	10	
SHW-331-W-P-14	206 ± 457	779		6 ± 15	77		54 ± 155	272		0.0 ± 0	10	
SHW-331-W-P-15	324 ± 465	779		9 ± 30	77		54 ± 155	272		0.0 ± 0	10	
SHW-331-W-P-16	49 ± 449	779		1 ± 4.5	77		61 ± 155	272		0.0 ± 0	10	
SHW-331-W-P-17	196 ± 457	779		5 ± 15	77		122 ± 162	272		0.0 ± 0	10	
SHW-331-W-P-18	216 ± 458	779		6 ± 11	77		61 ± 155	272		0.0 ± 0	10	
SHW-331-W-P-19	275 ± 461	779		7 ± 15	77		236 ± 175	272		0.0 ± 0	10	
SHW-331-W-P-20	265 ± 461	779		7 ± 14	77		-7 ± -149	272		0.0 ± 0	10	
SHW-331-W-P-21	186 ± 456	779		5 ± 14	77		189 ± 169	272		0.0 ± 0	10	
SHW-331-W-P-22	235 ± 459	779		6 ± 18	77		101 ± 159	272		0.0 ± 0	10	
SHW-331-W-P-23	167 ± 455	779		4 ± 12	77		196 ± 170	272		0.0 ± 0	10	
SHW-331-W-P-24	98 ± 451	779		3 ± 5.2	77		203 ± 171	272		3.4 ± 7	10	
SHW-331-C-P-25	-49 ± 445	779		-1 ± 4.5	77		88 ± 158	272		0.0 ± 0	10	
SHW-331-C-P-26	-294 ± 438	779		5 ± 27	77		68 ± 156	272		0.0 ± 0	10	
SHW-331-C-P-27	-20 ± 446	779		-1 ± 1.5	77		169 ± 167	272		0.0 ± 0	10	
SHW-331-C-P-28	-29 ± 446	779		-1 ± 2.2	77		47 ± 154	272		0.0 ± 0	10	
SHW-331-C-P-29	-167 ± 441	779		-4 ± 15	77		-34 ± -147	272		0.0 ± 0	10	
SHW-331-C-P-30	-29 ± 446	779		-1 ± 1.6	77		81 ± 157	272		0.0 ± 0	10	
SHW-331-C-P-31	-235 ± 439	779		-6 ± 21	77		7 ± 150	272		0.0 ± 0	10	
SHW-331-C-P-32	-343 ± 437	779		-9 ± 26	77		81 ± 157	272		0.0 ± 0	10	
Average	103			3			105			0.2		
Median	35			1			92			0.0		
Minimum	-461			-12			-34			0.0		
Maximum	2423			65			243			3.4		
Standard Deviation	482			13			72			0.8		

Attachment 3
Verification Soil Samples Analytical Report



January 03, 2017

Mr. Paul Jones
Ameripysics, LLC
911 Cross Park Dr.
Knoxville, Tennessee 37923

Re: Ameripysics, LLC
Work Order: 413419

Dear Mr. Jones:

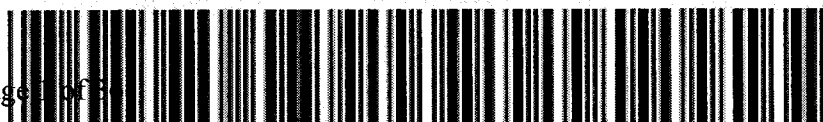
GEL Laboratories, LLC (GEL) appreciates the opportunity to provide the enclosed analytical results for the sample(s) we received on December 28, 2016. This original data report has been prepared and reviewed in accordance with GEL's standard operating procedures.

Our policy is to provide high quality, personalized analytical services to enable you to meet your analytical needs on time every time. We trust that you will find everything in order and to your satisfaction. If you have any questions, please do not hesitate to call me at (843) 556-8171, ext. 4453.

Sincerely,

Kaitlyn Stone for
Edith Kent
Project Manager

Purchase Order: 0316-001
Enclosures



GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis Report for

AMPH002 Ameripysics, LLC

Client SDG: 413419 GEL Work Order: 413419

The Qualifiers in this report are defined as follows:

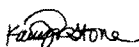
- * A quality control analyte recovery is outside of specified acceptance criteria
- ** Analyte is a Tracer compound
- ** Analyte is a surrogate compound
- U Analyte was analyzed for but not detected above the Lc
- U Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.
- UI Gamma Spectroscopy—Uncertain identification

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the Certificate of Analysis.

The designation ND, if present, appears in the result column when the analyte concentration is not detected above the limit as defined in the 'U' qualifier above.

This data report has been prepared and reviewed in accordance with GEL Laboratories LLC standard operating procedures. Please direct any questions to your Project Manager, Edith Kent.

Reviewed by



GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphysics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923
Contact: Mr. Paul Jones
Project: Ameriphysics, LLC

Client Sample ID: 1119-S18-SS-001
Sample ID: 413419001
Matrix: Soil
Collect Date: 20-DEC-16 08:00
Receive Date: 28-DEC-16
Collector: Client

Project: AMPH002
Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Actinium-228	U	0.0489	+/-0.151	0.310		pCi/g			MXR1	12/29/16	1219	1628237	1
Americium-241	U	-0.0896	+/-0.154	0.251		pCi/g							
Antimony-124	U	0.011	+/-0.0651	0.154		pCi/g							
Antimony-125	U	-0.0193	+/-0.0628	0.122		pCi/g							
Barium-133	U	0.00279	+/-0.0282	0.053		pCi/g							
Barium-140	U	0.145	+/-0.160	0.329		pCi/g							
Beryllium-7	U	-0.0568	+/-0.240	0.462		pCi/g							
Bismuth-207	U	0.0101	+/-0.0337	0.0745		pCi/g							
Bismuth-212	U	0.0199	+/-0.409	0.811		pCi/g							
Bismuth-214		0.446	+/-0.130	0.0863		pCi/g							
Cerium-139	U	0.0131	+/-0.0183	0.0398		pCi/g							
Cerium-141	U	0.00587	+/-0.0402	0.0822		pCi/g							
Cerium-144	U	-0.0149	+/-0.121	0.247		pCi/g							
Cesium-134	U	0.0112	+/-0.0296	0.064		pCi/g							
Cesium-136	U	-0.0413	+/-0.0594	0.0976		pCi/g							
Cesium-137	U	-0.0159	+/-0.0289	0.0517	0.100	pCi/g							
Chromium-51	U	0.179	+/-0.231	0.506		pCi/g							
Cobalt-56	U	-0.00859	+/-0.028	0.0525		pCi/g							
Cobalt-57	U	-0.00826	+/-0.0191	0.0337		pCi/g							
Cobalt-58	U	-0.0163	+/-0.0293	0.0435		pCi/g							
Cobalt-60	U	0.00331	+/-0.0271	0.0612		pCi/g							
Europium-152	U	-0.0399	+/-0.0743	0.131		pCi/g							
Europium-154	U	-0.00975	+/-0.0977	0.201		pCi/g							
Europium-155	U	0.0196	+/-0.0786	0.152		pCi/g							
Iridium-192	U	0.0105	+/-0.0253	0.0529		pCi/g							
Iron-59	U	0.0247	+/-0.0605	0.132		pCi/g							
Lead-210	U	3.19	+/-3.43	7.39		pCi/g							
Lead-212		0.239	+/-0.090	0.0786		pCi/g							
Lead-214		0.430	+/-0.132	0.219		pCi/g							
Manganese-54	U	0.00351	+/-0.0253	0.0527		pCi/g							
Mercury-203	U	-0.0216	+/-0.0257	0.0467		pCi/g							
Neodymium-147	U	-0.144	+/-0.272	0.499		pCi/g							
Neptunium-239	U	0.378	+/-0.433	0.432		pCi/g							
Niobium-94	U	-0.00493	+/-0.0268	0.0514		pCi/g							
Niobium-95	U	0.0179	+/-0.0326	0.0698		pCi/g							
Potassium-40		9.29	+/-1.28	0.539		pCi/g							

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphsics, LLC
Address : 911 Cross Park Dr.
Knoxville, Tennessee 37923
Contact: Mr. Paul Jones
Project: Ameriphsics, LLC

Client Sample ID: 1119-S18-SS-001
Sample ID: 413419001

Project: AMPH002
Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Promethium-144	U	-0.0538	+/-0.033	0.043		pCi/g							
Promethium-146	U	-0.0304	+/-0.0286	0.047		pCi/g							
Radium-228	U	0.0489	+/-0.151	0.310		pCi/g							
Ruthenium-106	U	-0.0622	+/-0.230	0.441		pCi/g							
Silver-110m	U	-0.00984	+/-0.0332	0.0632		pCi/g							
Sodium-22	U	0.000471	+/-0.0335	0.0708		pCi/g							
Thallium-208		0.100	+/-0.0626	0.0467		pCi/g							
Thorium-234	U	0.870	+/-2.58	1.92		pCi/g							
Tin-113	U	-0.0141	+/-0.0349	0.0659		pCi/g							
Uranium-235	U	0.0733	+/-0.153	0.297		pCi/g							
Uranium-238	U	0.870	+/-2.58	1.92		pCi/g							
Yttrium-88	U	0.0196	+/-0.0222	0.0704		pCi/g							
Zinc-65	U	0.009	+/-0.0604	0.115		pCi/g							
Zirconium-95	U	-0.000591	+/-0.0372	0.0788		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXC1	12/28/16	1325	1627937

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

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Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphsysics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923

Contact: Mr. Paul Jones
Project: Ameriphsysics, LLC

Client Sample ID: 1119-S18-SS-002
Sample ID: 413419002
Matrix: Soil
Collect Date: 20-DEC-16 08:15
Receive Date: 28-DEC-16
Collector: Client

Project: AMPH002
Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Actinium-228		0.449	+/-0.162	0.192		pCi/g			MXR1	12/29/16	1219	1628237	1
Americium-241	U	0.0066	+/-0.0244	0.0509		pCi/g							
Antimony-124	U	-0.0177	+/-0.0614	0.123		pCi/g							
Antimony-125	U	0.00438	+/-0.0548	0.113		pCi/g							
Barium-133	U	0.0114	+/-0.0236	0.048		pCi/g							
Barium-140	U	-0.0217	+/-0.120	0.234		pCi/g							
Beryllium-7	U	-0.0454	+/-0.215	0.373		pCi/g							
Bismuth-207	U	-0.000905	+/-0.0386	0.0769		pCi/g							
Bismuth-212	U	0.115	+/-0.380	0.761		pCi/g							
Bismuth-214		0.483	+/-0.119	0.0885		pCi/g							
Cerium-139	U	0.000276	+/-0.0135	0.027		pCi/g							
Cerium-141	U	0.0102	+/-0.0504	0.0484		pCi/g							
Cerium-144	U	0.0269	+/-0.0877	0.183		pCi/g							
Cesium-134	U	-0.00219	+/-0.0232	0.0481		pCi/g							
Cesium-136	U	-0.041	+/-0.0518	0.0892		pCi/g							
Cesium-137	U	0.000372	+/-0.0255	0.0501	0.100	pCi/g							
Chromium-51	U	-0.0518	+/-0.163	0.330		pCi/g							
Cobalt-56	U	0.00839	+/-0.0214	0.0481		pCi/g							
Cobalt-57	U	-0.00364	+/-0.00947	0.0189		pCi/g							
Cobalt-58	U	-0.00225	+/-0.0202	0.0422		pCi/g							
Cobalt-60	U	-0.00837	+/-0.0202	0.0379		pCi/g							
Europium-152	U	0.0112	+/-0.0556	0.117		pCi/g							
Europium-154	U	-0.000405	+/-0.0672	0.139		pCi/g							
Europium-155	U	0.0597	+/-0.0981	0.0747		pCi/g							
Iridium-192	U	0.00521	+/-0.0174	0.0375		pCi/g							
Iron-59	U	-0.0313	+/-0.0529	0.0949		pCi/g							
Lead-210	UI	0.00	+/-0.617	0.347		pCi/g							
Lead-212		0.314	+/-0.0789	0.0611		pCi/g							
Lead-214		0.492	+/-0.105	0.0755		pCi/g							
Manganese-54	U	0.0038	+/-0.0198	0.0432		pCi/g							
Mercury-203	U	0.0119	+/-0.0198	0.0406		pCi/g							
Neodymium-147	U	0.145	+/-0.241	0.527		pCi/g							
Neptunium-239	U	0.0346	+/-0.102	0.218		pCi/g							
Niobium-94	U	0.0054	+/-0.0248	0.0493		pCi/g							
Niobium-95	U	0.00286	+/-0.0271	0.0483		pCi/g							
Potassium-40		8.63	+/-1.20	0.543		pCi/g							

GEL LABORATORIES LLC

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Certificate of Analysis

Report Date: January 3, 2017

Company : Ameripysics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923

Contact: Mr. Paul Jones
Project: Ameripysics, LLC

Client Sample ID: 1119-S18-SS-002

Project: AMPH002

Sample ID: 413419002

Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Promethium-144	U	-0.00886	+/-0.0223	0.040		pCi/g							
Promethium-146	U	0.0117	+/-0.0225	0.050		pCi/g							
Radium-228		0.449	+/-0.162	0.192		pCi/g							
Ruthenium-106	U	0.033	+/-0.199	0.405		pCi/g							
Silver-110m	U	0.0311	+/-0.0321	0.0757		pCi/g							
Sodium-22	U	-0.00132	+/-0.0233	0.0478		pCi/g							
Thallium-208		0.0987	+/-0.0487	0.0441		pCi/g							
Thorium-234	UI	0.00	+/-0.941	0.508		pCi/g							
Tin-113	U	0.033	+/-0.0343	0.0412		pCi/g							
Uranium-235	U	0.0368	+/-0.182	0.177		pCi/g							
Uranium-238	UI	0.00	+/-0.941	0.508		pCi/g							
Yttrium-88	U	0.00464	+/-0.0295	0.0663		pCi/g							
Zinc-65	U	0.00152	+/-0.0589	0.106		pCi/g							
Zirconium-95	U	-0.00612	+/-0.036	0.0698		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXC1	12/28/16	1325	1627937

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC

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Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphysics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923

Contact: Mr. Paul Jones
Project: Ameriphysics, LLC

Client Sample ID: 1119-S18-SS-003
Sample ID: 413419003
Matrix: Soil
Collect Date: 20-DEC-16 08:30
Receive Date: 28-DEC-16
Collector: Client

Project: AMPH002

Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Actinium-228		0.315	+/-0.183	0.169		pCi/g			MXR1	12/29/16	1219	1628237	1
Americium-241	U	0.166	+/-0.145	0.316		pCi/g							
Antimony-124	U	0.0313	+/-0.0364	0.117		pCi/g							
Antimony-125	U	-0.047	+/-0.0639	0.114		pCi/g							
Barium-133	U	-0.00758	+/-0.0285	0.0492		pCi/g							
Barium-140	U	0.0758	+/-0.124	0.275		pCi/g							
Beryllium-7	U	0.0535	+/-0.209	0.431		pCi/g							
Bismuth-207	U	-0.0191	+/-0.0322	0.0598		pCi/g							
Bismuth-212	U	0.363	+/-0.604	0.879		pCi/g							
Bismuth-214		0.246	+/-0.129	0.137		pCi/g							
Cerium-139	U	-0.00673	+/-0.0192	0.0379		pCi/g							
Cerium-141	U	0.0247	+/-0.0773	0.0742		pCi/g							
Cerium-144	U	0.0107	+/-0.152	0.282		pCi/g							
Cesium-134	U	0.0068	+/-0.0223	0.0489		pCi/g							
Cesium-136	U	0.00282	+/-0.0578	0.120		pCi/g							
Cesium-137		0.0761	+/-0.0497	0.0463	0.100	pCi/g							
Chromium-51	U	-0.0209	+/-0.215	0.426		pCi/g							
Cobalt-56	U	0.0183	+/-0.0277	0.0607		pCi/g							
Cobalt-57	U	-0.00726	+/-0.0208	0.0368		pCi/g							
Cobalt-58	U	-0.000389	+/-0.0212	0.0431		pCi/g							
Cobalt-60	U	-0.00368	+/-0.022	0.0462		pCi/g							
Europium-152	U	0.0701	+/-0.0671	0.142		pCi/g							
Europium-154	U	0.00491	+/-0.0812	0.171		pCi/g							
Europium-155	U	-0.0449	+/-0.0877	0.156		pCi/g							
Iridium-192	U	-0.00245	+/-0.0208	0.0413		pCi/g							
Iron-59	U	-0.0111	+/-0.0579	0.116		pCi/g							
Lead-210	U	0.746	+/-6.24	12.4		pCi/g							
Lead-212		0.396	+/-0.083	0.0692		pCi/g							
Lead-214		0.524	+/-0.140	0.101		pCi/g							
Manganese-54	U	0.00399	+/-0.0257	0.0518		pCi/g							
Mercury-203	U	-0.0168	+/-0.0256	0.0476		pCi/g							
Neodymium-147	U	-0.00396	+/-0.287	0.567		pCi/g							
Neptunium-239	U	0.140	+/-0.203	0.406		pCi/g							
Niobium-94	U	0.00386	+/-0.0265	0.0525		pCi/g							
Niobium-95	U	0.00403	+/-0.0237	0.0452		pCi/g							
Potassium-40		7.76	+/-1.11	0.551		pCi/g							

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: January 3, 2017

Company : Ameripysics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923

Contact: Mr. Paul Jones
Project: Ameripysics, LLC

Client Sample ID: 1119-S18-SS-003

Project: AMPH002

Sample ID: 413419003

Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Promethium-144	U	-0.0128	+/-0.0277	0.0493		pCi/g							
Promethium-146	U	0.0151	+/-0.0281	0.0569		pCi/g							
Radium-228		0.315	+/-0.183	0.169		pCi/g							
Ruthenium-106	U	0.0468	+/-0.227	0.463		pCi/g							
Silver-110m	UI	0.00	+/-0.0941	0.0795		pCi/g							
Sodium-22	U	0.00602	+/-0.0279	0.0608		pCi/g							
Thallium-208		0.142	+/-0.0605	0.0575		pCi/g							
Thorium-234	U	-0.812	+/-1.35	2.49		pCi/g							
Tin-113	U	-0.0101	+/-0.0348	0.0588		pCi/g							
Uranium-235	U	0.220	+/-0.269	0.323		pCi/g							
Uranium-238	U	-0.812	+/-1.35	2.49		pCi/g							
Yttrium-88	U	-0.0122	+/-0.0311	0.0588		pCi/g							
Zinc-65	U	-0.0119	+/-0.0535	0.0941		pCi/g							
Zirconium-95	U	0.00764	+/-0.049	0.0991		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXC1	12/28/16	1325	1627937

The following Analytical Methods were performed:

Method	Description	Analyst Comments
I	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphysics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923

Contact: Mr. Paul Jones
Project: Ameriphysics, LLC

Client Sample ID: 1119-S18-SS-004
Sample ID: 413419004
Matrix: Soil
Collect Date: 20-DEC-16 08:45
Receive Date: 28-DEC-16
Collector: Client

Project: AMPH002
Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Actinium-228	UI	0.00	+/-0.212	0.253		pCi/g			MXR1	12/29/16	1220	1628237	1
Americium-241	U	-0.0568	+/-0.0855	0.174		pCi/g							
Antimony-124	U	0.0445	+/-0.075	0.207		pCi/g							
Antimony-125	U	-0.091	+/-0.0739	0.126		pCi/g							
Barium-133	U	0.0125	+/-0.0268	0.0563		pCi/g							
Barium-140	U	-0.0269	+/-0.159	0.328		pCi/g							
Beryllium-7	U	0.0378	+/-0.219	0.486		pCi/g							
Bismuth-207	U	0.0399	+/-0.0319	0.0961		pCi/g							
Bismuth-212	U	0.106	+/-0.422	0.925		pCi/g							
Bismuth-214		0.277	+/-0.127	0.124		pCi/g							
Cerium-139	U	0.00272	+/-0.0176	0.0363		pCi/g							
Cerium-141	U	-0.00703	+/-0.0355	0.0716		pCi/g							
Cerium-144	U	-0.0441	+/-0.117	0.231		pCi/g							
Cesium-134	U	0.0347	+/-0.0446	0.0785		pCi/g							
Cesium-136	U	-0.0388	+/-0.0712	0.124		pCi/g							
Cesium-137	UI	0.00	+/-0.0407	0.0521	0.100	pCi/g							
Chromium-51	U	0.187	+/-0.251	0.547		pCi/g							
Cobalt-56	U	-0.0202	+/-0.0362	0.0647		pCi/g							
Cobalt-57	U	0.00994	+/-0.0166	0.0361		pCi/g							
Cobalt-58	U	-0.00107	+/-0.0274	0.0584		pCi/g							
Cobalt-60	U	-0.0279	+/-0.0342	0.0578		pCi/g							
Europium-152	U	0.0564	+/-0.0776	0.169		pCi/g							
Europium-154	U	-0.0115	+/-0.083	0.184		pCi/g							
Europium-155	U	0.0575	+/-0.0678	0.152		pCi/g							
Iridium-192	U	0.00843	+/-0.0258	0.0531		pCi/g							
Iron-59	U	0.0273	+/-0.0674	0.161		pCi/g							
Lead-210	U	-0.257	+/-1.92	4.09		pCi/g							
Lead-212		0.303	+/-0.131	0.0906		pCi/g							
Lead-214		0.558	+/-0.140	0.268		pCi/g							
Manganese-54	U	-0.0078	+/-0.0242	0.0478		pCi/g							
Mercury-203	U	-0.0115	+/-0.0223	0.0402		pCi/g							
Neodymium-147	U	-0.0642	+/-0.268	0.557		pCi/g							
Neptunium-239	U	0.0815	+/-0.156	0.344		pCi/g							
Niobium-94	U	-0.0208	+/-0.0304	0.0539		pCi/g							
Niobium-95	U	-0.0241	+/-0.0382	0.0688		pCi/g							
Potassium-40		9.41	+/-1.50	0.461		pCi/g							

GEL LABORATORIES LLC

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Certificate of Analysis

Report Date: January 3, 2017

Company : Ameripysics, LLC
Address : 911 Cross Park Dr.
Knoxville, Tennessee 37923
Contact: Mr. Paul Jones
Project: Ameripysics, LLC

Client Sample ID: 1119-S18-SS-004
Sample ID: 413419004

Project: AMPH002
Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Promethium-144	U	-0.0219	+/-0.0272	0.0467		pCi/g							
Promethium-146	U	-0.0315	+/-0.0319	0.0562		pCi/g							
Radium-228	UI	0.00	+/-0.212	0.253		pCi/g							
Ruthenium-106	U	-0.0413	+/-0.231	0.479		pCi/g							
Silver-110m	U	0.00604	+/-0.0479	0.100		pCi/g							
Sodium-22	U	-0.00406	+/-0.0292	0.0646		pCi/g							
Thallium-208		0.130	+/-0.0586	0.0659		pCi/g							
Thorium-234	U	0.0408	+/-0.811	1.76		pCi/g							
Tin-113	U	-0.00929	+/-0.0348	0.0712		pCi/g							
Uranium-235	U	0.187	+/-0.228	0.245		pCi/g							
Uranium-238	U	0.0408	+/-0.811	1.76		pCi/g							
Yttrium-88	U	-0.00414	+/-0.0229	0.0566		pCi/g							
Zinc-65	U	-0.0016	+/-0.0731	0.149		pCi/g							
Zirconium-95	U	0.0568	+/-0.0585	0.144		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXC1	12/28/16	1325	1627937

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphysics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923

Contact: Mr. Paul Jones
Project: Ameriphysics, LLC

Client Sample ID: 1119-S18-SS-005
Sample ID: 413419005
Matrix: Soil
Collect Date: 20-DEC-16 08:50
Receive Date: 28-DEC-16
Collector: Client

Project: AMPH002
Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Actinium-228	UI	0.00	+/-0.238	0.376		pCi/g			MXR1	12/29/16	1239	1628237	1
Americium-241	U	-0.0504	+/-0.133	0.237		pCi/g							
Antimony-124	U	-0.0172	+/-0.0639	0.130		pCi/g							
Antimony-125	U	-0.0391	+/-0.0778	0.142		pCi/g							
Barium-133	U	0.00896	+/-0.0298	0.0563		pCi/g							
Barium-140	U	-0.000435	+/-0.143	0.280		pCi/g							
Beryllium-7	U	0.197	+/-0.227	0.496		pCi/g							
Bismuth-207	U	-0.00214	+/-0.0395	0.0785		pCi/g							
Bismuth-212	U	0.190	+/-0.393	0.849		pCi/g							
Bismuth-214		0.320	+/-0.152	0.0965		pCi/g							
Cerium-139	U	-0.000126	+/-0.0178	0.0369		pCi/g							
Cerium-141	U	-0.00864	+/-0.0442	0.0746		pCi/g							
Cerium-144	U	0.0696	+/-0.140	0.279		pCi/g							
Cesium-134	U	0.0174	+/-0.0425	0.0737		pCi/g							
Cesium-136	U	-0.0361	+/-0.0644	0.116		pCi/g							
Cesium-137	U	0.00769	+/-0.0318	0.0609	0.100	pCi/g							
Chromium-51	U	0.0946	+/-0.209	0.443		pCi/g							
Cobalt-56	U	-0.0043	+/-0.0278	0.0554		pCi/g							
Cobalt-57	U	0.000308	+/-0.0185	0.0353		pCi/g							
Cobalt-58	U	0.0184	+/-0.024	0.0359		pCi/g							
Cobalt-60	U	0.00595	+/-0.0205	0.0494		pCi/g							
Europium-152	U	-0.00857	+/-0.0733	0.143		pCi/g							
Europium-154	U	-0.025	+/-0.0937	0.176		pCi/g							
Europium-155	U	-0.0361	+/-0.0738	0.136		pCi/g							
Iridium-192	U	-0.00538	+/-0.0218	0.0425		pCi/g							
Iron-59	U	0.00718	+/-0.0643	0.130		pCi/g							
Lead-210	U	-0.224	+/-3.99	8.13		pCi/g							
Lead-212		0.370	+/-0.0852	0.0732		pCi/g							
Lead-214		0.389	+/-0.141	0.0908		pCi/g							
Manganese-54	U	0.0272	+/-0.0358	0.053		pCi/g							
Mercury-203	U	0.0029	+/-0.024	0.0488		pCi/g							
Neodymium-147	U	0.0981	+/-0.292	0.600		pCi/g							
Neptunium-239	U	0.0694	+/-0.188	0.373		pCi/g							
Niobium-94	U	-0.0137	+/-0.0272	0.0516		pCi/g							
Niobium-95	U	-0.00375	+/-0.0305	0.0607		pCi/g							
Potassium-40		8.14	+/-1.14	0.514		pCi/g							

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphsysics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923

Contact: Mr. Paul Jones
Project: Ameriphsysics, LLC

Client Sample ID: 1119-S18-SS-005

Project: AMPH002

Sample ID: 413419005

Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Promethium-144	U	-0.0163	+/-0.0247	0.0458		pCi/g							
Promethium-146	U	0.00787	+/-0.036	0.0717		pCi/g							
Radium-228	UI	0.00	+/-0.238	0.376		pCi/g							
Ruthenium-106	U	-0.0946	+/-0.238	0.428		pCi/g							
Silver-110m	U	0.00105	+/-0.039	0.0792		pCi/g							
Sodium-22	U	-0.0081	+/-0.0331	0.0624		pCi/g							
Thallium-208		0.110	+/-0.0658	0.0497		pCi/g							
Thorium-234	U	0.321	+/-2.22	1.95		pCi/g							
Tin-113	U	-0.0238	+/-0.0333	0.0598		pCi/g							
Uranium-235	U	0.0497	+/-0.232	0.279		pCi/g							
Uranium-238	U	0.321	+/-2.22	1.95		pCi/g							
Yttrium-88	U	-0.0194	+/-0.0288	0.0504		pCi/g							
Zinc-65	U	0.00113	+/-0.0711	0.130		pCi/g							
Zirconium-95	U	0.0182	+/-0.0495	0.107		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXC1	12/28/16	1325	1627937

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

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Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphysics, LLC
 Address : 911 Cross Park Dr.
 Knoxville, Tennessee 37923
 Contact: Mr. Paul Jones
 Project: Ameriphysics, LLC

Client Sample ID: 1119-S18-SS-006	Project: AMPH002
Sample ID: 413419006	Client ID: AMPH002
Matrix: Soil	
Collect Date: 20-DEC-16 09:05	
Receive Date: 28-DEC-16	
Collector: Client	

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Actinium-228	U	0.285	+/-0.185	0.340		pCi/g			MXR1	12/29/16	1240	1628237	1
Americium-241	U	-0.10	+/-0.0862	0.139		pCi/g							
Antimony-124	U	-0.0271	+/-0.0577	0.105		pCi/g							
Antimony-125	U	-0.0228	+/-0.0565	0.107		pCi/g							
Barium-133	U	0.0237	+/-0.0291	0.060		pCi/g							
Barium-140	U	-0.0728	+/-0.136	0.245		pCi/g							
Beryllium-7	U	0.110	+/-0.216	0.459		pCi/g							
Bismuth-207	U	0.0162	+/-0.0258	0.0645		pCi/g							
Bismuth-212	U	-0.0542	+/-0.407	0.757		pCi/g							
Bismuth-214		0.311	+/-0.115	0.106		pCi/g							
Cerium-139	U	-0.00997	+/-0.0182	0.0322		pCi/g							
Cerium-141	U	-0.0128	+/-0.0313	0.0569		pCi/g							
Cerium-144	U	0.0236	+/-0.120	0.235		pCi/g							
Cesium-134	U	0.011	+/-0.0302	0.0625		pCi/g							
Cesium-136	U	-0.00192	+/-0.0564	0.115		pCi/g							
Cesium-137	U	-0.00721	+/-0.0276	0.0516	0.100	pCi/g							
Chromium-51	U	0.00895	+/-0.231	0.423		pCi/g							
Cobalt-56	U	-0.00989	+/-0.0276	0.0538		pCi/g							
Cobalt-57	U	0.00602	+/-0.0144	0.0291		pCi/g							
Cobalt-58	U	0.0121	+/-0.029	0.0602		pCi/g							
Cobalt-60	U	0.000377	+/-0.0311	0.0634		pCi/g							
Europium-152	U	0.00523	+/-0.0562	0.117		pCi/g							
Europium-154	U	-0.0213	+/-0.0988	0.190		pCi/g							
Europium-155	U	0.0359	+/-0.0626	0.129		pCi/g							
Iridium-192	U	0.00583	+/-0.0209	0.0437		pCi/g							
Iron-59	U	-0.00446	+/-0.0502	0.103		pCi/g							
Lead-210	U	-0.716	+/-2.07	4.08		pCi/g							
Lead-212		0.321	+/-0.0767	0.0757		pCi/g							
Lead-214		0.438	+/-0.128	0.215		pCi/g							
Manganese-54	U	0.00517	+/-0.0207	0.0463		pCi/g							
Mercury-203	U	-0.0174	+/-0.0211	0.0388		pCi/g							
Neodymium-147	U	0.254	+/-0.275	0.621		pCi/g							
Neptunium-239	U	0.194	+/-0.332	0.341		pCi/g							
Niobium-94	U	0.0115	+/-0.0263	0.0542		pCi/g							
Niobium-95	U	0.0213	+/-0.0277	0.0579		pCi/g							
Potassium-40		8.69	+/-1.26	0.573		pCi/g							

GEL LABORATORIES LLC

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Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphsics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923

Contact: Mr. Paul Jones
Project: Ameriphsics, LLC

Client Sample ID: 1119-S18-SS-006

Project: AMPH002

Sample ID: 413419006

Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Promethium-144	U	-0.0102	+/-0.0287	0.0513		pCi/g							
Promethium-146	U	-8.31E-05	+/-0.0293	0.0585		pCi/g							
Radium-228	U	0.285	+/-0.185	0.340		pCi/g							
Ruthenium-106	U	-0.0543	+/-0.227	0.428		pCi/g							
Silver-110m	U	-0.0198	+/-0.0307	0.0462		pCi/g							
Sodium-22	U	-0.00749	+/-0.0348	0.0667		pCi/g							
Thallium-208		0.084	+/-0.0518	0.0518		pCi/g							
Thorium-234	UI	0.00	+/-1.60	1.48		pCi/g							
Tin-113	U	-7.52E-05	+/-0.0271	0.0498		pCi/g							
Uranium-235	U	0.0302	+/-0.132	0.252		pCi/g							
Uranium-238	UI	0.00	+/-1.60	1.48		pCi/g							
Yttrium-88	U	-0.0147	+/-0.0226	0.0412		pCi/g							
Zinc-65	U	0.0361	+/-0.0483	0.112		pCi/g							
Zirconium-95	U	-0.0391	+/-0.0453	0.0717		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXC1	12/28/16	1325	1627937

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC

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Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphysics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923

Contact: Mr. Paul Jones
Project: Ameriphysics, LLC

Client Sample ID: 1119-S18-SS-007
Sample ID: 413419007
Matrix: Soil
Collect Date: 20-DEC-16 09:15
Receive Date: 28-DEC-16
Collector: Client

Project: AMPH002

Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Actinium-228	U	0.310	+/-0.205	0.356		pCi/g			MXR1	12/29/16	1240	1628237	1
Americium-241	U	-0.0135	+/-0.124	0.252		pCi/g							
Antimony-124	U	-0.0184	+/-0.068	0.138		pCi/g							
Antimony-125	U	-0.00124	+/-0.0552	0.113		pCi/g							
Barium-133	U	0.000958	+/-0.0301	0.0554		pCi/g							
Barium-140	U	-0.176	+/-0.156	0.246		pCi/g							
Beryllium-7	U	-0.237	+/-0.250	0.347		pCi/g							
Bismuth-207	U	-0.00818	+/-0.0352	0.0695		pCi/g							
Bismuth-212	U	0.843	+/-0.466	0.949		pCi/g							
Bismuth-214	U	0.383	+/-0.116	0.0909		pCi/g							
Cerium-139	U	0.0134	+/-0.0206	0.0418		pCi/g							
Cerium-141	U	0.0052	+/-0.0418	0.0805		pCi/g							
Cerium-144	U	0.0114	+/-0.134	0.261		pCi/g							
Cesium-134	U	0.0158	+/-0.0255	0.060		pCi/g							
Cesium-136	U	-0.0264	+/-0.0596	0.0939		pCi/g							
Cesium-137	U	0.0115	+/-0.0297	0.0617	0.100	pCi/g							
Chromium-51	U	0.0137	+/-0.225	0.459		pCi/g							
Cobalt-56	U	-0.00692	+/-0.0248	0.0496		pCi/g							
Cobalt-57	U	-0.0141	+/-0.0193	0.0344		pCi/g							
Cobalt-58	U	-0.00131	+/-0.0215	0.0459		pCi/g							
Cobalt-60	U	-0.0179	+/-0.0235	0.0378		pCi/g							
Europium-152	U	-0.00543	+/-0.0677	0.136		pCi/g							
Europium-154	U	0.0319	+/-0.0863	0.189		pCi/g							
Europium-155	U	0.00788	+/-0.076	0.151		pCi/g							
Iridium-192	U	0.00789	+/-0.0239	0.0503		pCi/g							
Iron-59	U	-0.0266	+/-0.0732	0.136		pCi/g							
Lead-210	U	3.08	+/-4.26	9.47		pCi/g							
Lead-212		0.314	+/-0.0893	0.0814		pCi/g							
Lead-214		0.313	+/-0.153	0.107		pCi/g							
Manganese-54	U	-0.0199	+/-0.0336	0.0523		pCi/g							
Mercury-203	U	-0.000783	+/-0.0218	0.0447		pCi/g							
Neodymium-147	U	0.447	+/-0.444	0.691		pCi/g							
Neptunium-239	U	-0.0483	+/-0.190	0.361		pCi/g							
Niobium-94	U	0.0104	+/-0.0224	0.0506		pCi/g							
Niobium-95	U	0.00322	+/-0.0325	0.067		pCi/g							
Potassium-40		8.81	+/-1.20	0.513		pCi/g							

GEL LABORATORIES LLC

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Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphsics, LLC
Address : 911 Cross Park Dr.
Knoxville, Tennessee 37923
Contact: Mr. Paul Jones
Project: Ameriphsics, LLC

Client Sample ID: 1119-S18-SS-007

Project: AMPH002

Sample ID: 413419007

Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Promethium-144	U	0.0167	+/-0.0231	0.0538		pCi/g							
Promethium-146	U	-0.025	+/-0.0284	0.0487		pCi/g							
Radium-228	U	0.310	+/-0.205	0.356		pCi/g							
Ruthenium-106	U	0.0146	+/-0.229	0.459		pCi/g							
Silver-110m	U	0.0162	+/-0.0361	0.0805		pCi/g							
Sodium-22	U	0.00892	+/-0.0298	0.0648		pCi/g							
Thallium-208		0.104	+/-0.0476	0.0378		pCi/g							
Thorium-234	U	1.11	+/-2.40	2.17		pCi/g							
Tin-113	U	0.00185	+/-0.0274	0.0565		pCi/g							
Uranium-235	U	0.0356	+/-0.156	0.305		pCi/g							
Uranium-238	U	1.11	+/-2.40	2.17		pCi/g							
Yttrium-88	U	-0.0163	+/-0.0184	0.0154		pCi/g							
Zinc-65	U	0.00147	+/-0.0653	0.134		pCi/g							
Zirconium-95	U	0.0184	+/-0.0442	0.100		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXC1	12/28/16	1325	1627937

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphsics, LLC
Address : 911 Cross Park Dr.
Knoxville, Tennessee 37923
Contact: Mr. Paul Jones
Project: Ameriphsics, LLC

Client Sample ID: 1119-S18-SS-008
Sample ID: 413419008
Matrix: Soil
Collect Date: 20-DEC-16 09:25
Receive Date: 28-DEC-16
Collector: Client

Project: AMPH002
Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Actinium-228		0.268	+/-0.161	0.168		pCi/g			MXR1	12/29/16	1240	1628237	1
Americium-241	U	0.0128	+/-0.0976	0.206		pCi/g							
Antimony-124	U	0.0385	+/-0.053	0.136		pCi/g							
Antimony-125	U	0.0428	+/-0.0511	0.119		pCi/g							
Barium-133	U	0.00885	+/-0.0226	0.0471		pCi/g							
Barium-140	U	0.025	+/-0.114	0.245		pCi/g							
Beryllium-7	U	0.112	+/-0.180	0.404		pCi/g							
Bismuth-207	U	0.00673	+/-0.0293	0.0622		pCi/g							
Bismuth-212	U	-0.0318	+/-0.289	0.580		pCi/g							
Bismuth-214		0.316	+/-0.143	0.0757		pCi/g							
Cerium-139	U	-0.00978	+/-0.0148	0.0279		pCi/g							
Cerium-141	U	0.00462	+/-0.0282	0.0587		pCi/g							
Cerium-144	U	-0.0286	+/-0.107	0.214		pCi/g							
Cesium-134	U	0.00398	+/-0.0229	0.0485		pCi/g							
Cesium-136	U	0.00357	+/-0.038	0.082		pCi/g							
Cesium-137	U	0.00868	+/-0.0257	0.0544	0.100	pCi/g							
Chromium-51	U	0.128	+/-0.167	0.366		pCi/g							
Cobalt-56	U	0.00291	+/-0.0184	0.040		pCi/g							
Cobalt-57	U	-0.00685	+/-0.0116	0.0228		pCi/g							
Cobalt-58	U	0.0022	+/-0.0214	0.0448		pCi/g							
Cobalt-60	U	-0.00983	+/-0.0235	0.0455		pCi/g							
Europium-152	U	0.0119	+/-0.0486	0.0998		pCi/g							
Europium-154	U	0.0703	+/-0.0642	0.165		pCi/g							
Europium-155	U	0.0142	+/-0.0554	0.119		pCi/g							
Iridium-192	U	-0.00191	+/-0.017	0.0329		pCi/g							
Iron-59	U	-0.0101	+/-0.048	0.0913		pCi/g							
Lead-210	U	-4.94	+/-3.87	7.63		pCi/g							
Lead-212		0.255	+/-0.110	0.0721		pCi/g							
Lead-214		0.455	+/-0.129	0.0752		pCi/g							
Manganese-54	U	-0.0113	+/-0.0238	0.0435		pCi/g							
Mercury-203	U	0.0119	+/-0.0325	0.0368		pCi/g							
Neodymium-147	U	-0.0546	+/-0.230	0.471		pCi/g							
Neptunium-239	U	0.0909	+/-0.147	0.323		pCi/g							
Niobium-94	U	0.00206	+/-0.017	0.0363		pCi/g							
Niobium-95	U	0.0147	+/-0.0257	0.0557		pCi/g							
Potassium-40		8.36	+/-1.04	0.471		pCi/g							

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: January 3, 2017

Company : Ameripysics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923

Contact: Mr. Paul Jones
Project: Ameripysics, LLC

Client Sample ID: 1119-S18-SS-008

Project: AMPH002

Sample ID: 413419008

Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Promethium-144	U	0.00451	+/-0.0209	0.0439		pCi/g							
Promethium-146	U	0.013	+/-0.0269	0.0591		pCi/g							
Radium-228		0.268	+/-0.161	0.168		pCi/g							
Ruthenium-106	U	-0.0346	+/-0.140	0.288		pCi/g							
Silver-110m	U	-0.00996	+/-0.032	0.0603		pCi/g							
Sodium-22	U	0.0242	+/-0.0224	0.0577		pCi/g							
Thallium-208		0.140	+/-0.0631	0.0403		pCi/g							
Thorium-234	UI	0.00	+/-2.67	1.60		pCi/g							
Tin-113	U	-0.0176	+/-0.0198	0.0372		pCi/g							
Uranium-235	U	-0.0338	+/-0.110	0.220		pCi/g							
Uranium-238	UI	0.00	+/-2.67	1.60		pCi/g							
Yttrium-88	U	0.0186	+/-0.0227	0.0621		pCi/g							
Zinc-65	U	-0.00429	+/-0.0545	0.0941		pCi/g							
Zirconium-95	U	-0.00677	+/-0.0384	0.0764		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXC1	12/28/16	1325	1627937

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC

2040 Savage Road Charleston SC 29407 - (843) 556-8171 - www.gel.com

Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphsics, LLC
Address : 911 Cross Park Dr.
Knoxville, Tennessee 37923
Contact: Mr. Paul Jones
Project: Ameriphsics, LLC

Client Sample ID: 1119-S18-SS-009
Sample ID: 413419009
Matrix: Soil
Collect Date: 20-DEC-16 09:35
Receive Date: 28-DEC-16
Collector: Client

Project: AMPH002
Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Actinium-228	UI	0.00	+/-0.248	0.494		pCi/g			MXR1	12/29/16	1241	1628237	1
Americium-241	U	0.0264	+/-0.0579	0.117		pCi/g							
Antimony-124	U	0.0444	+/-0.0682	0.185		pCi/g							
Antimony-125	U	0.00339	+/-0.0688	0.147		pCi/g							
Barium-133	U	-0.0042	+/-0.037	0.069		pCi/g							
Barium-140	U	0.0337	+/-0.167	0.357		pCi/g							
Beryllium-7	U	-0.0482	+/-0.245	0.495		pCi/g							
Bismuth-207	U	0.0109	+/-0.0467	0.0943		pCi/g							
Bismuth-212	U	0.378	+/-0.501	1.12		pCi/g							
Bismuth-214	UI	0.00	+/-0.153	0.241		pCi/g							
Cerium-139	U	-0.017	+/-0.0202	0.0362		pCi/g							
Cerium-141	U	0.0197	+/-0.0394	0.0831		pCi/g							
Cerium-144	U	-0.0844	+/-0.125	0.235		pCi/g							
Cesium-134	U	0.00265	+/-0.046	0.0913		pCi/g							
Cesium-136	U	0.0282	+/-0.0548	0.134		pCi/g							
Cesium-137	U	0.00346	+/-0.0356	0.0729	0.100	pCi/g							
Chromium-51	U	0.169	+/-0.261	0.590		pCi/g							
Cobalt-56	U	-0.0177	+/-0.037	0.0676		pCi/g							
Cobalt-57	U	0.0135	+/-0.0169	0.0372		pCi/g							
Cobalt-58	U	0.0239	+/-0.038	0.0834		pCi/g							
Cobalt-60	U	0.00269	+/-0.0303	0.0679		pCi/g							
Europium-152	U	-0.00712	+/-0.0759	0.159		pCi/g							
Europium-154	U	-0.0864	+/-0.106	0.177		pCi/g							
Europium-155	U	0.00386	+/-0.0669	0.139		pCi/g							
Iridium-192	U	-0.0058	+/-0.0278	0.0571		pCi/g							
Iron-59	U	0.0608	+/-0.0709	0.173		pCi/g							
Lead-210	U	0.475	+/-1.16	0.973		pCi/g							
Lead-212		0.250	+/-0.135	0.109		pCi/g							
Lead-214		0.523	+/-0.177	0.244		pCi/g							
Manganese-54	U	0.000554	+/-0.0355	0.0703		pCi/g							
Mercury-203	U	0.00504	+/-0.029	0.0572		pCi/g							
Neodymium-147	U	0.167	+/-0.299	0.691		pCi/g							
Neptunium-239	U	-0.076	+/-0.168	0.329		pCi/g							
Niobium-94	U	0.0205	+/-0.0316	0.0701		pCi/g							
Niobium-95	U	-0.0338	+/-0.0369	0.0595		pCi/g							
Potassium-40		8.64	+/-1.35	0.594		pCi/g							

GEL LABORATORIES LLC

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Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphsics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923
Contact: Mr. Paul Jones
Project: Ameriphsics, LLC

Client Sample ID: 1119-S18-SS-009

Project: AMPH002

Sample ID: 413419009

Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Promethium-144	U	-0.00637	+/-0.0308	0.0598		pCi/g							
Promethium-146	U	-0.00254	+/-0.0315	0.0659		pCi/g							
Radium-228	UI	0.00	+/-0.248	0.494		pCi/g							
Ruthenium-106	U	0.127	+/-0.274	0.606		pCi/g							
Silver-110m	U	-0.00331	+/-0.0389	0.0834		pCi/g							
Sodium-22	U	-0.0304	+/-0.0371	0.0623		pCi/g							
Thallium-208		0.119	+/-0.0576	0.0722		pCi/g							
Thorium-234	UI	0.00	+/-1.65	1.05		pCi/g							
Tin-113	U	-0.000489	+/-0.0365	0.0762		pCi/g							
Uranium-235	U	-0.179	+/-0.150	0.267		pCi/g							
Uranium-238	UI	0.00	+/-1.65	1.05		pCi/g							
Yttrium-88	U	0.00199	+/-0.0347	0.082		pCi/g							
Zinc-65	U	-0.0477	+/-0.0904	0.141		pCi/g							
Zirconium-95	U	0.0736	+/-0.0456	0.121		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXC1	12/28/16	1325	1627937

The following Analytical Methods were performed:

Method	Description	Analyst Comments
1	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC

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Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphsysics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923

Contact: Mr. Paul Jones
Project: Ameriphsysics, LLC

Client Sample ID: 1119-S18-SS-010
Sample ID: 413419010
Matrix: Soil
Collect Date: 20-DEC-16 09:45
Receive Date: 28-DEC-16
Collector: Client

Project: AMPH002
Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammaspec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Actinium-228	UI	0.00	+/-0.207	0.166		pCi/g			MXR1	12/29/16	1242	1628237	1
Americium-241	U	-0.0458	+/-0.102	0.201		pCi/g							
Antimony-124	U	-0.0104	+/-0.0203	0.0279		pCi/g							
Antimony-125	U	0.000732	+/-0.0545	0.113		pCi/g							
Barium-133	U	-0.0021	+/-0.0316	0.0576		pCi/g							
Barium-140	U	-0.0425	+/-0.125	0.241		pCi/g							
Beryllium-7	U	-0.0966	+/-0.182	0.345		pCi/g							
Bismuth-207	U	0.0117	+/-0.0345	0.0762		pCi/g							
Bismuth-212	U	0.962	+/-0.656	1.00		pCi/g							
Bismuth-214	UI	0.00	+/-0.154	0.217		pCi/g							
Cerium-139	U	-0.00473	+/-0.0171	0.0321		pCi/g							
Cerium-141	U	0.00602	+/-0.0343	0.0678		pCi/g							
Cerium-144	U	-0.0413	+/-0.124	0.234		pCi/g							
Cesium-134	U	0.0131	+/-0.0219	0.0507		pCi/g							
Cesium-136	U	-0.0146	+/-0.0507	0.101		pCi/g							
Cesium-137	UI	0.00	+/-0.0621	0.0463	0.100	pCi/g							
Chromium-51	U	0.0202	+/-0.184	0.388		pCi/g							
Cobalt-56	U	0.00122	+/-0.0216	0.0447		pCi/g							
Cobalt-57	U	-0.000659	+/-0.0156	0.0305		pCi/g							
Cobalt-58	U	-0.00191	+/-0.0217	0.0434		pCi/g							
Cobalt-60	U	-0.00568	+/-0.0234	0.0476		pCi/g							
Europium-152	U	-0.00498	+/-0.0655	0.133		pCi/g							
Europium-154	U	0.0104	+/-0.0662	0.147		pCi/g							
Europium-155	U	0.0149	+/-0.0629	0.129		pCi/g							
Iridium-192	U	-0.011	+/-0.0191	0.037		pCi/g							
Iron-59	U	-0.00553	+/-0.046	0.0963		pCi/g							
Lead-210	U	4.20	+/-7.44	7.51		pCi/g							
Lead-212		0.324	+/-0.0995	0.0715		pCi/g							
Lead-214		0.397	+/-0.151	0.199		pCi/g							
Manganese-54	U	0.00342	+/-0.0237	0.0445		pCi/g							
Mercury-203	U	0.00432	+/-0.0175	0.0382		pCi/g							
Neodymium-147	U	-0.0666	+/-0.207	0.409		pCi/g							
Neptunium-239	U	0.0328	+/-0.171	0.343		pCi/g							
Niobium-94	U	0.0023	+/-0.0259	0.0515		pCi/g							
Niobium-95	U	0.0101	+/-0.024	0.0492		pCi/g							
Potassium-40		8.17	+/-1.11	0.398		pCi/g							

GEL LABORATORIES LLC

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Certificate of Analysis

Report Date: January 3, 2017

Company : Ameriphsysics, LLC
Address : 911 Cross Park Dr.

Knoxville, Tennessee 37923

Contact: Mr. Paul Jones
Project: Ameriphsysics, LLC

Client Sample ID: 1119-S18-SS-010

Project: AMPH002

Sample ID: 413419010

Client ID: AMPH002

Parameter	Qualifier	Result	Uncertainty	MDC	RL	Units	PF	DF	Analyst	Date	Time	Batch	Method
Rad Gamma Spec Analysis													
Gammascpec, Gamma, Solid (Standard List) "Dry Weight Corrected"													
Promethium-144	U	0.0024	+/-0.023	0.0468		pCi/g							
Promethium-146	U	-0.000378	+/-0.0248	0.0512		pCi/g							
Radium-228	UI	0.00	+/-0.207	0.166		pCi/g							
Ruthenium-106	U	0.181	+/-0.307	0.418		pCi/g							
Silver-110m	U	-0.00934	+/-0.0307	0.0578		pCi/g							
Sodium-22	U	0.00298	+/-0.0231	0.0511		pCi/g							
Thallium-208		0.0997	+/-0.0532	0.0416		pCi/g							
Thorium-234	U	0.165	+/-1.08	2.33		pCi/g							
Tin-113	U	0.0021	+/-0.025	0.0526		pCi/g							
Uranium-235	U	0.0041	+/-0.130	0.241		pCi/g							
Uranium-238	U	0.165	+/-1.08	2.33		pCi/g							
Yttrium-88	U	0.0108	+/-0.0289	0.0679		pCi/g							
Zinc-65	U	-0.0454	+/-0.0522	0.0912		pCi/g							
Zirconium-95	U	0.00428	+/-0.0436	0.0892		pCi/g							

The following Prep Methods were performed:

Method	Description	Analyst	Date	Time	Prep Batch
Dry Soil Prep	Dry Soil Prep GL-RAD-A-021	CXC1	12/28/16	1325	1627937

The following Analytical Methods were performed:

Method	Description	Analyst Comments
I	DOE HASL 300, 4.5.2.3/Ga-01-R	

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

Column headers are defined as follows:

DF: Dilution Factor	Lc/LC: Critical Level
DL: Detection Limit	PF: Prep Factor
MDA: Minimum Detectable Activity	RL: Reporting Limit
MDC: Minimum Detectable Concentration	SQL: Sample Quantitation Limit

GEL LABORATORIES LLC

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QC Summary

Report Date: January 3, 2017

Page 1 of 9

Ameriphsics, LLC
911 Cross Park Dr.
Knoxville, Tennessee

Contact: Mr. Paul Jones

Workorder: 413419

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Gamma Spec											
Batch 1628237											
QC1203700168 413419001 DUP											
Actinium-228	U	0.0489	U	0.159	pCi/g	N/A		N/A MXR1		12/30/16	06:21
	Uncertainty	+/-0.151		+/-0.202							
Americium-241	U	-0.0896	U	0.000861	pCi/g	N/A		N/A			
	Uncertainty	+/-0.154		+/-0.0282							
Antimony-124	U	0.011	U	-0.00697	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0651		+/-0.0399							
Antimony-125	U	-0.0193	U	-0.0472	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0628		+/-0.0571							
Barium-133	U	0.00279	U	-0.00511	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0282		+/-0.0263							
Barium-140	U	0.145	U	0.0315	pCi/g	N/A		N/A			
	Uncertainty	+/-0.160		+/-0.120							
Beryllium-7	U	-0.0568	U	-0.0492	pCi/g	N/A		N/A			
	Uncertainty	+/-0.240		+/-0.174							
Bismuth-207	U	0.0101	U	0.0197	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0337		+/-0.0346							
Bismuth-212	U	0.0199	U	0.386	pCi/g	N/A		N/A			
	Uncertainty	+/-0.409		+/-0.340							
Bismuth-214		0.446		0.423	pCi/g	5.39		(0%-20%)			
	Uncertainty	+/-0.130		+/-0.130							
Cerium-139	U	0.0131	U	-0.000972	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0183		+/-0.0133							
Cerium-141	U	0.00587	U	-0.0202	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0402		+/-0.0297							
Cerium-144	U	-0.0149	U	-0.00576	pCi/g	N/A		N/A			
	Uncertainty	+/-0.121		+/-0.0785							
Cesium-134	U	0.0112	U	0.0106	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0296		+/-0.0328							
Cesium-136	U	-0.0413	U	-0.0416	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0594		+/-0.0559							
Cesium-137	U	-0.0159	U	0.0164	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0289		+/-0.0231							
Chromium-51	U	0.179	U	-0.103	pCi/g	N/A		N/A			
	Uncertainty	+/-0.231		+/-0.205							
Cobalt-56	U	-0.00859	U	-0.0188	pCi/g	N/A		N/A			
	Uncertainty	+/-0.028		+/-0.0253							
Cobalt-57	U	-0.00826	U	-0.0046	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0191		+/-0.012							
Cobalt-58	U	-0.0163	U	0.00249	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0293		+/-0.0247							

GEL LABORATORIES LLC

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QC Summary

Workorder: 413419

Page 2 of 9

Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Gamma Spec											
Batch 1628237											
Cobalt-60	U	0.00331	U	-0.00212	pCi/g	N/A		N/A	MXR1	12/30/16	06:21
	Uncertainty	+/-0.0271		+/-0.0231							
Europium-152	U	-0.0399	U	0.0394	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0743		+/-0.0527							
Europium-154	U	-0.00975	U	-0.109	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0977		+/-0.0747							
Europium-155	U	0.0196	U	0.0299	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0786		+/-0.0408							
Iridium-192	U	0.0105	U	0.000346	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0253		+/-0.0196							
Iron-59	U	0.0247	U	-0.0208	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0605		+/-0.0557							
Lead-210	U	3.19	UI	0.00	pCi/g	N/A		N/A			
	Uncertainty	+/-3.43		+/-0.620							
Lead-212		0.239		0.316	pCi/g	27.5		(0% - 100%)			
	Uncertainty	+/-0.090		+/-0.0722							
Lead-214		0.430		0.425	pCi/g	1.22		(0% - 100%)			
	Uncertainty	+/-0.132		+/-0.133							
Manganese-54	U	0.00351	U	-0.00818	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0253		+/-0.0213							
Mercury-203	U	-0.0216	U	0.0201	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0257		+/-0.0192							
Neodymium-147	U	-0.144	U	0.0607	pCi/g	N/A		N/A			
	Uncertainty	+/-0.272		+/-0.256							
Neptunium-239	U	0.378	U	0.105	pCi/g	N/A		N/A			
	Uncertainty	+/-0.433		+/-0.130							
Niobium-94	U	-0.00493	U	-0.00106	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0268		+/-0.0221							
Niobium-95	U	0.0179	U	-0.0235	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0326		+/-0.0238							
Potassium-40		9.29		8.43	pCi/g	9.74		(0%-20%)			
	Uncertainty	+/-1.28		+/-1.11							
Promethium-144	U	-0.0538	U	0.00547	pCi/g	N/A		N/A			
	Uncertainty	+/-0.033		+/-0.021							
Promethium-146	U	-0.0304	U	-0.00875	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0286		+/-0.023							
Radium-228	U	0.0489	U	0.159	pCi/g	N/A		N/A			
	Uncertainty	+/-0.151		+/-0.202							
Ruthenium-106	U	-0.0622	U	0.050	pCi/g	N/A		N/A			
	Uncertainty	+/-0.230		+/-0.172							
Silver-110m	U	-0.00984	U	-0.0145	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0332		+/-0.0247							

GEL LABORATORIES LLC

2040 Savage Road Charleston, SC 29407 - (843) 556-8171 - www.gel.com

QC Summary

Workorder: 413419

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Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Gamma Spec											
Batch	1628237										
Sodium-22	U	0.000471	U	-0.0392	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0335		+/-0.0261							
Thallium-208		0.100		0.117	pCi/g	15.2		(0% - 100%)	MXR1	12/30/16	06:21
	Uncertainty	+/-0.0626		+/-0.0472							
Thorium-234	U	0.870	UI	0.00	pCi/g	N/A		N/A			
	Uncertainty	+/-2.58		+/-0.973							
Tin-113	U	-0.0141	U	-0.00631	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0349		+/-0.0253							
Uranium-235	U	0.0733	U	0.0623	pCi/g	N/A		N/A			
	Uncertainty	+/-0.153		+/-0.105							
Uranium-238	U	0.870	UI	0.00	pCi/g	N/A		N/A			
	Uncertainty	+/-2.58		+/-0.973							
Yttrium-88	U	0.0196	U	-0.00638	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0222		+/-0.0189							
Zinc-65	U	0.009	U	0.0122	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0604		+/-0.0541							
Zirconium-95	U	-0.000591	U	-0.0127	pCi/g	N/A		N/A			
	Uncertainty	+/-0.0372		+/-0.0454							
QC1203700169 LCS											
Actinium-228			U	-2.05	pCi/g					12/29/16	12:43
	Uncertainty			+/-3.51							
Americium-241	489			520	pCi/g		106	(75%-125%)			
	Uncertainty			+/-5.65							
Antimony-124			U	0.593	pCi/g						
	Uncertainty			+/-0.610							
Antimony-125			U	-0.825	pCi/g						
	Uncertainty			+/-1.84							
Barium-133			U	-0.213	pCi/g						
	Uncertainty			+/-0.732							
Barium-140			U	-2.46	pCi/g						
	Uncertainty			+/-2.30							
Beryllium-7			U	2.38	pCi/g						
	Uncertainty			+/-5.99							
Bismuth-207			U	0.967	pCi/g						
	Uncertainty			+/-1.16							
Bismuth-212			U	0.914	pCi/g						
	Uncertainty			+/-8.24							
Bismuth-214			U	0.849	pCi/g						
	Uncertainty			+/-1.23							
Cerium-139			U	0.0158	pCi/g						
	Uncertainty			+/-0.340							
Cerium-141			U	-0.148	pCi/g						
	Uncertainty			+/-0.507							
Cerium-144			U	-0.776	pCi/g						
	Uncertainty										

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QC Summary

Workorder: 413419

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Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Gamma Spec											
Batch	1628237										
Cesium-134			U	+/-2.23 0.167	pCi/g				MXR1	12/29/16	12:43
	Uncertainty			+/-0.762							
Cesium-136			U	-0.492	pCi/g						
	Uncertainty			+/-1.13							
Cesium-137	178			178	pCi/g		100	(75%-125%)			
	Uncertainty			+/-3.71							
Chromium-51			U	0.803	pCi/g						
	Uncertainty			+/-4.03							
Cobalt-56			U	-0.238	pCi/g						
	Uncertainty			+/-0.776							
Cobalt-57				0.959	pCi/g						
	Uncertainty			+/-0.475							
Cobalt-58			U	0.424	pCi/g						
	Uncertainty			+/-0.703							
Cobalt-60	155			152	pCi/g		97.8	(75%-125%)			
	Uncertainty			+/-3.97							
Europium-152			U	-0.573	pCi/g						
	Uncertainty			+/-1.56							
Europium-154			U	-0.175	pCi/g						
	Uncertainty			+/-1.08							
Europium-155			U	-0.242	pCi/g						
	Uncertainty			+/-1.07							
Iridium-192			U	0.0285	pCi/g						
	Uncertainty			+/-0.489							
Iron-59			U	-0.218	pCi/g						
	Uncertainty			+/-1.72							
Lead-210				5670	pCi/g						
	Uncertainty			+/-50.6							
Lead-212			U	0.247	pCi/g						
	Uncertainty			+/-0.801							
Lead-214			U	0.264	pCi/g						
	Uncertainty			+/-1.29							
Manganese-54			U	-0.27	pCi/g						
	Uncertainty			+/-0.735							
Mercury-203			U	0.344	pCi/g						
	Uncertainty			+/-0.521							
Neodymium-147			U	-0.101	pCi/g						
	Uncertainty			+/-4.28							
Neptunium-239			U	1.17	pCi/g						
	Uncertainty			+/-3.36							
Niobium-94			U	0.230	pCi/g						
	Uncertainty			+/-0.553							

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QC Summary

Workorder: 413419

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Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Gamma Spec											
Batch	1628237										
Niobium-95			U	0.118	pCi/g						
	Uncertainty			+/-0.642							
Potassium-40			U	1.66	pCi/g				MXR1	12/29/16	12:43
	Uncertainty			+/-2.31							
Promethium-144			U	0.0387	pCi/g						
	Uncertainty			+/-0.529							
Promethium-146			U	-0.0147	pCi/g						
	Uncertainty			+/-0.954							
Radium-228			U	-2.05	pCi/g						
	Uncertainty			+/-3.51							
Ruthenium-106			U	-3.64	pCi/g						
	Uncertainty			+/-5.35							
Silver-110m			U	-0.255	pCi/g						
	Uncertainty			+/-1.27							
Sodium-22			U	-0.0529	pCi/g						
	Uncertainty			+/-0.381							
Thallium-208			U	0.311	pCi/g						
	Uncertainty			+/-0.620							
Thorium-234			U	2.44	pCi/g						
	Uncertainty			+/-8.50							
Tin-113			U	-0.354	pCi/g						
	Uncertainty			+/-0.779							
Uranium-235			U	-0.921	pCi/g						
	Uncertainty			+/-2.21							
Uranium-238			U	2.44	pCi/g						
	Uncertainty			+/-8.50							
Yttrium-88			U	0.205	pCi/g						
	Uncertainty			+/-0.326							
Zinc-65			U	2.72	pCi/g						
	Uncertainty			+/-1.91							
Zirconium-95			U	-0.728	pCi/g						
	Uncertainty			+/-1.14							
QC1203700167	MB										
Actinium-228			U	0.0503	pCi/g					12/29/16	12:42
	Uncertainty			+/-0.0779							
Americium-241			U	-0.0104	pCi/g						
	Uncertainty			+/-0.0933							
Antimony-124			U	-0.04	pCi/g						
	Uncertainty			+/-0.0542							
Antimony-125			U	0.00257	pCi/g						
	Uncertainty			+/-0.0315							
Barium-133			U	0.00187	pCi/g						
	Uncertainty			+/-0.019							
Barium-140			U	0.0105	pCi/g						
	Uncertainty										

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QC Summary

Workorder: 413419

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Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Gamma Spec											
Batch	1628237										
Beryllium-7			U	+/-0.0562 0.0313	pCi/g				MXR1	12/29/16	12:42
	Uncertainty			+/-0.125							
Bismuth-207			U	0.029	pCi/g						
	Uncertainty			+/-0.0307							
Bismuth-212			U	0.198	pCi/g						
	Uncertainty			+/-0.266							
Bismuth-214			U	-0.00195	pCi/g						
	Uncertainty			+/-0.0394							
Cerium-139			U	0.00253	pCi/g						
	Uncertainty			+/-0.00926							
Cerium-141			U	0.000884	pCi/g						
	Uncertainty			+/-0.0173							
Cerium-144			U	0.0101	pCi/g						
	Uncertainty			+/-0.061							
Cesium-134			U	-0.00241	pCi/g						
	Uncertainty			+/-0.0195							
Cesium-136			U	0.00765	pCi/g						
	Uncertainty			+/-0.019							
Cesium-137			U	0.00894	pCi/g						
	Uncertainty			+/-0.0188							
Chromium-51			U	0.107	pCi/g						
	Uncertainty			+/-0.117							
Cobalt-56			U	-0.000186	pCi/g						
	Uncertainty			+/-0.0138							
Cobalt-57			U	-0.00104	pCi/g						
	Uncertainty			+/-0.00999							
Cobalt-58			U	-0.000395	pCi/g						
	Uncertainty			+/-0.0162							
Cobalt-60			U	1.68E-05	pCi/g						
	Uncertainty			+/-0.0191							
Europium-152			U	-0.00112	pCi/g						
	Uncertainty			+/-0.0468							
Europium-154			U	-0.0265	pCi/g						
	Uncertainty			+/-0.0492							
Europium-155			U	0.0135	pCi/g						
	Uncertainty			+/-0.0445							
Iridium-192			U	-0.00245	pCi/g						
	Uncertainty			+/-0.0148							
Iron-59			U	0.0173	pCi/g						
	Uncertainty			+/-0.0413							
Lead-210			U	2.50	pCi/g						
	Uncertainty			+/-3.90							

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QC Summary

Workorder: 413419

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Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Gamma Spec											
Batch 1628237											
Lead-212			U	0.00783	pCi/g						
	Uncertainty			+/-0.0513							
Lead-214			U	0.0226	pCi/g				MXR1	12/29/16	12:42
	Uncertainty			+/-0.0325							
Manganese-54			U	-0.0075	pCi/g						
	Uncertainty			+/-0.0144							
Mercury-203			U	0.00609	pCi/g						
	Uncertainty			+/-0.0123							
Neodymium-147			U	-0.0326	pCi/g						
	Uncertainty			+/-0.112							
Neptunium-239			U	-0.0452	pCi/g						
	Uncertainty			+/-0.129							
Niobium-94			U	-0.00128	pCi/g						
	Uncertainty			+/-0.0176							
Niobium-95			U	-0.00161	pCi/g						
	Uncertainty			+/-0.0173							
Potassium-40			U	-0.152	pCi/g						
	Uncertainty			+/-0.222							
Promethium-144			U	-0.0108	pCi/g						
	Uncertainty			+/-0.0162							
Promethium-146			U	0.00914	pCi/g						
	Uncertainty			+/-0.0174							
Radium-228			U	0.0503	pCi/g						
	Uncertainty			+/-0.0779							
Ruthenium-106			U	-0.0964	pCi/g						
	Uncertainty			+/-0.143							
Silver-110m			U	-0.00404	pCi/g						
	Uncertainty			+/-0.0272							
Sodium-22			U	-0.00604	pCi/g						
	Uncertainty			+/-0.016							
Thallium-208			U	-0.00975	pCi/g						
	Uncertainty			+/-0.0163							
Thorium-234			U	0.661	pCi/g						
	Uncertainty			+/-2.21							
Tin-113			U	-0.00825	pCi/g						
	Uncertainty			+/-0.0173							
Uranium-235			U	-0.0347	pCi/g						
	Uncertainty			+/-0.078							
Uranium-238			U	0.661	pCi/g						
	Uncertainty			+/-2.21							
Yttrium-88			U	-0.00527	pCi/g						
	Uncertainty			+/-0.0103							
Zinc-65			U	0.00683	pCi/g						
	Uncertainty			+/-0.0291							

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QC Summary

Workorder: 413419

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Parmname	NOM	Sample Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
Rad Gamma Spec										
Batch	1628237									
Zirconium-95		U	-0.00846	pCi/g						
	Uncertainty		+/-0.0252							

Notes:

Counting Uncertainty is calculated at the 95% confidence level (1.96-sigma).

The Qualifiers in this report are defined as follows:

- ** Analyte is a Tracer compound
- < Result is less than value reported
- > Result is greater than value reported
- BD Results are either below the MDC or tracer recovery is low
- FA Failed analysis.
- H Analytical holding time was exceeded
- J Value is estimated
- K Analyte present. Reported value may be biased high. Actual value is expected to be lower.
- L Analyte present. Reported value may be biased low. Actual value is expected to be higher.
- M M if above MDC and less than LLD
- M REMP Result > MDC/CL and < RDL
- N/A RPD or %Recovery limits do not apply.
- N1 See case narrative
- ND Analyte concentration is not detected above the detection limit
- NJ Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
- Q One or more quality control criteria have not been met. Refer to the applicable narrative or DER.
- R Sample results are rejected
- U Analyte was analyzed for but not detected above the Lc
- U Analyte was analyzed for, but not detected above the MDL, MDA, MDC or LOD.
- UI Gamma Spectroscopy--Uncertain identification
- UJ Gamma Spectroscopy--Uncertain identification
- UL Not considered detected. The associated number is the reported concentration, which may be inaccurate due to a low bias.
- X Consult Case Narrative, Data Summary package, or Project Manager concerning this qualifier
- Y Other specific qualifiers were required to properly define the results. Consult case narrative.
- ^ RPD of sample and duplicate evaluated using +/-RL. Concentrations are <5X the RL. Qualifier Not Applicable for Radiochemistry.
- h Preparation or preservation holding time was exceeded

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QC Summary

Workorder: 413419

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Parmname	NOM	Sample	Qual	QC	Units	RPD%	REC%	Range	Anlst	Date	Time
----------	-----	--------	------	----	-------	------	------	-------	-------	------	------

N/A indicates that spike recovery limits do not apply when sample concentration exceeds spike conc. by a factor of 4 or more or %RPD not applicable.

^ The Relative Percent Difference (RPD) obtained from the sample duplicate (DUP) is evaluated against the acceptance criteria when the sample is greater than five times (5X) the contract required detection limit (RL). In cases where either the sample or duplicate value is less than 5X the RL, a control limit of +/- the RL is used to evaluate the DUP result.

* Indicates that a Quality Control parameter was not within specifications.

For PS, PSD, and SDILT results, the values listed are the measured amounts, not final concentrations.

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless qualified on the QC Summary.

**Radiochemistry
Technical Case Narrative
Ameriphsysics, LLC (AMPH)
SDG #: 413419**

Product: Gammaspec, Gamma, Solid (Standard List)

Analytical Method: DOE HASL 300, 4.5.2.3/Ga-01-R

Analytical Procedure: GL-RAD-A-013 REV# 25

Analytical Batch: 1628237

Preparation Method: Dry Soil Prep

Preparation Procedure: GL-RAD-A-021 REV# 20

Preparation Batch: 1627937

The following samples were analyzed using the above methods and analytical procedure(s).

<u>GEL Sample ID#</u>	<u>Client Sample Identification</u>
413419001	1119-S18-SS-001
413419002	1119-S18-SS-002
413419003	1119-S18-SS-003
413419004	1119-S18-SS-004
413419005	1119-S18-SS-005
413419006	1119-S18-SS-006
413419007	1119-S18-SS-007
413419008	1119-S18-SS-008
413419009	1119-S18-SS-009
413419010	1119-S18-SS-010
1203700167	Method Blank (MB)
1203700168	413419001(1119-S18-SS-001) Sample Duplicate (DUP)
1203700169	Laboratory Control Sample (LCS)

The samples in this SDG were analyzed on a "dry weight" basis.

Data Summary:

There are no exceptions, anomalies or deviations from the specified methods. All sample data provided in this report met the acceptance criteria specified in the analytical methods and procedures for initial calibration, continuing calibration, instrument controls and process controls where applicable.

Qualifier Information

Qualifier	Reason	Analyte	Sample	Client Sample
UI	Data rejected due to high counting uncertainty.	Actinium-228	413419004	1119-S18-SS-004
			413419010	1119-S18-SS-010

		Lead-210	413419002	1119-S18-SS-002
			1203700168	1119-S18-SS-001(413419001DUP)
		Radium-228	413419004	1119-S18-SS-004
			413419010	1119-S18-SS-010
		Thorium-234	413419002	1119-S18-SS-002
			413419006	1119-S18-SS-006
			413419008	1119-S18-SS-008
			413419009	1119-S18-SS-009
			1203700168	1119-S18-SS-001(413419001DUP)
		Uranium-238	413419002	1119-S18-SS-002
			413419006	1119-S18-SS-006
			413419008	1119-S18-SS-008
			413419009	1119-S18-SS-009
			1203700168	1119-S18-SS-001(413419001DUP)
UI	Data rejected due to high peak-width.	Cesium-137	413419010	1119-S18-SS-010
UI	Data rejected due to low abundance.	Actinium-228	413419005	1119-S18-SS-005
			413419009	1119-S18-SS-009
		Bismuth-214	413419009	1119-S18-SS-009
			413419010	1119-S18-SS-010
		Radium-228	413419005	1119-S18-SS-005
			413419009	1119-S18-SS-009
		Silver-110m	413419003	1119-S18-SS-003
UI	Data rejected due to no valid peak.	Cesium-137	413419004	1119-S18-SS-004

Certification Statement

Where the analytical method has been performed under NELAP certification, the analysis has met all of the requirements of the NELAC standard unless otherwise noted in the analytical case narrative.

Page: _____ of _____
Project #: 1119-16
GEL Quote #: _____
COC Number ⁽¹⁾: _____
PO Number: 0316-00!

GEL Chain of Custody and Analytical Request

****See www.gel.com for GEL's Sample Acceptance SOP****

GEL Work Order Number:

413419

GEL Laboratories, LLC
2040 Savage Road
Charleston, SC 29407
Phone: (843) 556-8171
Fax: (843) 766-1178



Client Name: Ameriphsysics LLC / Tim Pratt						Phone #: 865-386-8066			Sample Analysis Requested ⁽⁵⁾ (Fill in the number of containers for each test)																		
Project/Site Name: 1119-16 IU Swain Hall						Fax #: 865-470-4179			Should this sample be considered:	Total number of containers	Gamma Spec. *													Preservative Type (6)			
Address: 9111 Cross Park Dr. Ste. D200, Knoxville, TN 37923						Radioactive	TSCA Regulated	Comments Note: extra sample is required for sample specific QC																			
Collected by: Tim Pratt									Send Results: via email: tpratt@ameriphsysics.com																		
Sample ID <i>* For composites - indicate start and stop date/time</i>		*Date Collected (mm-dd-yy)	*Time Collected (Military) (hhmm)	QC Code (^a)	Field Filtered (^b)	Sample Matrix (^c)																					
1119-S18-SS-001		12/20/2016	8:00	N	N	SO	Y	N	1	X																	
1119-S18-SS-002		12/20/2016	8:15	N	N	SO	Y	N	1	X																	
1119-S18-SS-003		12/20/2016	8:30	N	N	SO	Y	N	1	X																	
1119-S18-SS-004		12/20/2016	8:45	N	N	SO	Y	N	1	X																	
1119-S18-SS-005		12/20/2016	8:50	N	N	SO	Y	N	1	X																	
1119-S18-SS-006		12/20/2016	9:05	N	N	SO	Y	N	1	X																	
1119-S18-SS-007		12/20/2016	9:15	N	N	SO	Y	N	1	X																	
1119-S18-SS-008		12/20/2016	9:25	N	N	SO	Y	N	1	X																	
1119-S18-SS-009		12/20/2016	9:35	N	N	SO	Y	N	1	X																	
1119-S18-SS-010		12/20/2016	9:45	N	N	SO	Y	N	1	X																	
TAT Requested: Normal:			Rush: 5 day Specify:			(Subject to Surcharge)			Fax Results:			Yes / No			Circle Deliverable: C of A / QC Summary / Level 1 / Level 2 / Level 3 / Level 4												

**All detectable Gamma Emitters. Use your standard library.*

Specific Gamma Emitting Radionuclides suspected: Bi-207, Co-60, Cs-137, Eu-152, Eu-154. No Ra-226

Sample Collection Time Zone

Eastern	Pacific
Central	Other _____
Mountain	

Chain of Custody Signatures						Sample Shipping and Delivery Details	
Relinquished By (Signed)	Date	Time	Received by (signed)	Date	Time		
1 	12/27/16	0930	1 	12/28/16 @ 0900		GEL PM: Edie Kent	
2			2			Method of Shipment: Fed Ex	Date Shipped: 12/15/16
3			3			Airbill #: 7780 4501 3572	
						Airbill #:	

1.) Chain of Custody Number = Client Determined

2.) OC Codes: N = Normal Sample, TB = Trip Blank, FD = Field Duplicate, EB = Equipment Blank, MS = Matrix Spike Sample, MSD = Matrix Spike Duplicate Sample, G = Grab, C = Composite

3.) Field Filtered: For liquid matrices, indicate with a - Y - for yes the sample was field filtered or - N - for sample was not field filtered.

4.) Matrix Codes: **DW**=Drinking Water, **GW**=Groundwater, **SW**=Surface Water, **WW**=Waste Water, **W**=Water, **ML**=Misc Liquid, **SO**=Soil, **SD**=Sediment, **SL**=Sludge, **SS**=Solid Waste, **O**=Oil, **F**=Filter, **P**=Wipe, **U**=Urine, **F**=Fecal, **N**=Nasal

5.) Sample Analysis Requested: Analytical method requested (i.e. 8260B, 6010B/7470A) and number of containers provided for each (i.e. 8260B - 3, 6010B/7470A - 1).

6.) Preservative Type: **HA** = Hydrochloric Acid, **NI** = Nitric Acid, **SH** = Sodium Hydroxide, **SA** = Sulfuric Acid, **AA** = Ascorbic Acid, **HX** = Hexane, **ST** = Sodium Thiosulfate. If no preservative is added = leave field blank

WHITE = LABORATORY

YELLOW = FILE

PINK = CLIENT

For Lab Receiving Use Only

Custody Seal Intact?

YES NO

Cooler Temp: _____

C

SAMPLE RECEIPT & REVIEW FORM

Client: <u>Amph</u>			SDG/AR/COC/Work Order:		
Received By: <u>AG</u>			Date Received: <u>12/28/16</u>		
Suspected Hazard Information		Yes	No	*If Net Counts > 100cpm on samples not marked "radioactive", contact the Radiation Safety Group for further investigation.	
COC/Samples marked as radioactive?		<input checked="" type="checkbox"/>	<input type="checkbox"/>	Maximum Net Counts Observed* (Observed Counts - Area Background Counts): <u>0 cpm</u>	
Classified Radioactive II or III by RSO?		<input type="checkbox"/>	<input type="checkbox"/>	If yes, Were swipes taken of sample containers < action levels?	
COC/Samples marked containing PCBs?		<input type="checkbox"/>	<input type="checkbox"/>		
Package, COC, and/or Samples marked as beryllium or asbestos containing?		<input type="checkbox"/>	<input type="checkbox"/>	If yes, samples are to be segregated as Safety Controlled Samples, and opened by the GEL Safety Group.	
Shipped as a DOT Hazardous?		<input type="checkbox"/>	<input type="checkbox"/>	Hazard Class Shipped: UN#:	
Samples identified as Foreign Soil?		<input type="checkbox"/>	<input type="checkbox"/>		

Sample Receipt Criteria	Yes	NA	No	Comments/Qualifiers (Required for Non-Conforming Items)
1 Shipping containers received intact and sealed?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Circle Applicable: Seals broken Damaged container Leaking container Other (describe)
2 Samples requiring cold preservation within (0 ≤ 6 deg. C)?*	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Preservation Method: Ice bags Blue ice Dry ice <u>None</u> Other (describe) <u>18°C</u> *all temperatures are recorded in Celsius
2a Daily check performed and passed on IR temperature gun?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Temperature Device Serial #: <u>E5102009185</u> Secondary Temperature Device Serial # (If Applicable):
3 Chain of custody documents included with shipment?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4 Sample containers intact and sealed?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Circle Applicable: Seals broken Damaged container Leaking container Other (describe)
5 Samples requiring chemical preservation at proper pH?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Sample ID's, containers affected and observed pH: If Preservation added, Lot#:
6 Do Low Level Perchlorate samples have headspace as required?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Sample ID's and containers affected:
7 VOA vials contain acid preservation?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	(If unknown, select No)
8 VOA vials free of headspace (defined as < 6mm bubble)?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Sample ID's and containers affected:
9 Are Encore containers present?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	(If yes, immediately deliver to Volatiles laboratory)
10 Samples received within holding time?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	ID's and tests affected:
11 Sample ID's on COC match ID's on bottles?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Sample ID's and containers affected:
12 Date & time on COC match date & time on bottles?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Sample ID's affected:
13 Number of containers received match number indicated on COC?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Sample ID's affected:
14 Are sample containers identifiable as GEL provided?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
15 COC form is properly signed in relinquished/received sections?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
16 Carrier and tracking number.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Circle Applicable: <u>FedEx Air</u> FedEx Ground UPS Field Services Courier Other <u>7780 4501 3572</u>

Comments (Use Continuation Form if needed):

PM (or PMA) review: Initials EMD Date 12/29/16 Page 1 of 1

List of current GEL Certifications as of 03 January 2017

State	Certification
Alaska	UST-0110
Arkansas	88-0651
CLIA	42D0904046
California	2940
Colorado	SC00012
Connecticut	PH-0169
Delaware	SC00012
DoD ELAP/ ISO17025 A2LA	2567.01
Florida NELAP	E87156
Foreign Soils Permit	P330-15-00283, P330-15-00253
Georgia	SC00012
Georgia SDWA	967
Hawaii	SC00012
Idaho Chemistry	SC00012
Idaho Radiochemistry	SC00012
Illinois NELAP	200029
Indiana	C-SC-01
Kansas NELAP	E-10332
Kentucky SDWA	90129
Kentucky Wastewater	90129
Louisiana NELAP	03046 (A133904)
Louisiana SDWA	LA170010
Maryland	270
Massachusetts	M-SC012
Michigan	9976
Mississippi	SC00012
Nebraska	NE-OS-26-13
Nevada	SC000122016-1
New Hampshire NELAP	205415
New Jersey NELAP	SC002
New Mexico	SC00012
New York NELAP	11501
North Carolina	233
North Carolina SDWA	45709
North Dakota	R-158
Oklahoma	9904
Pennsylvania NELAP	68-00485
S.Carolina Radchem	10120002
South Carolina Chemistry	10120001
Tennessee	TN 02934
Texas NELAP	T104704235-16-11
Utah NELAP	SC000122016-21
Vermont	VT87156
Virginia NELAP	460202
Washington	C780
West Virginia	997404

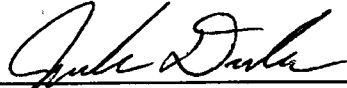
Attachment 4
Completed Final Status Survey Packages

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>243</u>	Page <u>1</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>243</u>		


Approvals

Prepared By:


Jordan Davidson,

12-12-16
Date

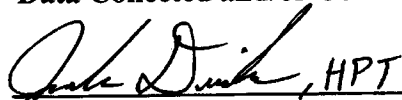
Reviewed By:


Tim Pratt, Project Manager

12/12/16
Date

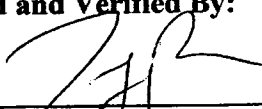
Completion and Review

Data Collected and/or Converted By:

 , HPT
Name, Title

12-17-16
Date

Reviewed and Verified By:


Tim Pratt, Project Manager

12/27/16
Date

Ameriphsyics LLC
Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>243</u>
MARSSIM Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2	<input type="checkbox"/> Class 3
Room Nos. Included in Survey Unit:	<u>243</u>		

Radionuclides of Historical Use:	Approximate Date of Last Use:
²⁰⁷ Bi, ¹⁴ C, ³⁶ Cl, ⁶⁰ Co, ¹³⁷ Cs, ¹⁵² Eu, ¹⁵⁴ Eu, ³ H, ⁶³ Ni, ²¹⁰ Pb, ²²⁶ Ra, ⁹⁰ Sr, ²⁰⁴ Tl, ²³⁵ U, ²³⁸ U	Unknown

Eliminated Due to Decay Since Date of Last Use:
None

Remaining Radionuclides of Concern:
²⁰⁷ Bi, ¹⁴ C, ³⁶ Cl, ⁶⁰ Co, ¹³⁷ Cs, ¹⁵² Eu, ¹⁵⁴ Eu, ³ H, ⁶³ Ni, ²¹⁰ Pb, ²²⁶ Ra, ⁹⁰ Sr, ²⁰⁴ Tl, ²³⁵ U, ²³⁸ U

Release Limits (DCGLs)			
	Total Activity Limits	Removable Activity Limit	Limits Based On:
Alpha	480 dpm/100 cm ²	48 dpm/100 cm ²	²³⁵ U
Beta/Gamma	7,100 dpm/100 cm ²	710 dpm/100 cm ²	⁶⁰ Co

Applicable Survey Unit Surfaces	% of Accessible Surface for Scan Surveys
<input checked="" type="checkbox"/> Floors	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Lower Walls	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Upper Walls	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Ceiling	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input type="checkbox"/> Structures (Interior and Exterior Surfaces)	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input type="checkbox"/> 100%

Required Survey Instrumentation	Measurement Type	Static Count Time:	Scan Rate	Efficiency Based On:
Ludlum 2360 w/ 43-68	Gross Alpha and Beta Total Activity	1 minute	5 cm/sec	Beta- ¹⁴ C Alpha- ²³⁰ Th
Ludlum 2360 w/ 43-37	Gross Alpha and Beta Scans	N/A	5 cm/sec	Beta- ¹⁴ C Alpha- ²³⁰ Th
Ludlum 3030E w/43-10-1	Gross Alpha and Beta Removable Activity	1 minute	N/A	Beta- ¹⁴ C Alpha- ²³⁰ Th
Liquid Scintillation Counter	Low Energy Beta Removable Activity	1 minute	N/A	³ H, ¹⁴ C
Other: <u>(Specify)</u>	N/A	N/A	N/A	N/A

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>243</u>	Page <u>3</u> of <u>12</u>
MARSSIM Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3
Room Nos. Included in Survey Unit:	243	

Survey Instructions	
1)	Perform the required scan surveys at the rate prescribed on the previous page. Document the performance of the scan survey on the attached survey maps using markings and legends as necessary to allow the reviewer enough information to verify that sufficient areas has been covered.
2)	The estimated number of static measurement locations needed for the statistical evaluation of this survey unit is 17.
3)	For Class 1 and Class 2 survey units, the locations are determined by using a random start point and a systematic spacing from this point. Due to this method, the actual number of plotted locations may vary. In this case, collect the actual locations provided on the survey map even if this number is greater than 17. For most cases, surveys are designed to plot 17-25 sample locations since the estimated required number of 17 locations was based on estimated result variations and averages.
4)	Locate and mark the required measurement locations using the provided survey map(s). Survey Maps have been provided with the required measurement locations. Sufficient detail has been provided on these maps to measure and locate all of these locations.
5)	Collect static measurements for gross beta and gross alpha at each identified location. Collect wipe samples for gross beta, gross alpha and LSC at each sample location. Document the results on the associated data results sheets. Additional measurements may be taken in suspect areas at the discretion of the Project Manager or survey technician. However, these additional locations are not included in the analysis of the statistical sample set.
6)	Notify the Project Manager if any static measurement or applicable removable contamination measurements exceeds the applicable investigation level.
7)	Ensure that all package information is completed and signed prior to turning in this Survey Package to the Project Manager for review.

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>243</u>	Page <u>4</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:		243

Location Code Description

A unique location code shall be assigned to each individual survey location to ensure proper data management of the survey results. The following format shall be used to ensure consistency throughout the final status survey process:

BBBB-RRRR-SS-M-LLL

Where:

- BBBB =** Building or area code. This field represents the facility area. This will be the building number or an assigned area number. (1 to 4 characters)
- RRRR =** Survey unit ID code. This field has been assigned based on the actual building room number or a specific number assigned by the Field Work Supervisor. (1 to 4 characters)
- SS =** Structural surface code. This field represents the structural surface such as floor, wall, ceiling, etc. and the surface division code. For example, if a room has a very large floor area it may be divided into two or more divisions and each section would be assigned unique codes such as F1, F2 and so on. Walls may be divided on a frequent basis. If only one surface area is identified for a particular survey area, then the default number will be "1" (e.g. W1, F1, etc.). (2 characters)
- M =** Structural material code. This field represents the type of structural material on which a particular measurement is taken. This field is used for background assignment, data sorting and analysis. The Field Work Supervisor assigns applicable codes. (1 character)
- LLL =** Numerical identification number. This field represents the survey point assigned numerical identifier. The field "001" means survey point location number 1. Numerical Identifiers shall not be duplicated within the same survey unit. (3 characters)

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>243</u>	Page <u>5</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:		<u>243</u>

Survey Unit Type: Building Surfaces and Structures

Survey Unit Area: 114.37 m²

Floor Area: 20.96 m²

Number of Samples used for Calculation (N): 20

X-axis dimension: 13.61 m

X Rand:¹ 0.819994957

Y-axis dimension: 14.02 m

Y Rand:¹ 0.959359156

X-Axis Start Location:² 11.16 m

Y-Axis Start Location:² 13.45 m

Sampling Spacing (L): 2.39 m

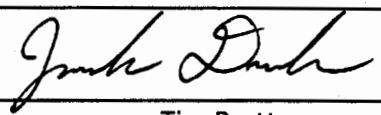
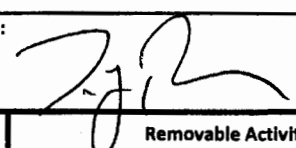
$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Note 2: X-Axis and Y-Axis start locations were calculated by multiplying the appropriate dimension by the corresponding random number.

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>243</u>	Page <u>6</u> of <u>12</u>
Marssim Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>243</u>		

Project Name: IU Swain Hall		Project Number: 1119-16		Survey Number: 1119-028		Date: 12/17/2016	
Time: 8:00							

Instrument / Detector	Serial Number	Cal. Due Date	Total Efficiency	Background (CPM)	Probe Area (cm ²)	Surveyor: Jordan Davidson
Ludlum 2360/Ludlum 43-37 (Alpha)	185769/PR216876	4/29/2017	8.68%	See Comments	584	Signature: 
Ludlum 2360/Ludlum 43-37 (Beta)	185769/PR216876	4/29/2017	7.20%	See Comments	584	
Ludlum 2360/Ludlum 43-68 (Alpha)	297722/PR216848	3/3/2017	7.87%	See Below	126	Reviewer: Tim Pratt
Ludlum 2360/Ludlum 43-68 (Beta)	297722/PR216848	3/3/2017	8.09%	See Below	126	
Ludlum 3030E/Ludlum 43-10-1 (Alpha)	328277/PR337587	3/3/2017	29.73%	0	100	Signature: 
Ludlum 3030E/Ludlum 43-10-1 (Beta)	328277/PR337587	3/3/2017	14.81%	69	100	

Location Code	Total Activity Results						Removable Activity Results			
	Alpha ¹			Beta-Gamma			Alpha		Beta-Gamma	
	Gross CPM	BKG	Net DPM/100 cm ²	Gross CPM	BKG	Net DPM/100 cm ²	Gross CPM	Net DPM/100 cm ²	Gross CPM	Net DPM/100 cm ²
SHW-243-F-C-1	0	1	46.5	397	220	1736	0	0.0	78	61
SHW-243-F-C-2	0	1	-7.4	192	220	-275	0	0.0	78	61
SHW-243-F-C-3	2	1	-6.8	194	220	-255	0	0.0	82	88
SHW-243-W-P-4	2	1	-4.7	252	270	-177	0	0.0	80	74
SHW-243-W-P-5	3	1	-7.9	240	270	-294	0	0.0	76	47
SHW-243-W-P-6	2	1	19.7	345	270	736	0	0.0	84	101
SHW-243-W-P-7	2	1	3.9	285	270	147	0	0.0	90	142
SHW-243-W-P-8	3	1	-17.9	202	270	-667	0	0.0	91	149
SHW-243-W-P-9	1	1	-27.6	165	270	-1030	0	0.0	74	34

Comments:	¹ See Comment #2 on the comments page regarding the alpha total activity values reported.
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$$\text{net DPM} / 100 \text{ cm}^2 = \frac{\text{Gross CPM} - \text{BKG}}{\text{Total Efficiency} \times A / 100}$$

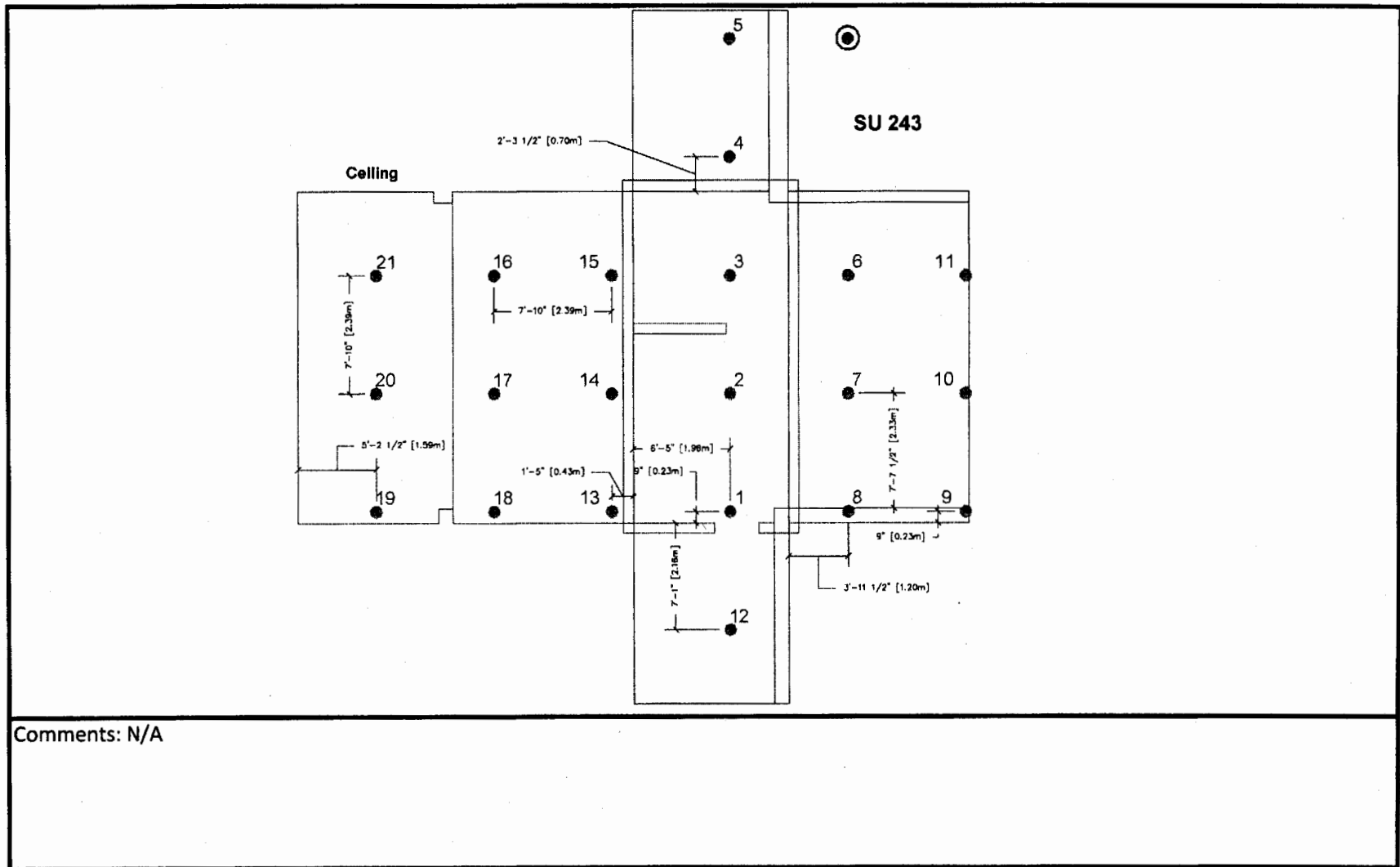
Final Status Survey Design Package

243

¹See Comment #2 on the comments page regarding the alpha total activity values reported.

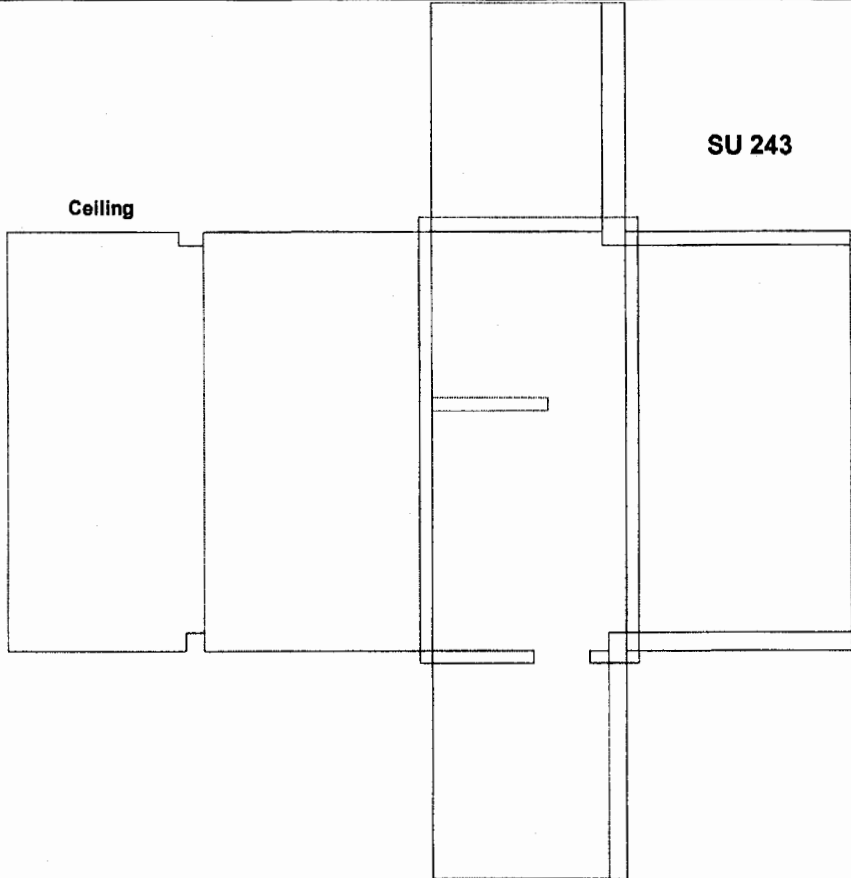
Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>243</u>	Page <u>8</u> of <u>12</u>
Marssim Classification:	<input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3	
Room Nos. Included in Survey Unit:	243	



Ameripysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>243</u>	Page <u>9</u> of <u>12</u>
Marssim Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>243</u>		

	<p>SU 243</p>
<p>Comments: Performed 100% scan for alpha and beta. No elevated activity detected.</p>	

Assay Definition-

SHW-243

Assay Description:

Assay Type: CPM

Report Name: Report1

Output Data Path: C:\Packard\Tricarb\Results\TJP\Ameriphsysics\20161220_1425

Raw Results Path: C:\Packard\Tricarb\Results\TJP\Ameriphsysics\20161220_1425\20161220_1425.results

Assay File Name: C:\Packard\TriCarb\Assays\Ameriphsysics.lsa

Count Conditions-

Nuclide: 3H-14C-Open

Quench Indicator: tSIE/AEC

External Std Terminator (sec): 0.5 2s%

Pre-Count Delay (min): 0.00

Quench Set: n/a

Count Time (min): 1.00

Count Mode: Normal

Assay Count Cycles: 1

Repeat Sample Count: 1

#Vials/Sample: 1

Calculate % Reference: Off

Background Subtract: On - IPA

Low CPM Threshold: Off

2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	9.05
B	12.0	156.0	6.05
C	0.0	2000.0	24.13

Count Corrections-

Static Controller: On

Luminescence Correction: Off

Colored Samples: n/a

Heterogeneity Monitor: n/a

Coincidence Time (nsec): 18

Delay Before Burst (nsec): 75

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count	Time	CPMA	CPMB	CPMC	SIS	MESSAGES	tSIE
1	1.00		2	7	11	40.40		473.66
2	1.00		2	9	12	78.51		444.60
3	1.00		0	4	2	148.99		433.68
4	1.00		0	9	12	163.51		562.19
5	1.00		5	5	15	83.94		582.55
6	1.00		5	5	17	54.50		513.47
7	1.00		5	6	16	83.57		605.99
8	1.00		5	3	24	138.55		589.23
9	1.00		0	6	10	241.16		578.97
10	1.00		6	15	27	124.24		595.81
11	1.00		3	0	2	156.96		596.52
12	1.00		3	5	8	89.93		588.97

SHW-0243

13	1.00	0	0	4	0.00	583.72
14	1.00	0	7	4	269.24	582.04
15	1.00	1	0	4	189.87	579.23
16	1.00	5	6	12	109.44	580.13
17	1.00	7	4	15	126.94	590.45
18	1.00	1	6	12	149.49	591.07
19	1.00	5	0	7	80.66	604.06
20	1.00	7	5	17	63.96	609.25
21	1.00	5	9	17	95.87	593.03

Ameriphysics LLC

Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>243</u>	Page	of
Marssim Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2	<input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:	<u>243</u>				

Comments Section

Date	Comment
12/17/2016	1. Backgrounds for the 43-37 varied from material to material. (0-15 cpm Alpha) (750-1600cpm Beta)
12/17/2016	2. Alpha total activity measurements were corrected based on the alpha to beta ratio determined from a composite concrete sample performed on the highest detectable activity floor areas prior to remediation. This ratio is determined using the gross alpha/beta results from laboratory analysis. The ratio is 48.2 pCi/g alpha divided by 1800 pCi/g beta or 0.0268.
12/17/2016	3. See attached LSC results.

N/A

Ameripysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>244</u>	Page <u>1</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>244</u>		

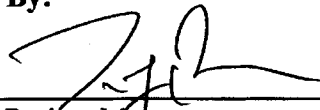
Approvals

Prepared By:


Jordan Davidson,

12-12-16
Date


Reviewed By:


Tim Pratt, Project Manager

12/12/16
Date

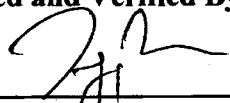
Completion and Review

Data Collected and/or Converted By:

 , HPT
Name, Title

12-16-16
Date

Reviewed and Verified By:


Tim Pratt, Project Manager

12/27/16
Date

Ameriphysics LLC

Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>244</u>	Page <u>2</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:		244

Radionuclides of Historical Use: ²⁰⁷ Bi, ¹⁴ C, ³⁶ Cl, ⁶⁰ Co, ¹³⁷ Cs, ¹⁵² Eu, ¹⁵⁴ Eu, ³ H, ⁶³ Ni, ²¹⁰ Pb, ²²⁶ Ra, ⁹⁰ Sr, ²⁰⁴ Tl, ²³⁵ U, ²³⁸ U	Approximate Date of Last Use: Unknown
---	---

Eliminated Due to Decay Since Date of Last Use: None
--

Remaining Radionuclides of Concern: ²⁰⁷ Bi, ¹⁴ C, ³⁶ Cl, ⁶⁰ Co, ¹³⁷ Cs, ¹⁵² Eu, ¹⁵⁴ Eu, ³ H, ⁶³ Ni, ²¹⁰ Pb, ²²⁶ Ra, ⁹⁰ Sr, ²⁰⁴ Tl, ²³⁵ U, ²³⁸ U
--

Release Limits (DCGLs)			
	Total Activity Limits	Removable Activity Limit	Limits Based On:
Alpha	480 dpm/100 cm ²	48 dpm/100 cm ²	²³⁵ U
Beta/Gamma	7,100 dpm/100 cm ²	710 dpm/100 cm ²	⁶⁰ Co

Applicable Survey Unit Surfaces	% of Accessible Surface for Scan Surveys
<input checked="" type="checkbox"/> Floors	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Lower Walls	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Upper Walls	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Ceiling	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input type="checkbox"/> Structures (Interior and Exterior Surfaces)	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input type="checkbox"/> 100%

Required Survey Instrumentation	Measurement Type	Static Count Time:	Scan Rate	Efficiency Based On:
Ludlum 2360 w/ 43-68	Gross Alpha and Beta Total Activity	1 minute	5 cm/sec	Beta- ¹⁴ C Alpha - ²³⁰ Th
Ludlum 2360 w/ 43-37	Gross Alpha and Beta Scans	N/A	5 cm/sec	Beta- ¹⁴ C Alpha - ²³⁰ Th
Ludlum 3030E w/43-10-1	Gross Alpha and Beta Removable Activity	1 minute	N/A	Beta- ¹⁴ C Alpha - ²³⁰ Th
Liquid Scintillation Counter	Low Energy Beta Removable Activity	1 minute	N/A	³ H, ¹⁴ C
Other: <u>(Specify)</u>	N/A	N/A	N/A	N/A

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>244</u>	Page <u>3</u> of <u>12</u>
MARSSIM Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3
Room Nos. Included in Survey Unit:	<u>244</u>	

Survey Instructions

1)	Perform the required scan surveys at the rate prescribed on the previous page. Document the performance of the scan survey on the attached survey maps using markings and legends as necessary to allow the reviewer enough information to verify that sufficient areas has been covered.
2)	The estimated number of static measurement locations needed for the statistical evaluation of this survey unit is 17.
3)	For Class 1 and Class 2 survey units, the locations are determined by using a random start point and a systematic spacing from this point. Due to this method, the actual number of plotted locations may vary. In this case, collect the actual locations provided on the survey map even if this number is greater than 17. For most cases, surveys are designed to plot 17-25 sample locations since the estimated required number of 17 locations was based on estimated result variations and averages.
4)	Locate and mark the required measurement locations using the provided survey map(s). Survey Maps have been provided with the required measurement locations. Sufficient detail has been provided on these maps to measure and locate all of these locations.
5)	Collect static measurements for gross beta and gross alpha at each identified location. Collect wipe samples for gross beta, gross alpha and LSC at each sample location. Document the results on the associated data results sheets. Additional measurements may be taken in suspect areas at the discretion of the Project Manager or survey technician. However, these additional locations are not included in the analysis of the statistical sample set.
6)	Notify the Project Manager if any static measurement or applicable removable contamination measurements exceeds the applicable investigation level.
7)	Ensure that all package information is completed and signed prior to turning in this Survey Package to the Project Manager for review.

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>244</u>	Page <u>4</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:		244

Location Code Description

A unique location code shall be assigned to each individual survey location to ensure proper data management of the survey results. The following format shall be used to ensure consistency throughout the final status survey process:

BBBB-RRRR-SS-M-LLL

Where:

BBBB =	Building or area code. This field represents the facility area. This will be the building number or an assigned area number. (1 to 4 characters)
RRRR =	Survey unit ID code. This field has been assigned based on the actual building room number or a specific number assigned by the Field Work Supervisor. (1 to 4 characters)
SS =	Structural surface code. This field represents the structural surface such as floor, wall, ceiling, etc. and the surface division code. For example, if a room has a very large floor area it may be divided into two or more divisions and each section would be assigned unique codes such as F1, F2 and so on. Walls may be divided on a frequent basis. If only one surface area is identified for a particular survey area, then the default number will be "1" (e.g. W1, F1, etc.). (2 characters)
M =	Structural material code. This field represents the type of structural material on which a particular measurement is taken. This field is used for background assignment, data sorting and analysis. The Project Manager assigns applicable codes. (1 character)
LLL =	Numerical identification number. This field represents the survey point assigned numerical identifier. The field "001" means survey point location number 1. Numerical Identifiers shall not be duplicated within the same survey unit. (3 characters)

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Building: <u>SHW</u>	Survey Unit ID: <u>244</u>	Page <u>5</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:		244

Survey Unit Type: Building Surfaces and Structures

Survey Unit Area: 114.37 m²

Floor Area: 17.36 m²

Number of Samples used for Calculation (N): 20

X-axis dimension: 13.34 m

X Rand:¹ 0.613374933

Y-axis dimension: 14.02 m

Y Rand:¹ 0.651090215

X-Axis Start Location:² 8.18 m

Y-Axis Start Location:² 9.13 m

Sampling Spacing (L): 2.39 m

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

Note 2: X-Axis and Y-Axis start locations were calculated by multiplying the appropriate dimension by the corresponding random number.

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Building:	SHW	Survey Unit ID:	244	Page	6	of	12
Marssim Classification:	<input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3						
Room Nos. Included in Survey Unit:	244						

Project Name:		Project Number:		Survey Number:		Date:	
IU Swain Hall		1119-16		1119-027		12/16/2016	
Time:		14:00					

Instrument / Detector	Serial Number	Cal. Due Date	Total Efficiency	Background (CPM)	Probe Area (cm ²)	Surveyor: Jordan Davidson
Ludlum 2360/Ludlum 43-37 (Alpha)	185769/PR216876	4/29/2017	8.68%	See Comments	584	Signature:
Ludlum 2360/Ludlum 43-37 (Beta)	185769/PR216876	4/29/2017	7.20%	See Comments	584	
Ludlum 2360/Ludlum 43-68 (Alpha)	297722/PR216848	3/3/2017	7.87%	See Below	126	Reviewer: Tim Pratt
Ludlum 2360/Ludlum 43-68 (Beta)	297722/PR216848	3/3/2017	8.09%	See Below	126	
Ludlum 3030E/Ludlum 43-10-1 (Alpha)	328277/PR337587	3/3/2017	29.73%	0	100	Signature:
Ludlum 3030E/Ludlum 43-10-1 (Beta)	328277/PR337587	3/3/2017	14.81%	64	100	

Location Code	Total Activity Results						Removable Activity Results			
	Alpha ¹			Beta-Gamma			Alpha		Beta-Gamma	
	Gross CPM	BKG	Net DPM/100 cm ²	Gross CPM	BKG	Net DPM/100 cm ²	Gross CPM	Net DPM/100 cm ²	Gross CPM	Net DPM/100 cm ²
SHW-244-F-C-1	1	1	16.6	283	220	618	0	0.0	81	115
SHW-244-F-C-2	2	1	-9.5	184	220	-353	0	0.0	71	47
SHW-244-F-C-3	2	1	-0.5	218	220	-20	1	3.4	80	108
SHW-244-W-G-4	2	1	-7.6	106	135	-284	0	0.0	80	108
SHW-244-W-P-5	1	1	-28.7	161	270	-1069	0	0.0	65	7
SHW-244-W-P-6	0	1	-4.5	253	270	-167	0	0.0	70	41
SHW-244-W-P-7	0	1	3.2	282	270	118	0	0.0	85	142
SHW-244-W-P-8	1	1	0.8	273	270	29	0	0.0	78	95
SHW-244-W-P-9	0	1	-0.3	269	270	-10	0	0.0	61	-20

Comments:	¹ See Comment #2 on the comments page regarding the alpha total activity values reported.
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$$\text{net DPM}/100 \text{ cm}^2 = \frac{\text{Gross CPM} - \text{BKG}}{\text{Total Efficiency} \times A/100}$$

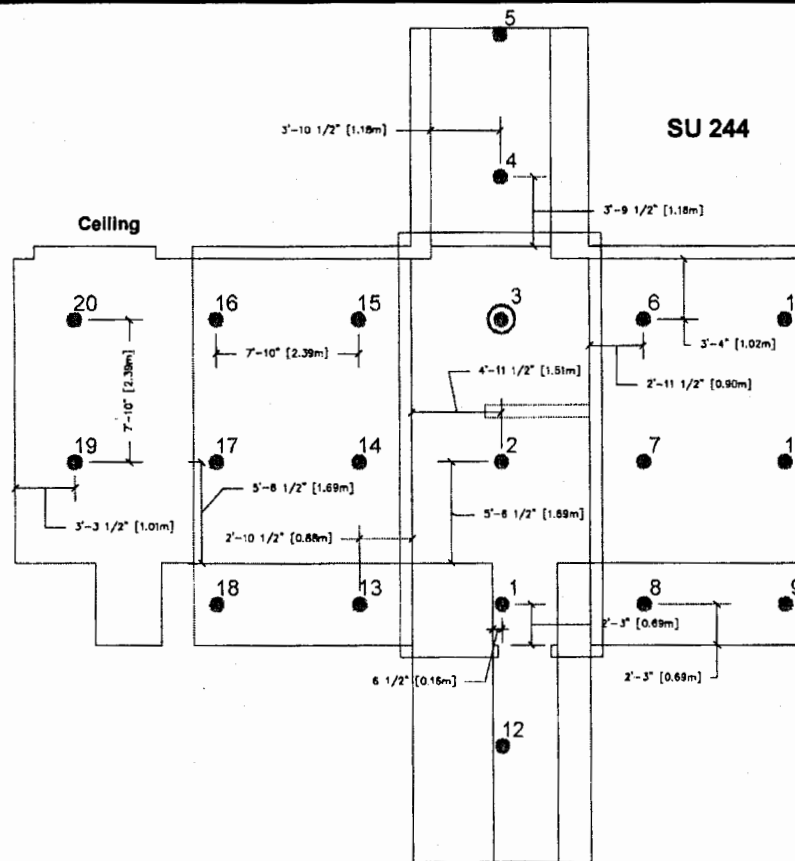
Final Status Survey Design Package

244

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Ameriphysics LLC
Final Status Survey Design Package

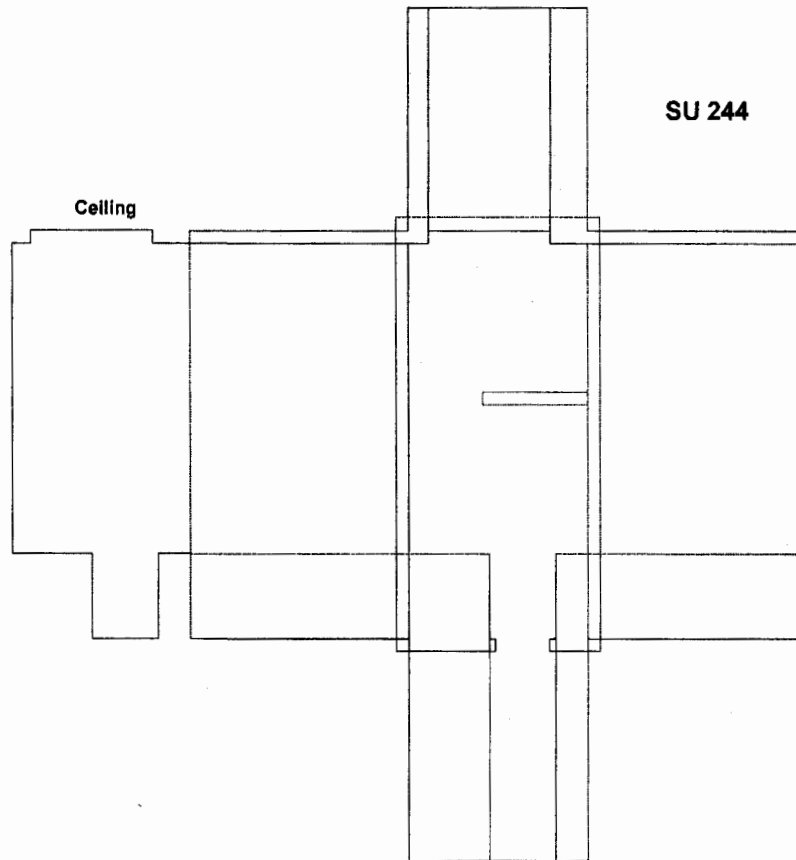
Building: <u>SHW</u>	Survey Unit ID: <u>244</u>	Page <u>8</u> of <u>12</u>
Marssim Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2
Room Nos. Included in Survey Unit:	244	



Comments: N/A

Ameripysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>244</u>	Page <u>9</u> of <u>12</u>
Marssim Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>244</u>		



Comments: Performed 100% scan for alpha and beta. No elevated activity detected.

Assay Definition-

Assay Description:

Assay Type: CPM

Report Name: Report1

Output Data Path: C:\Packard\Tricarb\Results\TJP\Ameriphsysics\20161220_1501

Raw Results Path: C:\Packard\Tricarb\Results\TJP\Ameriphsysics\20161220_1501\20161220_1501.results

Assay File Name: C:\Packard\TriCarb\Assays\Ameriphsysics.lsa

Count Conditions-

Nuclide: 3H-14C-Open

Quench Indicator: tSIE/AEC

External Std Terminator (sec): 0.5 2s%

Pre-Count Delay (min): 0.00

Quench Set: n/a

Count Time (min): 1.00

Count Mode: Normal

Assay Count Cycles: 1

Repeat Sample Count: 1

#Vials/Sample: 1

Calculate % Reference: Off

Background Subtract: On - IPA

Low CPM Threshold: Off

2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	9.05
B	12.0	156.0	6.05
C	0.0	2000.0	24.13

Count Corrections-

Static Controller: On

Luminescence Correction: Off

Colored Samples: n/a

Heterogeneity Monitor: n/a

Coincidence Time (nsec): 18

Delay Before Burst (nsec): 75

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count	Time	CPMA	CPMB	CPMC	SIS	MESSAGES	tSIE
1	1.00		14	0	19	0.00		427.25
2	1.00		13	0	10	22.17		442.20
3	1.00		12	2	10	26.46		452.04
4	1.00		6	6	20	93.01		500.14
5	1.00		8	2	19	51.53		565.70
6	1.00		4	5	13	102.78		581.31
7	1.00		1	6	18	171.74		588.43
8	1.00		8	3	13	61.43		575.01
9	1.00		3	2	6	61.66		590.79
10	1.00		5	1	9	141.93		597.13
11	1.00		3	5	12	84.73		587.77
12	1.00		6	6	15	83.46		537.41

SHW-244

13	1.00	11	11	30	69.42	587.74
14	1.00	7	9	21	78.01	579.30
15	1.00	2	0	3	392.44	585.49
16	1.00	10	6	16	75.54	593.68
17	1.00	15	3	15	25.23	575.55
18	1.00	3	0	3	14.26	588.98
19	1.00	7	7	13	92.06	592.10
20	1.00	2	5	12	71.91	592.11

Ameriphysics LLC

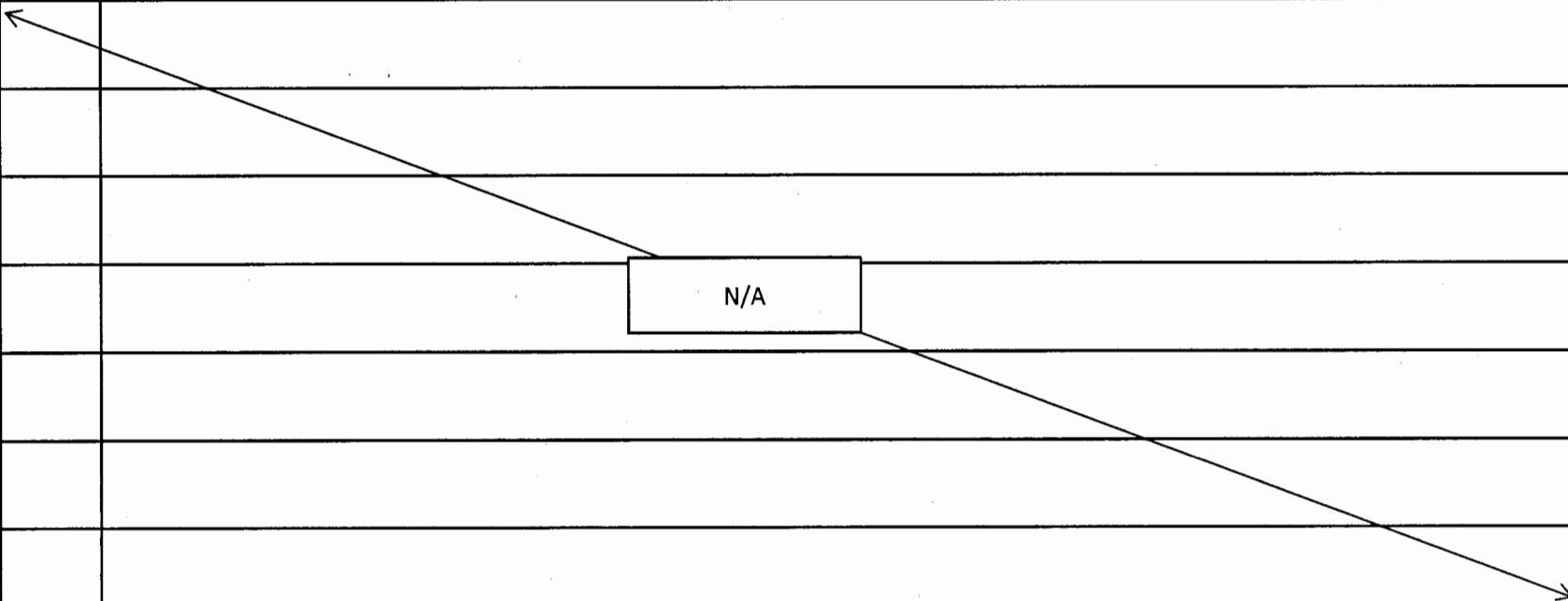
Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>244</u>	Page	of
Marssim Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2	<input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:	<u>244</u>				

Comments Section

Date	Comment
12/16/2016	1. Backgrounds for the 43-37 varied from material to material. (0-15 cpm Alpha) (750-1600cpm Beta)
12/16/2016	2. Alpha total activity measurements were corrected based on the alpha to beta ratio determined from a composite concrete sample performed on the highest detectable activity floor areas prior to remediation. This ratio is determined using the gross alpha/beta results from laboratory analysis. The ratio is 48.2 pCi/g alpha divided by 1800 pCi/g beta or 0.0268.
12/16/2016	3. See attached LSC results.

N/A



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Building: <u>SHW</u>	Survey Unit ID: <u>301</u>	Page <u>1</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>301</u>		

Approvals

Prepared By:


Jordan Davidson

12-12-16
Date

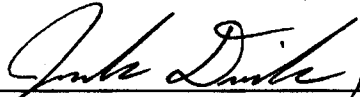
Reviewed By:


Tim Pratt, Project Manager

12/12/16
Date

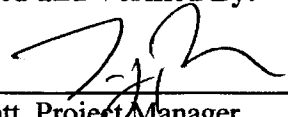
Completion and Review

Data Collected and/or Converted By:

 , HPT
Name, Title

12-15-16
Date

Reviewed and Verified By:


Tim Pratt, Project Manager

12/27/16
Date

Ameriphsics LLC

Final Status Survey Design Package

Building: <u>SHU</u>	Survey Unit ID: <u>301</u>	Page <u>2</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:		301

Radionuclides of Historical Use: ²⁰⁷ Bi, ¹⁴ C, ³⁶ Cl, ⁶⁰ Co, ¹³⁷ Cs, ¹⁵² Eu, ¹⁵⁴ Eu, ³ H, ⁶³ Ni, ²¹⁰ Pb, ²²⁶ Ra, ⁹⁰ Sr, ²⁰⁴ Tl, ²³⁵ U, ²³⁸ U	Approximate Date of Last Use: Unknown
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Eliminated Due to Decay Since Date of Last Use: None
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Remaining Radionuclides of Concern: ²⁰⁷ Bi, ¹⁴ C, ³⁶ Cl, ⁶⁰ Co, ¹³⁷ Cs, ¹⁵² Eu, ¹⁵⁴ Eu, ³ H, ⁶³ Ni, ²¹⁰ Pb, ²²⁶ Ra, ⁹⁰ Sr, ²⁰⁴ Tl, ²³⁵ U, ²³⁸ U
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Release Limits (DCGLs)			
	Total Activity Limits	Removable Activity Limit	Limits Based On:
Alpha	480 dpm/100 cm ²	48 dpm/100 cm ²	²³⁵ U
Beta/Gamma	7,100 dpm/100 cm ²	710 dpm/100 cm ²	⁶⁰ Co

Applicable Survey Unit Surfaces	% of Accessible Surface for Scan Surveys
<input checked="" type="checkbox"/> Floors	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Lower Walls	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Upper Walls	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Ceiling	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input type="checkbox"/> Structures (Interior and Exterior Surfaces)	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input type="checkbox"/> 100%

Required Survey Instrumentation	Measurement Type	Static Count Time:	Scan Rate	Efficiency Based On:
Ludlum 2360 w/ 43-68	Gross Alpha and Beta Total Activity	1 minute	5 cm/sec	Beta- ¹⁴ C Alpha - ²³⁰ Th
Ludlum 2360 w/ 43-37	Gross Alpha and Beta Scans	N/A	5 cm/sec	Beta- ¹⁴ C Alpha - ²³⁰ Th
Ludlum 3030E w/43-10-1	Gross Alpha and Beta Removable Activity	1 minute	N/A	Beta- ¹⁴ C Alpha - ²³⁰ Th
Liquid Scintillation Counter	Low Energy Beta Removable Activity	1 minute	N/A	³ H, ¹⁴ C
Other: <u>(Specify)</u>	N/A	N/A	N/A	N/A

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Building: <u>SHW</u>	Survey Unit ID: <u>301</u>	Page <u>3</u> of <u>12</u>	
MARSSIM Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2	<input type="checkbox"/> Class 3
Room Nos. Included in Survey Unit:	301		

Survey Instructions	
1)	Perform the required scan surveys at the rate prescribed on the previous page. Document the performance of the scan survey on the attached survey maps using markings and legends as necessary to allow the reviewer enough information to verify that sufficient areas has been covered.
2)	The estimated number of static measurement locations needed for the statistical evaluation of this survey unit is 17.
3)	For Class 1 and Class 2 survey units, the locations are determined by using a random start point and a systematic spacing from this point. Due to this method, the actual number of plotted locations may vary. In this case, collect the actual locations provided on the survey map even if this number is greater than 17. For most cases, surveys are designed to plot 17-25 sample locations since the estimated required number of 17 locations was based on estimated result variations and averages.
4)	Locate and mark the required measurement locations using the provided survey map(s). Survey Maps have been provided with the required measurement locations. Sufficient detail has been provided on these maps to measure and locate all of these locations.
5)	Collect static measurements for gross beta and gross alpha at each identified location. Collect wipe samples for gross beta, gross alpha and LSC at each sample location. Document the results on the associated data results sheets. Additional measurements may be taken in suspect areas at the discretion of the Project Manager or survey technician. However, these additional locations are not included in the analysis of the statistical sample set.
6)	Notify the Project Manager if any static measurement or applicable removable contamination measurements exceeds the applicable investigation level.
7)	Ensure that all package information is completed and signed prior to turning in this Survey Package to the Project Manager for review.

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Building: <u>SHW</u>	Survey Unit ID: <u>301</u>	Page <u>4</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:		301

Location Code Description

A unique location code shall be assigned to each individual survey location to ensure proper data management of the survey results. The following format shall be used to ensure consistency throughout the final status survey process:

BBBB-RRRR-SS-M-LLL

Where:

- BBBB =** Building or area code. This field represents the facility area. This will be the building number or an assigned area number. (1 to 4 characters)
- RRRR =** Survey unit ID code. This field has been assigned based on the actual building room number or a specific number assigned by the Field Work Supervisor. (1 to 4 characters)
- SS =** Structural surface code. This field represents the structural surface such as floor, wall, ceiling, etc. and the surface division code. For example, if a room has a very large floor area it may be divided into two or more divisions and each section would be assigned unique codes such as F1, F2 and so on. Walls may be divided on a frequent basis. If only one surface area is identified for a particular survey area, then the default number will be "1" (e.g. W1, F1, etc.). (2 characters)
- M =** Structural material code. This field represents the type of structural material on which a particular measurement is taken. This field is used for background assignment, data sorting and analysis. The Field Work Supervisor assigns applicable codes. (1 character)
- LLL =** Numerical identification number. This field represents the survey point assigned numerical identifier. The field "001" means survey point location number 1. Numerical Identifiers shall not be duplicated within the same survey unit. (3 characters)

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Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>301</u>	Page	<u>5</u>	of	<u>12</u>
MARSSIM Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2	<input type="checkbox"/> Class 3				
Room Nos. Included in Survey Unit:	<u>301</u>						

Survey Unit Type: Building Surfaces and Structures

Survey Unit Area: 86.73 m²

Floor Area: 20.66 m²

Number of Samples used for Calculation (N): 20

X-axis dimension: 11.40 m

X Rand:¹ 0.635902044

Y-axis dimension: 12.34 m

Y Rand:¹ 0.31254572

X-Axis Start Location:² 7.25 m

Y-Axis Start Location:² 3.86 m

Sampling Spacing (L): 2.08 m

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

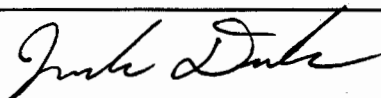
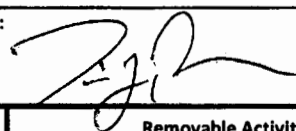
Note 2: X-Axis and Y-Axis start locations were calculated by multiplying the appropriate dimension by the corresponding random number.

Ameriphysics LLC

Final Status Survey Design Package

Building: SHW	Survey Unit ID: 301	Page 6 of 12
Marssim Classification:	<input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3	
Room Nos. Included in Survey Unit:	301	

Project Name: IU Swain Hall		Project Number: 1119-16		Survey Number: 1119-026		Date: 12/15/2016	
						Time: 9:00	

Instrument / Detector	Serial Number	Cal. Due Date	Total Efficiency	Background (CPM)	Probe Area (cm ²)	Surveyor: Jordan Davidson
Ludlum 2360/Ludlum 43-37 (Alpha)	185769/PR216876	4/29/2017	8.68%	See Comments	584	Signature: 
Ludlum 2360/Ludlum 43-37 (Beta)	185769/PR216876	4/29/2017	7.20%	See Comments	584	
Ludlum 2360/Ludlum 43-68 (Alpha)	297722/PR216848	3/3/2017	7.87%	See Below	126	Reviewer: Tim Pratt
Ludlum 2360/Ludlum 43-68 (Beta)	297722/PR216848	3/3/2017	8.09%	See Below	126	
Ludlum 3030E/Ludlum 43-10-1 (Alpha)	328277/PR337587	3/3/2017	29.73%	0	100	Signature: 
Ludlum 3030E/Ludlum 43-10-1 (Beta)	328277/PR337587	3/3/2017	14.81%	64	100	

Location Code	Total Activity Results						Removable Activity Results			
	Alpha ¹			Beta-Gamma			Alpha		Beta-Gamma	
	Gross CPM	BKG	Net DPM/100 cm ²	Gross CPM	BKG	Net DPM/100 cm ²	Gross CPM	Net DPM/100 cm ²	Gross CPM	Net DPM/100 cm ²
SHW-301-F-C-1	1	1	-0.3	219	220	-10	0	0.0	84	135
SHW-301-F-C-2	2	1	1.1	224	220	39	0	0.0	81	115
SHW-301-F-C-3	3	1	-4.2	204	220	-157	0	0.0	78	95
SHW-301-W-P-4	2	1	-9.5	234	270	-353	0	0.0	69	34
SHW-301-W-P-5	0	1	-28.9	160	270	-1079	1	3.4	80	108
SHW-301-W-P-6	1	1	-13.9	217	270	-520	0	0.0	98	230
SHW-301-W-P-7	2	1	2.9	281	270	108	0	0.0	86	149
SHW-301-W-P-8	0	1	-1.8	263	270	-69	0	0.0	75	74
SHW-301-W-P-9	2	1	6.8	296	270	255	1	3.4	82	122

Comments:	¹ See Comment #2 on the comments page regarding the alpha total activity values reported.
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$$\text{net DPM}/100 \text{ cm}^2 = \frac{\text{Gross CPM} - \text{BKG}}{\text{Total Efficiency} \times A/100}$$

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Building: SHW

Survey Unit ID: 301

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☒ Class 1

- Class 2

- Class 3

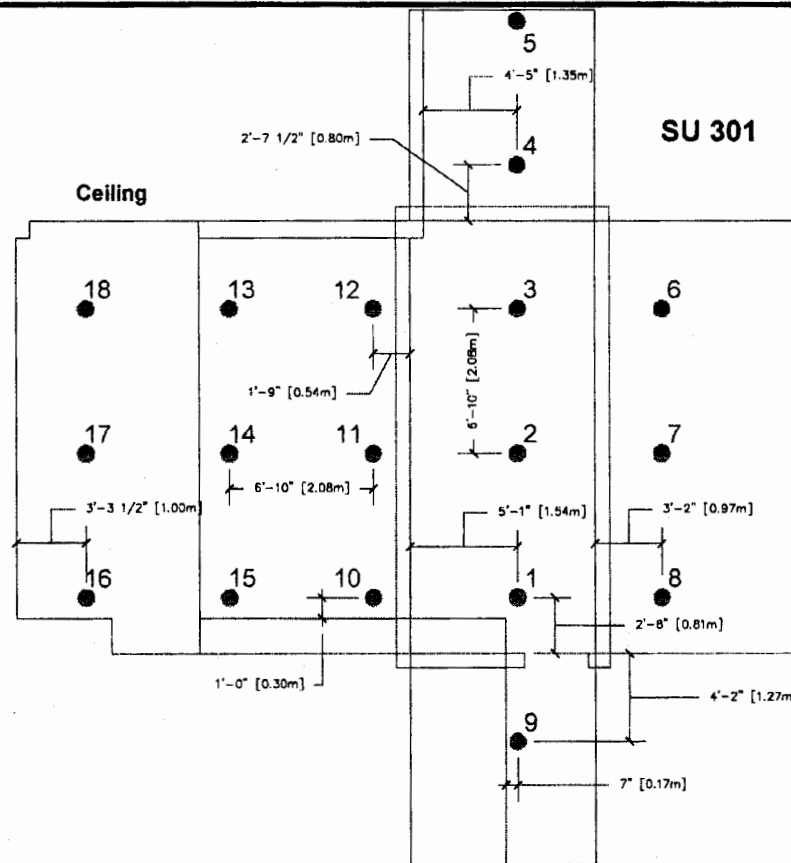
Room Nos. Included in Survey Unit:

301

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Ameriphysics LLC
Final Status Survey Design Package

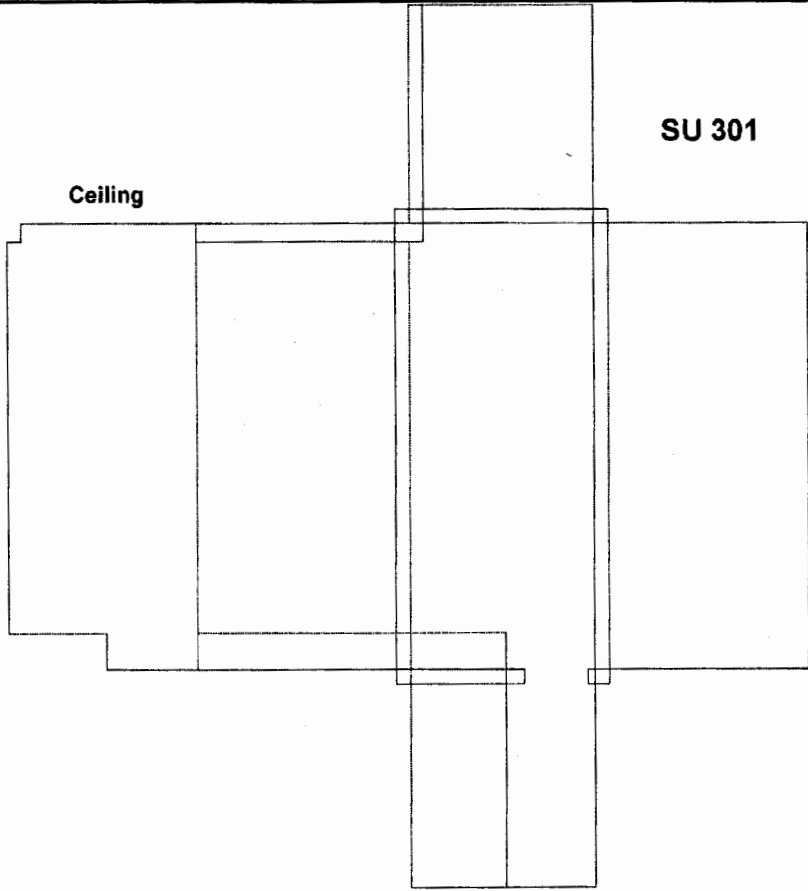
Building: <u>SHW</u>	Survey Unit ID: <u>301</u>	Page <u>8</u> of <u>12</u>
Marssim Classification:	<input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3	
Room Nos. Included in Survey Unit:	301	



Comments: N/A

Ameripysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>301</u>	Page <u>9</u> of <u>12</u>
Marssim Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2
Room Nos. Included in Survey Unit:	<u>301</u>	

 <p style="margin-left: 100px;">Ceiling</p>	SU 301
Comments: Performed 100% scan for alpha and beta. No elevated activity detected.	

SHW-301

13	1.00	5	0	9	80.35	548.01
14	1.00	7	0	19	46.04	556.86
15	1.00	7	6	19	126.25	568.39
16	1.00	3	5	14	72.56	580.04
17	1.00	5	5	19	110.41	583.86
18	1.00	10	5	20	48.24	579.93

Ameriphysics LLC

Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>301</u>	Page	<u> </u>	of	<u> </u>
Marssim Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2	<input type="checkbox"/> Class 3				
Room Nos. Included in Survey Unit:	<u>301</u>						

Comments Section

Date	Comment
12/15/2016	1. Backgrounds for the 43-37 varied from material to material. (0-15 cpm Alpha) (750-1600cpm Beta)
12/15/2016	2. Alpha total activity measurements were corrected based on the alpha to beta ratio determined from a composite concrete sample performed on the highest detectable activity floor areas prior to remediation. This ratio is determined using the gross alpha/beta results from laboratory analysis. The ratio is 48.2 pCi/g alpha divided by 1800 pCi/g beta or 0.0268.
12/15/2016	3. See attached LSC results.

N/A

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>302</u>	Page <u>1</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>302</u>		

Approvals

Prepared By:


Jordan Davidson

12-12-16
Date

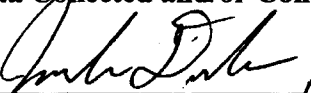
Reviewed By:


Tim Pratt, Project Manager

12/12/16
Date

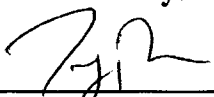
Completion and Review

Data Collected and/or Converted By:

 , HPT
Name, Title

12-15-16
Date

Reviewed and Verified By:


Tim Pratt, Project Manager

12/27/16
Date

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>302</u>	Page <u>2</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:		302

Radionuclides of Historical Use: ²⁰⁷ Bi, ¹⁴ C, ³⁶ Cl, ⁶⁰ Co, ¹³⁷ Cs, ¹⁵² Eu, ¹⁵⁴ Eu, ³ H, ⁶³ Ni, ²¹⁰ Pb, ²²⁶ Ra, ⁹⁰ Sr, ²⁰⁴ Tl, ²³⁵ U, ²³⁸ U	Approximate Date of Last Use: Unknown
--	---

Eliminated Due to Decay Since Date of Last Use: None
--

Remaining Radionuclides of Concern: ²⁰⁷ Bi, ¹⁴ C, ³⁶ Cl, ⁶⁰ Co, ¹³⁷ Cs, ¹⁵² Eu, ¹⁵⁴ Eu, ³ H, ⁶³ Ni, ²¹⁰ Pb, ²²⁶ Ra, ⁹⁰ Sr, ²⁰⁴ Tl, ²³⁵ U, ²³⁸ U
--

Release Limits (DCGLs)			
	Total Activity Limits	Removable Activity Limit	Limits Based On:
Alpha	480 dpm/100 cm ²	48 dpm/100 cm ²	²³⁵ U
Beta/Gamma	7,100 dpm/100 cm ²	710 dpm/100 cm ²	⁶⁰ Co

Applicable Survey Unit Surfaces	% of Accessible Surface for Scan Surveys		
<input checked="" type="checkbox"/> Floors	<input type="checkbox"/> 10%	<input type="checkbox"/> 10-100%	<input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Lower Walls	<input type="checkbox"/> 10%	<input type="checkbox"/> 10-100%	<input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Upper Walls	<input type="checkbox"/> 10%	<input type="checkbox"/> 10-100%	<input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Ceiling	<input type="checkbox"/> 10%	<input type="checkbox"/> 10-100%	<input checked="" type="checkbox"/> 100%
<input type="checkbox"/> Structures (Interior and Exterior Surfaces)	<input type="checkbox"/> 10%	<input type="checkbox"/> 10-100%	<input type="checkbox"/> 100%

Required Survey Instrumentation	Measurement Type	Static Count Time:	Scan Rate	Efficiency Based On:
Ludlum 2360 w/ 43-68	Gross Alpha and Beta Total Activity	1 minute	5 cm/sec	Beta- ¹⁴ C Alpha- ²³⁰ Th
Ludlum 2360 w/ 43-37	Gross Alpha and Beta Scans	N/A	5 cm/sec	Beta- ¹⁴ C Alpha- ²³⁰ Th
Ludlum 3030E w/43-10-1	Gross Alpha and Beta Removable Activity	1 minute	N/A	Beta- ¹⁴ C Alpha- ²³⁰ Th
Liquid Scintillation Counter	Low Energy Beta Removable Activity	1 minute	N/A	³ H, ¹⁴ C
Other: <u>(Specify)</u>	N/A	N/A	N/A	N/A

Ameriphysics LLC
Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>302</u>	Page	<u>3</u>	of	<u>12</u>
MARSSIM Classification:	<input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3						
Room Nos. Included in Survey Unit:	<u>302</u>						

Survey Instructions	
1)	Perform the required scan surveys at the rate prescribed on the previous page. Document the performance of the scan survey on the attached survey maps using markings and legends as necessary to allow the reviewer enough information to verify that sufficient areas has been covered.
2)	The estimated number of static measurement locations needed for the statistical evaluation of this survey unit is 17.
3)	For Class 1 and Class 2 survey units, the locations are determined by using a random start point and a systematic spacing from this point. Due to this method, the actual number of plotted locations may vary. In this case, collect the actual locations provided on the survey map even if this number is greater than 17. For most cases, surveys are designed to plot 17-25 sample locations since the estimated required number of 17 locations was based on estimated result variations and averages.
4)	Locate and mark the required measurement locations using the provided survey map(s). Survey Maps have been provided with the required measurement locations. Sufficient detail has been provided on these maps to measure and locate all of these locations.
5)	Collect static measurements for gross beta and gross alpha at each identified location. Collect wipe samples for gross beta, gross alpha and LSC at each sample location. Document the results on the associated data results sheets. Additional measurements may be taken in suspect areas at the discretion of the Project Manager or survey technician. However, these additional locations are not included in the analysis of the statistical sample set.
6)	Notify the Project Manager if any static measurement or applicable removable contamination measurements exceeds the applicable investigation level.
7)	Ensure that all package information is completed and signed prior to turning in this Survey Package to the Project Manager for review.

Ameripysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>302</u>	Page <u>4</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:		302

Location Code Description

A unique location code shall be assigned to each individual survey location to ensure proper data management of the survey results. The following format shall be used to ensure consistency throughout the final status survey process:

BBBB-RRRR-SS-M-LLL

Where:

BBBB =	Building or area code. This field represents the facility area. This will be the building number or an assigned area number. (1 to 4 characters)
RRRR =	Survey unit ID code. This field has been assigned based on the actual building room number or a specific number assigned by the Field Work Supervisor. (1 to 4 characters)
SS =	Structural surface code. This field represents the structural surface such as floor, wall, ceiling, etc. and the surface division code. For example, if a room has a very large floor area it may be divided into two or more divisions and each section would be assigned unique codes such as F1, F2 and so on. Walls may be divided on a frequent basis. If only one surface area is identified for a particular survey area, then the default number will be "1" (e.g. W1, F1, etc.). (2 characters)
M =	Structural material code. This field represents the type of structural material on which a particular measurement is taken. This field is used for background assignment, data sorting and analysis. The Field Work Supervisor assigns applicable codes. (1 character)
LLL =	Numerical identification number. This field represents the survey point assigned numerical identifier. The field "001" means survey point location number 1. Numerical Identifiers shall not be duplicated within the same survey unit. (3 characters)

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>302</u>	Page <u>5</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:		<u>302</u>

Survey Unit Type: Building Surfaces and Structures

Survey Unit Area: 100.27 m²

Floor Area: 20.90 m²

Number of Samples used for Calculation (N): 20

X-axis dimension: 12.80 m

X Rand:¹ 0.18599298

Y-axis dimension: 12.34 m

Y Rand:¹ 0.521199338

X-Axis Start Location:² 2.38 m

Y-Axis Start Location:² 6.43 m

Sampling Spacing (L): 2.24 m

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

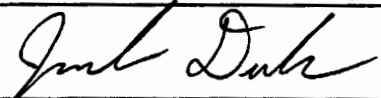
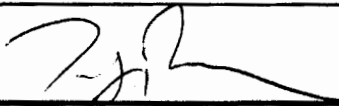
Note 2: X-Axis and Y-Axis start locations were calculated by multiplying the appropriate dimension by the corresponding random number.

Ameriphysics LLC

Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>302</u>	Page	<u>6</u>	of	<u>12</u>
Marssim Classification:	<input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3						
Room Nos. Included in Survey Unit:	<u>302</u>						

Project Name:		Project Number:		Survey Number:		Date:	
IU Swain Hall		1119-16		1119-025		12/15/2016	
Time:		14:30					

Instrument / Detector	Serial Number	Cal. Due Date	Total Efficiency	Background (CPM)	Probe Area (cm ²)	Surveyor: Jordan Davidson
Ludlum 2360/Ludlum 43-37 (Alpha)	185769/PR216876	4/29/2017	8.68%	See Comments	584	Signature: 
Ludlum 2360/Ludlum 43-37 (Beta)	185769/PR216876	4/29/2017	7.20%	See Comments	584	
Ludlum 2360/Ludlum 43-68 (Alpha)	297722/PR216848	3/3/2017	7.87%	See Below	126	Reviewer: Tim Pratt
Ludlum 2360/Ludlum 43-68 (Beta)	297722/PR216848	3/3/2017	8.09%	See Below	126	
Ludlum 3030E/Ludlum 43-10-1 (Alpha)	328277/PR337587	3/3/2017	29.73%	0	100	Signature: 
Ludlum 3030E/Ludlum 43-10-1 (Beta)	328277/PR337587	3/3/2017	14.81%	64	100	

Location Code	Total Activity Results						Removable Activity Results			
	Alpha ¹			Beta-Gamma			Alpha		Beta-Gamma	
	Gross CPM	BKG	Net DPM/100 cm ²	Gross CPM	BKG	Net DPM/100 cm ²	Gross CPM	Net DPM/100 cm ²	Gross CPM	Net DPM/100 cm ²
SHW-302-F-C-1	3	1	-2.1	212	220	-78	0	0	74	68
SHW-302-F-C-2	0	1	-10.3	181	220	-383	0	0	68	27
SHW-302-F-C-3	4	1	0.3	221	220	10	0	0	67	20
SHW-302-F-C-4	1	1	-10.0	182	220	-373	0	0	65	7
SHW-302-F-C-5	0	1	-10.8	179	220	-402	0	0	78	95
SHW-302-F-C-6	1	1	-13.7	168	220	-510	0	0	78	95
SHW-302-W-P-7	2	1	-1.8	263	270	-69	0	0	85	142
SHW-302-W-G-8	0	1	-5.5	114	135	-206	0	0	90	176
SHW-302-W-P-9	3	1	12.4	317	270	461	0	0	77	88

Comments:	¹ See Comment #2 on the comments page regarding the alpha total activity values reported.
------------------	--

$$\text{net DPM}/100 \text{ cm}^2 = \frac{\text{Gross CPM} - \text{BKG}}{\text{Total Efficiency} \times A/100}$$

Ameriphysics LLC
Final Status Survey Design Package

Building: SHW

Survey Unit ID: 302

Page 7 of 12

Marssim Classification:

☒ **Class 1**

- Class 2

- Class 3

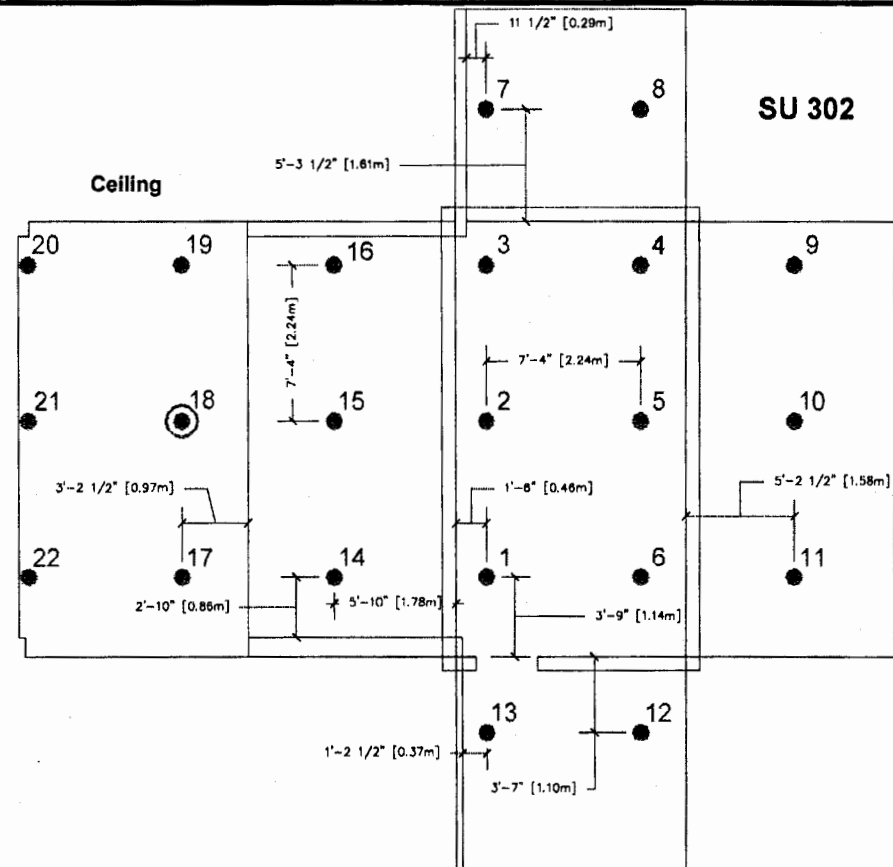
Room Nos. Included in Survey Unit:

302

[illegible]

Ameriphysics LLC
Final Status Survey Design Package

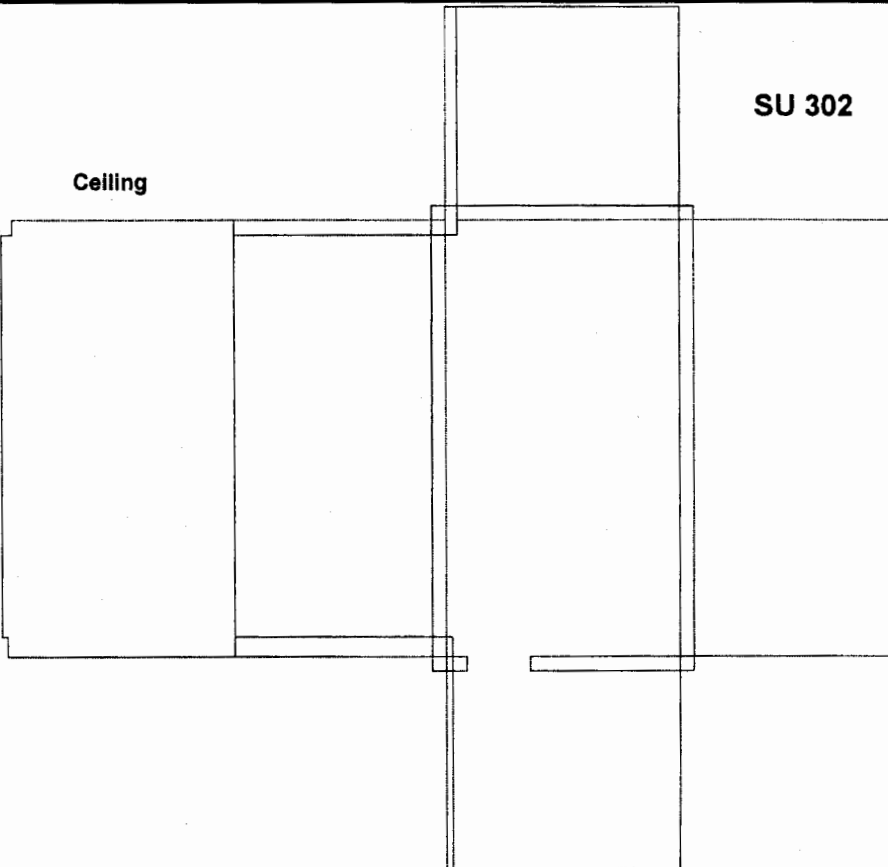
Building: <u>SHW</u>	Survey Unit ID: <u>302</u>	Page <u>9</u> of <u>12</u>
Marssim Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2
Room Nos. Included in Survey Unit:	302	



Comments: N/A

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>302</u>	Page <u>9</u> of <u>12</u>
Marssim Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2
Room Nos. Included in Survey Unit:	302	

<p>Celling</p> 	<p>SU 302</p>
<p>Comments: Performed 100% scan for alpha and beta. No elevated activity detected.</p>	

Assay Definition-

Assay Description:

Assay Type: CPM

Report Name: Report1

Output Data Path: C:\Packard\Tricarb\Results\TJP\Ameriphysics\20161220_1602

Raw Results Path: C:\Packard\Tricarb\Results\TJP\Ameriphysics\20161220_1602\20161220_1602.results

Assay File Name: C:\Packard\TriCarb\Assays\Ameriphysics.lsa

Count Conditions-

Nuclide: 3H-14C-Open

Quench Indicator: tSIE/AEC

External Std Terminator (sec): 0.5 2s

Pre-Count Delay (min): 0.00

Quench Set: n/a

Count Time (min): 1.00

Count Mode: Normal

Assay Count Cycles: 1

Repeat Sample Count: 1

#Vials/Sample: 1

Calculate % Reference: Off

Background Subtract: On - IPA

Low CPM Threshold: Off

2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	9.05
B	12.0	156.0	6.05
C	0.0	2000.0	24.13

Count Corrections-

Static Controller: On

Luminescence Correction: Off

Colored Samples: n/a

Heterogeneity Monitor: n/a

Coincidence Time (nsec): 18

Delay Before Burst (nsec): 75

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	CPMC	SIS	MESSAGES	tSIE
1	1.00	37	7	50	17.84		440.62
2	1.00	23	6	33	36.28		419.27
3	1.00	11	12	26	38.11		427.68
4	1.00	19	11	37	55.94		403.50
5	1.00	27	6	40	32.04		431.06
6	1.00	10	0	18	29.55		496.34
7	1.00	11	6	17	55.69		576.20
8	1.00	4	4	7	59.21		560.07
9	1.00	10	2	17	19.69		543.31
10	1.00	10	8	21	75.05		547.28
11	1.00	3	4	8	98.90		465.55
12	1.00	6	8	19	75.85		580.60

HW-302

13	1.00	6	4	12	36.43	501.59
14	1.00	6	9	16	88.22	475.28
15	1.00	0	6	9	101.82	528.59
16	1.00	8	3	22	59.34	491.19
17	1.00	11	3	14	36.61	585.74
18	1.00	6	4	10	113.10	572.07
19	1.00	9	4	25	82.00	532.12
20	1.00	2	0	2	0.00	552.40
21	1.00	7	0	1	18.54	578.36
22	1.00	4	0	6	73.87	549.45

Ameriphysics LLC
Final Status Survey Design Package

Building: SHW **Survey Unit ID:** 302 **Page** _____ **of** _____
Marssim Classification: ☒ Class 1 ☐ Class 2 ☐ Class 3
Room Nos. Included in Survey Unit: **302**

Comments Section

Date	Comment
12/15/2016	1. Backgrounds for the 43-37 varied from material to material. (0-15 cpm Alpha) (750-1600cpm Beta)
12/15/2016	2. Alpha total activity measurements were corrected based on the alpha to beta ratio determined from a composite concrete sample performed on the highest detectable activity floor areas prior to remediation. This ratio is determined using the gross alpha/beta results from laboratory analysis. The ratio is 48.2 pCi/g alpha divided by 1800 pCi/g beta or 0.0268.
12/15/2016	3. See attached LSC results.
	N/A

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>330</u>	Page <u>1</u>	of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3			
Room Nos. Included in Survey Unit: <u>330</u>			

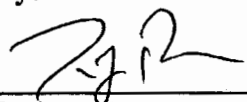
Approvals

Prepared By:


Jordan Davidson

12-12-16
Date

Reviewed By:


Tim Pratt, Project Manager

12/12/16
Date

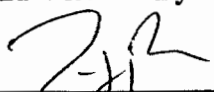
Completion and Review

Data Collected and/or Converted By:

 , HPT
Name, Title

12-14-16
Date

Reviewed and Verified By:


Tim Pratt, Project Manager

12/27/16
12/27/16 ^{12/27/16}
Date

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>330</u>	Page <u>2</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>330</u>		

Radionuclides of Historical Use: ²⁰⁷ Bi, ¹⁴ C, ³⁶ Cl, ⁶⁰ Co, ¹³⁷ Cs, ¹⁵² Eu, ¹⁵⁴ Eu, ³ H, ⁶³ Ni, ²¹⁰ Pb, ²²⁶ Ra, ⁹⁰ Sr, ²⁰⁴ Tl, ²³⁵ U, ²³⁸ U	Approximate Date of Last Use: <p style="text-align: center;">Unknown</p>
--	--

Eliminated Due to Decay Since Date of Last Use: None
--

Remaining Radionuclides of Concern: ²⁰⁷ Bi, ¹⁴ C, ³⁶ Cl, ⁶⁰ Co, ¹³⁷ Cs, ¹⁵² Eu, ¹⁵⁴ Eu, ³ H, ⁶³ Ni, ²¹⁰ Pb, ²²⁶ Ra, ⁹⁰ Sr, ²⁰⁴ Tl, ²³⁵ U, ²³⁸ U
--

Release Limits (DCGLs)			
	Total Activity Limits	Removable Activity Limit	Limits Based On:
Alpha	480 dpm/100 cm ²	48 dpm/100 cm ²	²³⁵ U
Beta/Gamma	7,100 dpm/100 cm ²	710 dpm/100 cm ²	⁶⁰ Co

Applicable Survey Unit Surfaces	% of Accessible Surface for Scan Surveys
<input checked="" type="checkbox"/> Floors	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Lower Walls	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Upper Walls	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Ceiling	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input type="checkbox"/> Structures (Interior and Exterior Surfaces)	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input type="checkbox"/> 100%

Required Survey Instrumentation	Measurement Type	Static Count Time:	Scan Rate	Efficiency Based On:
Ludlum 2360 w/ 43-68	Gross Alpha and Beta Total Activity	1 minute	5 cm/sec	Beta- ¹⁴ C Alpha - ²³⁰ Th
Ludlum 2360 w/ 43-37	Gross Alpha and Beta Scans	N/A	5 cm/sec	Beta- ¹⁴ C Alpha - ²³⁰ Th
Ludlum 3030E w/43-10-1	Gross Alpha and Beta Removable Activity	1 minute	N/A	Beta- ¹⁴ C Alpha - ²³⁰ Th
Liquid Scintillation Counter	Low Energy Beta Removable Activity	1 minute	N/A	³ H, ¹⁴ C
Other: <u>(Specify)</u>	N/A	N/A	N/A	N/A

Ameriphsysics LLC
Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>330</u>	Page	<u>3</u>	of	<u>12</u>
MARSSIM Classification:	<input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3						
Room Nos. Included in Survey Unit:	<u>330</u>						

Survey Instructions	
1)	Perform the required scan surveys at the rate prescribed on the previous page. Document the performance of the scan survey on the attached survey maps using markings and legends as necessary to allow the reviewer enough information to verify that sufficient areas has been covered.
2)	The estimated number of static measurement locations needed for the statistical evaluation of this survey unit is 17.
3)	For Class 1 and Class 2 survey units, the locations are determined by using a random start point and a systematic spacing from this point. Due to this method, the actual number of plotted locations may vary. In this case, collect the actual locations provided on the survey map even if this number is greater than 17. For most cases, surveys are designed to plot 17-25 sample locations since the estimated required number of 17 locations was based on estimated result variations and averages.
4)	Locate and mark the required measurement locations using the provided survey map(s). Survey Maps have been provided with the required measurement locations. Sufficient detail has been provided on these maps to measure and locate all of these locations.
5)	Collect static measurements for gross beta and gross alpha at each identified location. Collect wipe samples for gross beta, gross alpha and LSC at each sample location. Document the results on the associated data results sheets. Additional measurements may be taken in suspect areas at the discretion of the Project Manager or survey technician. However, these additional locations are not included in the analysis of the statistical sample set.
6)	Notify the Project Manager if any static measurement or applicable removable contamination measurements exceeds the applicable investigation level.
7)	Ensure that all package information is completed and signed prior to turning in this Survey Package to the Project Manager for review.

Ameriphsics LLC
Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>330</u>	Page	<u>4</u>	of	<u>12</u>
MARSSIM Classification:	<input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3						
Room Nos. Included in Survey Unit:	<u>330</u>						

Location Code Description

A unique location code shall be assigned to each individual survey location to ensure proper data management of the survey results. The following format shall be used to ensure consistency throughout the final status survey process:

BBBB-RRRR-SS-M-LLL

Where:

- BBBB =** Building or area code. This field represents the facility area. This will be the building number or an assigned area number. (1 to 4 characters)
- RRRR =** Survey unit ID code. This field has been assigned based on the actual building room number or a specific number assigned by the Field Work Supervisor. (1 to 4 characters)
- SS =** Structural surface code. This field represents the structural surface such as floor, wall, ceiling, etc. and the surface division code. For example, if a room has a very large floor area it may be divided into two or more divisions and each section would be assigned unique codes such as F1, F2 and so on. Walls may be divided on a frequent basis. If only one surface area is identified for a particular survey area, then the default number will be "1" (e.g. W1, F1, etc.). (2 characters)
- M =** Structural material code. This field represents the type of structural material on which a particular measurement is taken. This field is used for background assignment, data sorting and analysis. The Field Work Supervisor assigns applicable codes. (1 character)
- LLL =** Numerical identification number. This field represents the survey point assigned numerical identifier. The field "001" means survey point location number 1. Numerical Identifiers shall not be duplicated within the same survey unit. (3 characters)

Ameripysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>330</u>	Page <u>5</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>330</u>		

Survey Unit Type: Building Surfaces and Structures

Survey Unit Area: 101.02 m²

Floor Area: 20.66 m²

Number of Samples used for Calculation (N): 25

X-axis dimension: 12.24 m

X Rand:¹ 0.914713201

Y-axis dimension: 12.81 m

Y Rand:¹ 0.674297798

X-Axis Start Location:² 11.20 m

Y-Axis Start Location:² 8.64 m

Sampling Spacing (L): 2.01 m

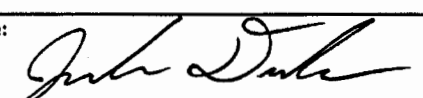
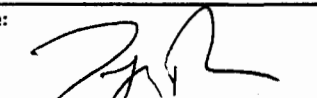
$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Note 2: X-Axis and Y-Axis start locations were calculated by multiplying the appropriate dimension by the corresponding random number.

Ameriphsics LLC
Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>330</u>
Marssim Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2	<input type="checkbox"/> Class 3
Room Nos. Included in Survey Unit:	330		

Project Name:		Project Number:		Survey Number:		Date:	
IU Swain Hall		1119-16		1119-024		12/14/2016	
Time:		15:00					

Instrument / Detector	Serial Number	Cal. Due Date	Total Efficiency	Background (CPM)	Probe Area (cm ²)	Surveyor: Jordan Davidson
Ludlum 2360/Ludlum 43-37 (Alpha)	185769/PR216876	4/29/2017	8.68%	See Comments	584	Signature: 
Ludlum 2360/Ludlum 43-37 (Beta)	185769/PR216876	4/29/2017	7.20%	See Comments	584	
Ludlum 2360/Ludlum 43-68 (Alpha)	297722/PR216848	3/3/2017	7.87%	See Below	126	Reviewer: Tim Pratt
Ludlum 2360/Ludlum 43-68 (Beta)	297722/PR216848	3/3/2017	8.09%	See Below	126	
Ludlum 3030E/Ludlum 43-10-1 (Alpha)	328277/PR337587	3/3/2017	29.73%	0	100	Signature: 
Ludlum 3030E/Ludlum 43-10-1 (Beta)	328277/PR337587	3/3/2017	14.81%	64	100	

Location Code	Total Activity Results						Removable Activity Results			
	Alpha ¹			Beta-Gamma			Alpha		Beta-Gamma	
	Gross CPM	BKG	Net DPM/100 cm ²	Gross CPM	BKG	Net DPM/100 cm ²	Gross CPM	Net DPM/100 cm ²	Gross CPM	Net DPM/100 cm ²
SHW-330-F-C-1	3	1	28.1	327	220	1050	1	3.4	79	101
SHW-330-F-C-2	3	1	-3.9	205	220	-147	0	0.0	72	54
SHW-330-F-C-3	2	1	-8.2	189	220	-304	0	0.0	75	74
SHW-330-F-C-4	1	1	13.7	272	220	510	0	0.0	81	115
SHW-330-F-C-5	2	1	26.3	320	220	981	0	0.0	81	115
SHW-330-F-C-6	4	1	8.7	253	220	324	0	0.0	82	122
SHW-330-F-C-7	0	1	59.7	447	220	2227	0	0.0	72	54
SHW-330-W-G-8	3	1	11.8	180	135	441	0	0.0	52	-81
SHW-330-W-P-9	4	1	-19.5	196	270	-726	0	0.0	77	88

Comments:	¹ See Comment #2 on the comments page regarding the alpha total activity values reported.
------------------	--

$$\text{net DPM}/100 \text{ cm}^2 = \frac{\text{Gross CPM} - \text{BKG}}{\text{Total Efficiency} \times A/100}$$

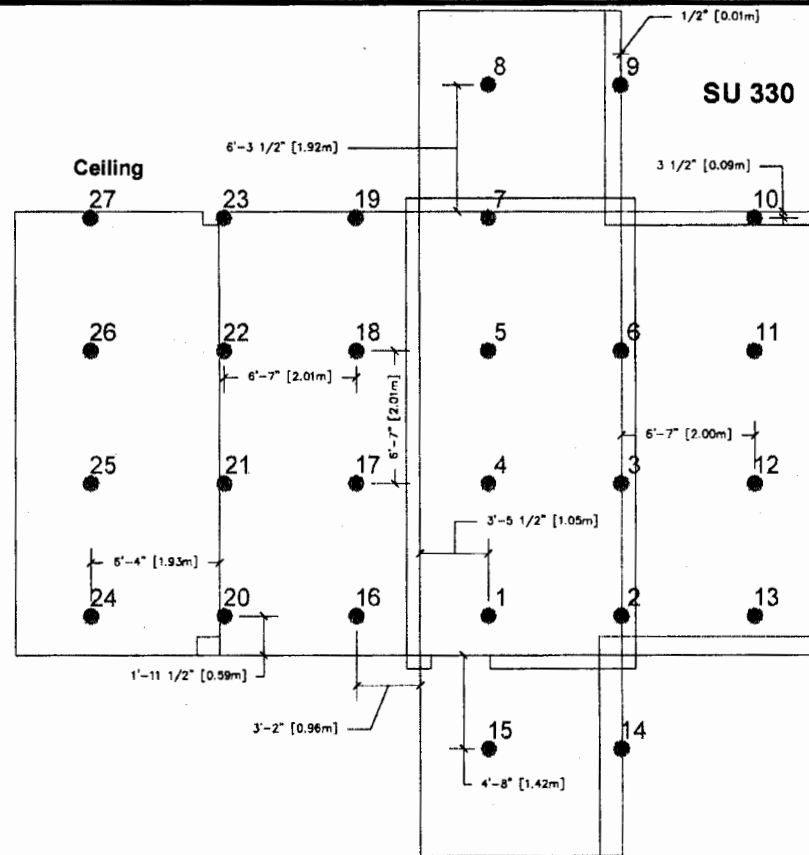
Ameriphysics LLC
Final Status Survey Design Package

Building: SHW Survey Unit ID: 330 Page 7 of 12
 Marssim Classification: ☒ Class 1 ☐ Class 2 ☐ Class 3
 Room Nos. Included in Survey Unit: 330

[illegible]

Ameriphysics LLC
Final Status Survey Design Package

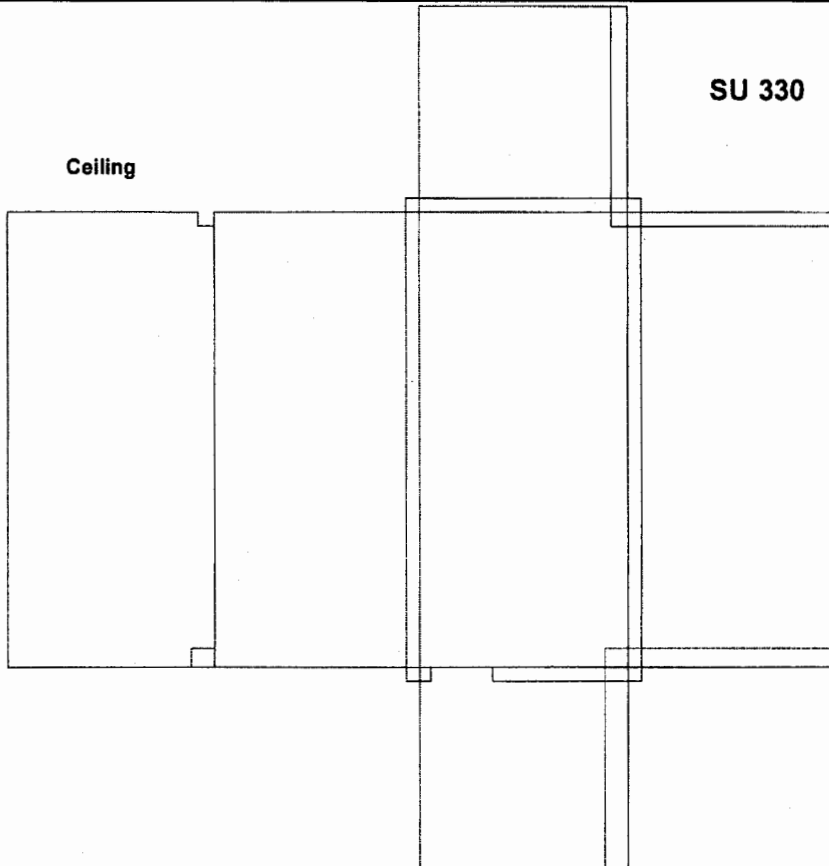
Building: <u>SHW</u>	Survey Unit ID: <u>330</u>	Page <u>8</u> of <u>12</u>
Marssim Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: 330		



Comments: N/A

Ameripysics LLC
Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>330</u>	Page	<u>9</u>	of	<u>12</u>
Marssim Classification:	<input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3						
Room Nos. Included in Survey Unit:	330						

<p>Ceiling</p> 	<p>SU 330</p>
Comments: Performed 100% scan for alpha and beta. No elevated activity detected.	

Assay Definition-

Assay Description:

Assay Type: CPM

Report Name: Report1

Output Data Path: C:\Packard\Tricarb\Results\TJP\Ameripysics\20161220_1637

Raw Results Path: C:\Packard\Tricarb\Results\TJP\Ameripysics\20161220_1637\20161220_1637.results

Assay File Name: C:\Packard\TriCarb\Assays\Ameripysics.lsa

Count Conditions-

Nuclide: 3H-14C-Open

Quench Indicator: tSIE/AEC

External Std Terminator (sec): 0.5 2s%

Pre-Count Delay (min): 0.00

Quench Set: n/a

Count Time (min): 1.00

Count Mode: Normal

Assay Count Cycles: 1

Repeat Sample Count: 1

#Vials/Sample: 1

Calculate % Reference: Off

Background Subtract: On - IPA

Low CPM Threshold: Off

2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	9.05
B	12.0	156.0	6.05
C	0.0	2000.0	24.13

Count Corrections-

Static Controller: On

Luminescence Correction: Off

Colored Samples: n/a

Heterogeneity Monitor: n/a

Coincidence Time (nsec): 18

Delay Before Burst (nsec): 75

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count	Time	CPMA	CPMB	CPMC	SIS	MESSAGES	tSIE
1	1.00		4	7	18	76.14		445.87
2	1.00		13	4	22	48.77		528.41
3	1.00		12	13	31	94.66		543.41
4	1.00		8	0	5	0.00		518.55
5	1.00		4	7	22	57.52		439.07
6	1.00		4	3	10	63.03		528.70
7	1.00		8	5	16	48.33		345.79
8	1.00		6	7	21	87.44		572.63
9	1.00		2	0	4	40.12		573.75
10	1.00		7	0	3	0.00		571.85
11	1.00		6	7	16	95.16		491.08
12	1.00		8	4	19	99.28		555.79

Protocol# 1 - Ameripysics.lsa

User: TJP

SHW-202 *3H* 12/21/16
330

13	1.00	5	3	15	110.69	584.72
14	1.00	0	5	4	486.17	561.59
15	1.00	9	6	20	66.14	526.87
16	1.00	12	3	21	68.65	568.73
17	1.00	7	1	11	22.29	544.65
18	1.00	3	6	17	109.29	544.97
19	1.00	7	0	10	60.81	546.65
20	1.00	20	0	22	10.31	522.11
21	1.00	0	0	0	0.00	551.15
22	1.00	6	2	18	68.63	524.70
23	1.00	8	0	9	5.40	496.24
24	1.00	8	7	17	82.58	558.64
25	1.00	10	5	20	68.43	550.56
26	1.00	9	4	18	69.39	573.52
27	1.00	16	5	28	54.41	565.88

Ameriphysics LLC
Final Status Survey Design Package

Building: SHW **Survey Unit ID:** 330 **Page** _____ **of** _____
Marssim Classification: ☒ Class 1 ☐ Class 2 ☐ Class 3
Room Nos. Included in Survey Unit: **330**

Comments Section

[illegible]

Ameripysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>331</u>	Page <u>1</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>331</u>		

Approvals

Prepared By:


Jordan Davidson

12-12-16
Date


Reviewed By:


Tim Pratt, Project Manager

12/12/16
Date

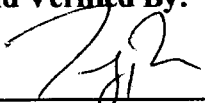
Completion and Review

Data Collected and/or Converted By:

 , HPT
Name, Title

12-14-16
Date

Reviewed and Verified By:


Tim Pratt, Project Manager

12/27/16
Date

Ameriphsics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>331</u>	Page <u>2</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>331</u>		

Radionuclides of Historical Use: ²⁰⁷ Bi, ¹⁴ C, ³⁶ Cl, ⁶⁰ Co, ¹³⁷ Cs, ¹⁵² Eu, ¹⁵⁴ Eu, ³ H, ⁶³ Ni, ²¹⁰ Pb, ²²⁶ Ra, ⁹⁰ Sr, ²⁰⁴ Tl, ²³⁵ U, ²³⁸ U	Approximate Date of Last Use: Unknown
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Eliminated Due to Decay Since Date of Last Use: None
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Remaining Radionuclides of Concern: ²⁰⁷ Bi, ¹⁴ C, ³⁶ Cl, ⁶⁰ Co, ¹³⁷ Cs, ¹⁵² Eu, ¹⁵⁴ Eu, ³ H, ⁶³ Ni, ²¹⁰ Pb, ²²⁶ Ra, ⁹⁰ Sr, ²⁰⁴ Tl, ²³⁵ U, ²³⁸ U
--

Release Limits (DCGLs)			
	Total Activity Limits	Removable Activity Limit	Limits Based On:
Alpha	480 dpm/100 cm ²	48 dpm/100 cm ²	²³⁵ U
Beta/Gamma	7,100 dpm/100 cm ²	710 dpm/100 cm ²	⁶⁰ Co

Applicable Survey Unit Surfaces	% of Accessible Surface for Scan Surveys
<input checked="" type="checkbox"/> Floors	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Lower Walls	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Upper Walls	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input checked="" type="checkbox"/> Ceiling	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input checked="" type="checkbox"/> 100%
<input type="checkbox"/> Structures (Interior and Exterior Surfaces)	<input type="checkbox"/> 10% <input type="checkbox"/> 10-100% <input type="checkbox"/> 100%

Required Survey Instrumentation	Measurement Type	Static Count Time:	Scan Rate	Efficiency Based On:
Ludlum 2360 w/ 43-68	Gross Alpha and Beta Total Activity	1 minute	5 cm/sec	Beta- ¹⁴ C Alpha - ²³⁰ Th
Ludlum 2360 w/ 43-37	Gross Alpha and Beta Scans	N/A	5 cm/sec	Beta- ¹⁴ C Alpha - ²³⁰ Th
Ludlum 3030E w/43-10-1	Gross Alpha and Beta Removable Activity	1 minute	N/A	Beta- ¹⁴ C Alpha - ²³⁰ Th
Liquid Scintillation Counter	Low Energy Beta Removable Activity	1 minute	N/A	³ H, ¹⁴ C
Other: <u>(Specify)</u>	N/A	N/A	N/A	N/A

Ameripysics LLC
Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>331</u>	Page	<u>3</u>	of	<u>12</u>
MARSSIM Classification:	<input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3						
Room Nos. Included in Survey Unit:	<u>331</u>						

Survey Instructions

1)	Perform the required scan surveys at the rate prescribed on the previous page. Document the performance of the scan survey on the attached survey maps using markings and legends as necessary to allow the reviewer enough information to verify that sufficient areas has been covered.
2)	The estimated number of static measurement locations needed for the statistical evaluation of this survey unit is 17.
3)	For Class 1 and Class 2 survey units, the locations are determined by using a random start point and a systematic spacing from this point. Due to this method, the actual number of plotted locations may vary. In this case, collect the actual locations provided on the survey map even if this number is greater than 17. For most cases, surveys are designed to plot 17-25 sample locations since the estimated required number of 17 locations was based on estimated result variations and averages.
4)	Locate and mark the required measurement locations using the provided survey map(s). Survey Maps have been provided with the required measurement locations. Sufficient detail has been provided on these maps to measure and locate all of these locations.
5)	Collect static measurements for gross beta and gross alpha at each identified location. Collect wipe samples for gross beta, gross alpha and LSC at each sample location. Document the results on the associated data results sheets. Additional measurements may be taken in suspect areas at the discretion of the Project Manager or survey technician. However, these additional locations are not included in the analysis of the statistical sample set.
6)	Notify the Project Manager if any static measurement or applicable removable contamination measurements exceeds the applicable investigation level.
7)	Ensure that all package information is completed and signed prior to turning in this Survey Package to the Project Manager for review.

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>331</u>	Page <u>4</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit:		331

Location Code Description

A unique location code shall be assigned to each individual survey location to ensure proper data management of the survey results. The following format shall be used to ensure consistency throughout the final status survey process:

BBBB-RRRR-SS-M-LLL

Where:

BBBB =	Building or area code. This field represents the facility area. This will be the building number or an assigned area number. (1 to 4 characters)
RRRR =	Survey unit ID code. This field has been assigned based on the actual building room number or a specific number assigned by the Field Work Supervisor. (1 to 4 characters)
SS =	Structural surface code. This field represents the structural surface such as floor, wall, ceiling, etc. and the surface division code. For example, if a room has a very large floor area it may be divided into two or more divisions and each section would be assigned unique codes such as F1, F2 and so on. Walls may be divided on a frequent basis. If only one surface area is identified for a particular survey area, then the default number will be "1" (e.g. W1, F1, etc.). (2 characters)
M =	Structural material code. This field represents the type of structural material on which a particular measurement is taken. This field is used for background assignment, data sorting and analysis. The Field Work Supervisor assigns applicable codes. (1 character)
LLL =	Numerical identification number. This field represents the survey point assigned numerical identifier. The field "001" means survey point location number 1. Numerical Identifiers shall not be duplicated within the same survey unit. (3 characters)

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>331</u>	Page <u>5</u> of <u>12</u>
MARSSIM Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>331</u>		

Survey Unit Type: Building Surfaces and Structures

Survey Unit Area: 116.66 m²

Floor Area: 26.03 m²

Number of Samples used for Calculation (N): 25

X-axis dimension: 13.84 m

X Rand:¹ 0.200333033

Y-axis dimension: 12.81 m

Y Rand:¹ 0.411252367

X-Axis Start Location:² 2.77 m

Y-Axis Start Location:² 5.27 m

Sampling Spacing (L): 2.16 m


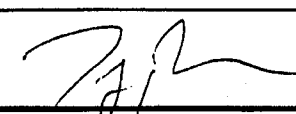
$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Note 2: X-Axis and Y-Axis start locations were calculated by multiplying the appropriate dimension by the corresponding random number.

Ameriphysics LLC
Final Status Survey Design Package

Building: <u>SHW</u>	Survey Unit ID: <u>331</u>	Page <u>6</u> of <u>12</u>
Marssim Classification: <input checked="" type="checkbox"/> Class 1 <input type="checkbox"/> Class 2 <input type="checkbox"/> Class 3		
Room Nos. Included in Survey Unit: <u>331</u>		

Project Name: IU Swain Hall		Project Number: 1119-16		Survey Number: 1119-023		Date: 12/14/2016	
						Time: 12:30	

Instrument / Detector	Serial Number	Cal. Due Date	Total Efficiency	Background (CPM)	Probe Area (cm ²)	Surveyor: Jordan Davidson
Ludlum 2360/Ludlum 43-37 (Alpha)	185769/PR216876	4/29/2017	8.68%	See Comments	584	Signature: 
Ludlum 2360/Ludlum 43-37 (Beta)	185769/PR216876	4/29/2017	7.20%	See Comments	584	
Ludlum 2360/Ludlum 43-68 (Alpha)	297722/PR216848	3/3/2017	7.87%	See Below	126	Reviewer: Tim Pratt
Ludlum 2360/Ludlum 43-68 (Beta)	297722/PR216848	3/3/2017	8.09%	See Below	126	
Ludlum 3030E/Ludlum 43-10-1 (Alpha)	328277/PR337587	3/3/2017	29.73%	0	100	Signature: 
Ludlum 3030E/Ludlum 43-10-1 (Beta)	328277/PR337587	3/3/2017	14.81%	64	100	

Location Code	Total Activity Results						Removable Activity Results			
	Alpha ¹			Beta-Gamma			Alpha		Beta-Gamma	
	Gross CPM	BKG	Net DPM/100 cm ²	Gross CPM	BKG	Net DPM/100 cm ²	Gross CPM	Net DPM/100 cm ²	Gross CPM	Net DPM/100 cm ²
SHW-331-F-C-1	1	1	-1.3	215	220	-49	0	0.0	70	41
SHW-331-F-C-2	2	1	-3.2	208	220	-118	0	0.0	100	243
SHW-331-F-C-3	1	1	-3.4	207	220	-128	1	3.4	93	196
SHW-331-F-C-4	2	1	-7.1	193	220	-265	0	0.0	63	-7
SHW-331-F-C-5	1	1	-12.4	173	220	-461	0	0.0	91	182
SHW-331-F-C-6	3	1	19.5	294	220	726	0	0.0	76	81
SHW-331-F-C-7	0	1	64.9	467	220	2423	0	0.0	82	122
SHW-331-F-C-8	2	1	0.5	222	220	20	0	0.0	75	74
SHW-331-W-G-9	2	1	-2.1	127	135	-78	0	0.0	85	142

Comments: ¹See Comment #2 on the comments page regarding the alpha total activity values reported.

$$\text{net DPM} / 100 \text{ cm}^2 = \frac{\text{Gross CPM} - \text{BKG}}{\text{Total Efficiency} \times A / 100}$$

Final Status Survey Design Package

Building: SHW

Survey Unit ID: 331

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- Class 3

331

Location Code	Total Activity Results						Removable Activity Results			
	Alpha ¹			Beta-Gamma			Alpha		Beta-Gamma	
	Gross CPM	BKG	Net DPM/ 100 cm ²	Gross CPM	BKG	Net DPM/ 100 cm ²	Gross CPM	Net DPM/ 100 cm ²	Gross CPM	Net DPM/ 100 cm ²
SHW-331-W-P-10	1	1	1.3	275	270	49	0	0.0	78	95
SHW-331-W-P-11	1	1	-1.1	266	270	-39	0	0.0	82	122
SHW-331-W-P-12	0	1	1.3	275	270	49	0	0.0	88	162
SHW-331-W-P-13	2	1	2.9	281	270	108	0	0.0	85	142
SHW-331-W-P-14	1	1	5.5	291	270	206	0	0.0	72	54
SHW-331-W-P-15	2	1	8.7	303	270	324	0	0.0	72	54
SHW-331-W-P-16	2	1	1.3	275	270	49	0	0.0	73	61
SHW-331-W-P-17	1	1	5.3	290	270	196	0	0.0	82	122
SHW-331-W-P-18	3	1	5.8	292	270	216	0	0.0	73	61
SHW-331-W-P-19	0	1	7.4	298	270	275	0	0.0	99	236
SHW-331-W-P-20	0	1	7.1	297	270	265	0	0.0	63	-7
SHW-331-W-P-21	1	1	5.0	289	270	186	0	0.0	92	189
SHW-331-W-P-22	1	1	6.3	294	270	235	0	0.0	79	101
SHW-331-W-P-23	1	1	4.5	287	270	167	0	0.0	93	196
SHW-331-W-P-24	0	1	2.6	280	270	98	1	3.4	94	203
SHW-331-C-P-25	2	1	-1.3	265	270	-49	0	0.0	77	88
SHW-331-C-P-26	2	1	-7.9	240	270	-294	0	0.0	74	68
SHW-331-C-P-27	1	1	-0.5	268	270	-20	0	0.0	89	169
SHW-331-C-P-28	1	1	-0.8	267	270	-29	0	0.0	71	47
SHW-331-C-P-29	2	1	-4.5	253	270	-167	0	0.0	59	-34
SHW-331-C-P-30	3	1	-0.8	267	270	-29	0	0.0	76	81
SHW-331-C-P-31	2	1	-6.3	246	270	-235	0	0.0	65	7
SHW-331-C-P-32	1	1	-9.2	235	270	-343	0	0.0	76	81

Comments: ¹See Comment #2 on the comments page regarding the alpha total activity values reported.

Final Status Survey Design Package

Building: SHW

Survey Unit ID: 331

Page 8 of 12

Marssim Classification:

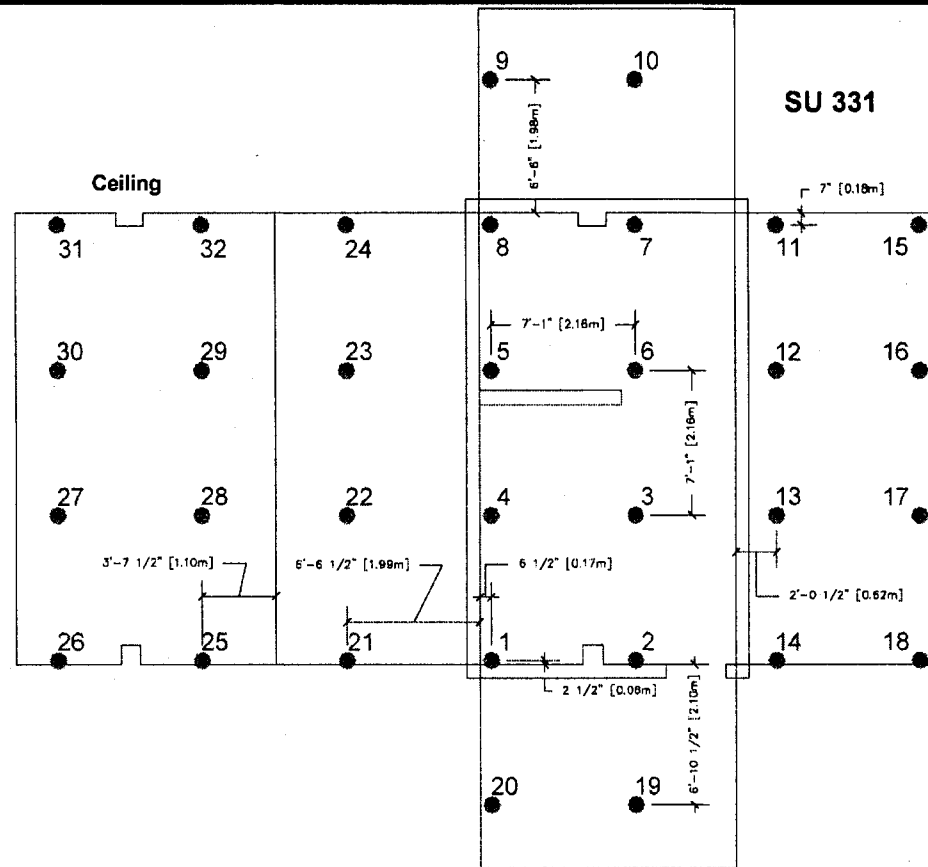
☒ Class 1

☐ Class 2

☐ Class 3

Room Nos. Included in Survey Unit:

331



Comments: N/A

Final Status Survey Design Package

Building: SHW

Survey Unit ID: 331

Page 9 of 12

Marssim Classification:

☒ Class 1

☐ Class 2

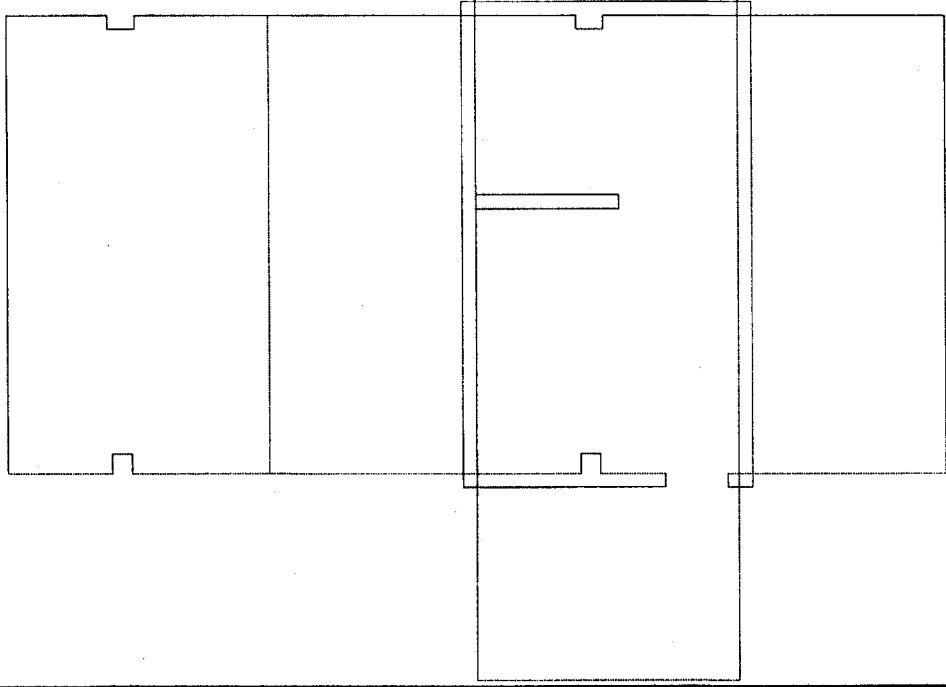
☐ Class 3

Room Nos. Included in Survey Unit:

331

SU 331

Ceiling



Comments: Performed 100% scan for alpha and beta. No elevated activity detected.

Assay Definition-

Assay Description:

Assay Type: CPM
 Report Name: Report1
 Output Data Path: C:\Packard\Tricarb\Results\TJP\Ameriphysics\20161221_0925
 Raw Results Path: C:\Packard\Tricarb\Results\TJP\Ameriphysics\20161221_0925\20161221_0925.results
 Assay File Name: C:\Packard\TriCarb\Assays\Ameriphysics.lsa

Count Conditions-

Nuclide: 3H-14C-Open
 Quench Indicator: tSIE/AEC
 External Std Terminator (sec): 0.5 2s
 Pre-Count Delay (min): 0.00
 Quench Set: n/a
 Count Time (min): 1.00
 Count Mode: Normal
 Assay Count Cycles: 1 Repeat Sample Count: 1
 #Vials/Sample: 1 Calculate % Reference: Off

Background Subtract: On - IPA
 Low CPM Threshold: Off
 2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	9.05
B	12.0	156.0	6.05
C	0.0	2000.0	24.13

Count Corrections-

Static Controller: On Luminescence Correction: Off
 Colored Samples: n/a Heterogeneity Monitor: n/a
 Coincidence Time (nsec): 18 Delay Before Burst (nsec): 75

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count	Time	CPMA	CPMB	CPMC	SIS	MESSAGES	tSIE
1	1.00	7	7	19	50.67			280.18
2	1.00	6	1	13	79.71			482.19
3	1.00	10	4	19	37.01			454.69
4	1.00	6	2	11	77.75			456.18
5	1.00	1	1	11	378.89			474.69
6	1.00	3	7	15	120.71			470.70
7	1.00	6	0	12	93.73			463.81
8	1.00	1	5	14	209.62			412.16
9	1.00	6	2	14	87.79			516.65
10	1.00	3	2	7	87.97			517.82
11	1.00	2	5	17	174.53			563.59
12	1.00	11	3	25	79.47			567.91

Protocol# 4 - Ameriphsysics.lsa

User: TJP

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13	1.00	8	0	13	38.59	566.62
14	1.00	2	0	0	0.00	558.98
15	1.00	7	4	10	72.39	570.05
16	1.00	1	1	10	121.86	543.76
17	1.00	1	1	5	225.78	563.12
18	1.00	6	4	19	62.21	581.71
19	1.00	6	0	5	199.94	571.45
20	1.00	6	5	20	88.41	549.89
21	1.00	12	0	20	40.25	550.23
22	1.00	15	0	19	37.35	542.63
23	1.00	13	0	19	45.24	545.40
24	1.00	4	7	21	118.76	566.87
25	1.00	13	0	21	77.65	537.86
26	1.00	10	2	21	48.13	543.82
27	1.00	5	4	12	120.21	551.82
28	1.00	8	4	16	66.71	533.32
29	1.00	18	8	29	46.49	540.68
30	1.00	8	5	21	109.19	526.83
31	1.00	5	2	18	88.90	525.42
32	1.00	1	4	14	140.79	511.03

Final Status Survey Design Package

Building:	<u>SHW</u>	Survey Unit ID:	<u>331</u>	Page		of	
Marssim Classification:	<input checked="" type="checkbox"/> Class 1	<input type="checkbox"/> Class 2	<input type="checkbox"/> Class 3				
Room Nos. Included in Survey Unit:	<u>331</u>						

Comments Section

Date	Comment
12/14/2016	1. Backgrounds for the 43-37 varied from material to material. (0-15 cpm Alpha) (750-1600cpm Beta)
12/14/2016	2. Alpha total activity measurements were corrected based on the alpha to beta ratio determined from a composite concrete sample performed on the highest detectable activity floor areas prior to remediation. This ratio is determined using the gross alpha/beta results from laboratory analysis. The ratio is 48.2 pCi/g alpha divided by 1800 pCi/g beta or 0.0268.
12/14/2016	3. See attached LSC results.

N/A