NRC FORM 314
(01-2021)
10 CFR 30.36(j)(1); 40.42(j)(1); 70.38(j)(1); and 72.54(k)(5)(1)(1)

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF DISPOSITION OF MATERIALS

APPROVED BY OMB: NO. 3150-0028 EXPIRES: 03/31/2023

LICENSEE NAME AND ADDRESS	LICENSE NUMBER	DOCKET NUMBER
Cayman Chemical Company, Inc. 1180 East Ellsworth Road Ann Arbor, MI 48108	21-24683-01	030-29143
	LICENSE EXPIRATION DATE December 31, 2021	

A. LICENSE STATUS (Check the appropriate box)

☐ This license has expired. ☑ This license has not yet expired; please terminate it.

B. DISPOSAL OF RADIOACTIVE MATERIAL

(Check the appropriate boxes and complete as necessary. If additional space is needed, provide attachments)

The licensee, or any individual executing this certificate on behalf of the licensee, certifies that:

☐ 1. No radioactive materials have ever been procured or possessed by the licensee under this license.

☑ 2. All activities authorized by this license have ceased, and all radioactive materials procured and/or possessed by the licensee under this license number cited above have been disposed of in the following manner.

☐ a. Transfer of radioactive materials to the licensee listed below:

☑ b. Disposal of radioactive materials:

☐ 1. Directly by the licensee:

☐ 2. By licensed disposal site:

☑ 3. By waste contractor:

Philotechnics, Ltd.
201 Renovare Blvd., Oak Ridge, TN 37830 (Phone: 865-483-1551)

☑ c. All radioactive materials have been removed such that any remaining residual radioactivity is within the limits of 10 CFR Part 20, Subpart E, and is ALARA.

C. SURVEYS PERFORMED AND REPORTED

☑ 1. A radiation survey was conducted by the licensee. The survey confirms:

☐ a. the absence of licensed radioactive materials

☑ b. that any remaining residual radioactivity is within the limits of 10 CFR 20, Subpart E, and is ALARA.

☐ 2. A copy of the radiation survey results:

☑ a. is attached; or ☐ b. is not attached (Provide explanation); or ☐ c. was forwarded to NRC on: ____________ Date

☐ 3. A radiation survey is not required as only sealed sources were ever possessed under this license, and

☐ a. The results of the latest leak test are attached; and/or ☐ b. No leaking sources have ever been identified.

The person to be contacted regarding the information provided on this form:

NAME	TITLE	TELEPHONE *(Include Area Code)*	E-MAIL ADDRESS
Anita Cooney	Manager, Regulatory and Safety	734-249-5560	acooney@caymanchem.com

Mail all future correspondence regarding this license to:

1180 E. Ellsworth Road, Ann Arbor, MI 48108

C. CERTIFYING OFFICIAL

I CERTIFY UNDER PENALTY OF PERJURY THAT THE FOREGOING IS TRUE AND CORRECT

PRINTED NAME AND TITLE	SIGNATURE	DATE
Shannon Stacey, VP Quality and Regulatory Affairs	Shannon Stacey	12/21/2021

WARNING: FALSE STATEMENTS IN THIS CERTIFICATE MAY BE SUBJECT TO CIVIL AND/OR CRIMINAL PENALTIES. NRC REGULATIONS REQUIRE THAT SUBMISSIONS TO THE NRC BE COMPLETE AND ACCURATE IN ALL MATERIAL RESPECT. 18 U.S.C. SECTION 1001 MAKES IT A CRIMINAL OFFENSE TO MAKE A WILLFULLY FALSE STATEMENT OR REPRESENTATION TO ANY DEPARTMENT OR AGENCY OF THE UNITED STATES AS TO ANY MATTER WITHIN ITS JURISDICTION.

CERTIFICATE OF DISPOSITION OF MATERIALS

PLEASE READ THESE INSTRUCTIONS BEFORE COMPLETING NRC FORM 314.

Subpart E of 10 CFR Part 20 establishes the radiological criteria for license terminations/decommissioning of facilities licensed under 10 CFR Parts 30, 40, 50, 60, 61, 70, and 72, as well as other facilities subject to the Commission's jurisdiction under the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended.

INSTRUCTIONS

Section B, Item 2.
Licensees should describe the specific radioactive material transfer actions. If radioactive wastes were generated in terminating this license, the licensee should describe the disposal actions taken, including the disposition of low-level radioactive waste, mixed waste, greater-than-Class-C waste, and sealed sources.

Section B, Item 2.a.
The information provided concerning the transfer of radioactive material to another licensee should specify the date of the transfer, the name of the licensee recipient, an individual contact name and telephone number for the licensee recipient, and the recipient's NRC or Agreement State license number.

Section B, Item 2.b.
For disposal of radioactive materials, licensees should describe the specific disposal method or procedure (e.g., decay-in-storage). For those cases when radioactive materials are disposed of by a licensed disposal site or by a waste contractor, the licensee should specify the name, address, and telephone number of the licensed disposal site operator or waste contractor.

Section B, Item 2.c.
"Residual radioactivity," as defined in 10 CFR 20.1003, means radioactivity in ‘areas' (structures, materials, soils, etc.) remaining as a result of activities (licensed and unlicensed) under the licensee's control from sources used by the licensee, excluding background radiation. ALARA is defined in 10 CFR 20.1003.

FILE CERTIFICATES AS FOLLOWS:

IF YOU ARE LOCATED IN:

ALABAMA, CONNECTICUT, DELAWARE, DISTRICT OF COLUMBIA, FLORIDA, GEORGIA, KENTUCKY, MAINE, MARYLAND, MASSACHUSETTS, NEW HAMPSHIRE, NEW JERSEY, NEW YORK, NORTH CAROLINA, PENNSYLVANIA, PUERTO RICO, RHODE ISLAND, SOUTH CAROLINA, TENNESSEE, VERMONT, VIRGINIA, VIRGIN ISLANDS, OR WEST VIRGINIA, SEND CERTIFICATES TO:

LICENSING ASSISTANT SECTION
NUCLEAR MATERIALS SAFETY BRANCH
U.S. NUCLEAR REGULATORY COMMISSION, REGION I
2100 RENAISSANCE BOULEVARD, SUITE 100
KING OF PRUSSIA, PA 19406-2713

ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, MISSOURI, OHIO, OR WISCONSIN, SEND CERTIFICATES TO:

MATERIALS LICENSING SECTION
U.S. NUCLEAR REGULATORY COMMISSION, REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, IL 60532-4352

IF YOU ARE LOCATED IN:

ALASKA, ARIZONA, ARKANSAS, CALIFORNIA, COLORADO, HAWAII, IDAHO, KANSAS, LOUISIANA, MISSISSIPPI, MONTANA, NEBRASKA, NEVADA, NEW MEXICO, NORTH DAKOTA, OKLAHOMA, OREGON, PACIFIC TRUST TERRITORIES, SOUTH DAKOTA, TEXAS, UTAH, WASHINGTON, OR WYOMING, SEND CERTIFICATES TO:

MATERIAL RADIATION PROTECTION SECTION
U. S. NUCLEAR REGULATORY COMMISSION, REGION IV
1600 E. LAMAR BOULEVARD
ARLINGTON, TX 76011-4511

CAYMAN CHEMICAL COMPANY, INC.
FINAL STATUS SURVEY REPORT
ANN ARBOR, MI

Submitted to:

Cayman Chemical Company, Inc.
1180 E. Ellsworth Road
Ann Arbor, MI 48108

Prepared By: Philotechnics Health Physics Project Manager	Date
Kevin Banks	12/20/2021
Reviewed By: Philotechnics CA-RML RSO	Date
James Reese, CHP	12/20/2021
Reviewed By: Cayman Chemical RSO	Date
Elizabeth Hurst	12/21/2021

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Acronyms and Abbreviations

5025 Building	Cayman Chemical facility located at 5025 Venture Drive, Ann Arbor, Michigan
ALARA	As Low as Reasonably Achievable
C-14	Carbon-14
CA-RML	Philotechnics' State of California Radioactive Materials License Number 7754-37
Cayman	Cayman Chemical Company, Incorporated
CHP	Certified Health Physicist
CFR	Code of Federal Regulations
DCGL	Derived Concentration Guideline Level
$DCGL_W$	The DCGL applicable to the average concentration over a survey unit is called the $DCGL_W$
DP	Decommissioning Plan
dpm/100 cm^2	Disintegrations Per Minute Per 100 Square Centimeters
DQO	Data Quality Objective
DSV	Default Screening Value
FSS	Final Status Survey
FSSR	Final Status Survey Report
H-3	Tritium
HPT	Health Physics Technician
HSA	Historical Site Assessment
HVAC	Heating, Ventilation, and Air Conditioning
I-125	Iodine-125
LBGR	Lower Bound of the Gray Region
LLRW	Low-Level Radioactive Waste
LTR	License Termination Rule
MARSAME	Multi-Agency Radiological Survey and Assessment of Materials & Equip
MARSSIM	Multi-Agency Radiological Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
NUREG	Nuclear Regulatory Commission Guidance Document
OSHA	Occupational Safety and Health Administration
P-32	Phosphorous-32
Philotechnics	Philotechnics, Ltd.
PM	Project Manager
PPE	Personal Protective Equipment
QA	Quality Assurance
QC	Quality Control
RAM	Radioactive Materials
RML	Radioactive Materials License
ROC	Radionuclide of Concern
RSO	Radiation Safety Officer
RSP	Radiation Safety Program
S-35	Sulfur-35
SDS	Safety Data Sheet
SU	Survey Unit
TEDE	Total Effective Dose Equivalent

GLOSSARY

ALARA. Acronym for "as low as is reasonably achievable," which means making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical, consistent with the purpose for which the licensed activity is undertaken, and taking into account the state of technology, the economics of improvements in relation to the state of technology, the economics of improvements in relation to the benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest (see 10 CFR 20.1003).

Characterization survey. A type of survey that includes facility or site sampling, monitoring, and analysis activities to determine the extent and nature of residual radioactivity. Characterization surveys provide the basis for acquiring necessary technical information to develop, analyze, and select appropriate cleanup techniques.

Decommission. To remove a facility or site safely from service and reduce residual radioactivity to a level that permits (1) release of the property for unrestricted use and termination of the license or (2) release of the property under restricted conditions and termination of the license.

Decontamination. The removal of undesired residual radioactivity from facilities, soils, or equipment prior to the release of a site or facility and termination of a license. Also known as remediation, remedial action, and cleanup.

Derived Concentration Guideline Levels. Radionuclide-specific concentration limits used by the licensee during decommissioning to achieve the regulatory dose standard that permits the release of the property and termination of the license. The Derived Concentration Guideline Level applicable to the average concentration over a survey unit is called the Derived Concentration Guideline Level Wide-Area. The Derived Concentration Guideline Level applicable to limited areas of elevated concentrations within a survey unit is called the Derived Concentration Guideline Level Elevated Measurement Comparison.

Dose (or radiation dose). A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of 10 CFR 20.1003. In this NUREG report, dose generally refers to total effective dose equivalent.

Decommissioning Plan. A detailed description of the activities that the licensee intends to use to assess the radiological status of its facility, to remove radioactivity attributable to licensed operations at its facility to levels that permit release of the site in accordance with Nuclear Regulary Commission's regulations and termination of the license, and to demonstrate that the facility meets Nuclear Regulatory Commission's requirements for release. A Decommissioning Plan typically consists of several interrelated components, including (1) site characterization information; (2) description of remedial approach that has several components, including a description of remediation tasks, health and safety, and quality assurance; (3) site-specific cost estimates for the decommissioning; and (4) a final status survey plan.

Final Status Survey. Measurements and sampling to describe the radiological conditions of a site or facility, following completion of decontamination activities (if any) and in preparation for release of the site or facility.

Final Status Survey Report. The results of the Final Status Survey conducted by a licensee to demonstrate the radiological status of its facility. The Final Status Survey Report is submitted to Nuclear Regulatory Commission for review and approval.

Historical Site Assessment). The identification of potential, likely, or known sources of radioactive material and radioactive contamination based on existing or derived information for the purpose of classifying a facility or site, or parts thereof, as impacted or non-impacted.

Impact. The positive or negative effect of an action (past, present, or future) on the natural environment (land use, air quality, water resources, geological resources, ecological resources, aesthetic and scenic resources) and the human environment (infrastructure, economics, social, and cultural).

Impacted Areas. The areas with some reasonable potential for residual radioactivity in excess of natural background or fallout levels.

Leak Test. A test for leakage of radioactivity from sealed radioactive sources. These tests are made when the sealed source is received and on a regular schedule thereafter. The frequency is usually specified in the sealed source and device registration certificate and/or license.

Multi-Agency Radiation Site Survey and Investigation Manual (NUREG–1575) is a multi-agency consensus manual that provides information on planning, conducting, evaluating, and documenting building surface and surface soil final status radiological surveys for demonstrating compliance with dose- or risk-based regulations or standards.

Monitoring. Monitoring (radiation monitoring, radiation protection monitoring) is the measurement of radiation levels, concentrations, surface area concentrations, or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses.

Non-impacted Areas. The areas with no reasonable potential for residual radioactivity in excess of natural background or fallout levels.

Residual Radioactivity. Radioactivity in structures, materials, soils, ground water, and other media at a site resulting from activities under the licensee's control. This includes radioactivity from all licensed and unlicensed sources used by the licensee but excludes background radiation. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of 10 CFR Part 20.

Scoping Survey. A type of survey that is conducted to identify (1) radionuclide contaminants, (2) relative radionuclide ratios, and (3) general levels and extent of residual radioactivity.

Site Characterization. Studies that enable the licensee to sufficiently describe the conditions of the site, separate building, or outdoor area to evaluate the acceptability of the decommissioning plan.

Survey Unit. A geographical area consisting of structures or land areas of specified size and shape at a site for which a separate decision will be made as to whether the unit attains the site-specific reference-based cleanup standard for the designated pollution parameter. Survey units are established to facilitate the survey process and the statistical analysis of survey data.

1 INTRODUCTION

Cayman Chemical Company, Inc. (Cayman) decided to cease all operations; permanently decommission their facility located at 5025 Venture Drive (5025 Building), Ann Arbor, Michigan 48108; and terminate their Nuclear Regulatory Commission (NRC) Radioactive Materials License (RML) (NRC-RML) Number 21-24683-01. As a result, Philotechnics, Ltd. (Philotechnics) was contracted to perform independent third-party final surveys and attain release for unrestricted use of the site.

The facility received, stored, and used radionuclides for research and development. Licensed radionuclides included Hydrogen-3 (H-3), Carbon-14 (C-14), Phosphorus-32 (P-32), Sulfur-35 (S-35), and Iodine-125 (I-125).

The only rooms wherein radioactive materials (RAM) were used or stored within the 5025 Building were rooms 1357 (hot lab), 1350 (the transport area), and the hallway between the transport area and the hot lab. The 5025 Building is a single story, and the hot lab is a radiological designated and isolated room with a floor area of approximately (~) 410 square feet (ft^2) located in the 5025 Building. The 5025 Building has a footprint of ~ 25,000 ft^2 bounded Morgan Road to the North, Venture Drive to the West, Payeur Road to the South, and Marton Road to the East. The 5025 Building is located in Ann Arbor, Michigan. See Appendix A for site plan, facility layout and satellite image.

Philotechnics performed all project activities per the Decommissioning Plan (DP) developed following the requirements listed in Chapter 16 and 17 of NRC Guidance Document (NUREG) 1757 Volume 1, Revision 2, and approved by Cayman. The DP detailed work activities to be conducted during the final surveys of the site and ensured pertinent information was acquired to support RML termination.

The NRC divides decommissioning into seven (7) groups as defined in Chapter 7 of *NUREG 1757 Volume 1, Consolidated NMSS Decommissioning Guidance – Decommissioning Process for Materials Licensees* (*NUREG-1757 Vol.1*) based on the complexity of the decommissioning and the decommissioning alternatives in the License Termination Rule (LTR). RAM used at the facility consisted of a variety of radionuclides for research. All the radionuclides of concern (ROC)s were supported by NRC DandD code. Since ROCs were supported by DandD; have associated Default Screening Values (DVS)s as detailed in **Section 6 Release Criteria** below; no groundwater contamination exists; and a Decommissioning Plan was not required by Cayman's NRC-RML) Conditions, Cayman categorized this decommissioning effort as Group 2 and a DP was not required.

However, as detailed in **Section 1.3 Project Specific DP** below, as a common practice, Philotechnics routinely prepares a DP for any project or activity involving the possession, use of, or work with materials with the potential for exposure to ionizing radiation. Therefore, the DP was developed and submitted for Cayman review and subsequent approval.

The DP ensured analytical data and pertinent information were acquired to provide for the RML termination. The DP followed the guidance and recommendations provided in NUREG 1757, "*Consolidated NMSS Decommissioning Guidance*"; and NUREG 1575, "*Multi-Agency Radiation Survey and Site Investigation Manual*" (*MARSSIM*) the *"Multi-Agency Radiation Survey and Assessment of Materials and Equipment"* (*MARSAME*), and NRC regulations. This guidance provided the approach, methods, and techniques for the final surveys and radiological release for unrestricted use of the 5025 Building hot lab.

To demonstrate compliance with the Derived Concentration Guideline Levels (DCGLs), final status surveys (FSS)s implemented the protocols and guidance provided in *MARSSIM*. This ensured technically defensible data was generated to release each facility for unrestricted use in accordance with the criterion of 10 Code of Federal Regulations (CFR) §20.1402, *"A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a Total Effective Dose Equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and that the residual radioactivity has been reduced to levels that are ALARA. Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal"*.

All on site activities were conducted under the direction of Cayman's Radiation Safety Officer (RSO) and per the radiological program associated with Cayman's NRC-RML and Radiation Safety Program (RSP) requirements and Radiation Safety Manual, 2017 Revision. The intent was to successfully release the site for unrestricted use.

Remediation was not required.

1.1 General Site Description

1.1.1 Ann Arbor

The currently occupied building at 5025 Venture Drive, Ann Arbor, Michigan 48108 contains impacted Room 1357 hot lab.

Figure 1 – Cayman Chemical Corporation, Inc. Ann Arbor Location

1.2 Historical Site Assessment

The purpose of the historical site assessment (HSA) was to determine the current status of the site including potential, likely or known sources of radioactive contamination by gathering data from various sources. This data included physical characteristics, site location and information found in operating records, including previous radiological surveys.

Mr. Ken Gavlik, Philotechnics, conducted interviews and correspondence with Elizabeth Hurst, B.S., Ph.D., Cayman RSO and Anita Cooney, Certified Safety Professional (CSP), Certified Hazardous Materials Manager (CHMM), Cayman Manager of Regulatory and Safety to acquire pertinent historical RAM use and storage information for the site. Cayman conducted a thorough review of historical operations and use from the beginning of licensed operations. Use and storage included receipt, storage, and use of radionuclides for research and development. Used and/or stored radionuclides consisted of H-3, C-14, and P-32. I-125 and S-35 were never received at the facility.

1.3 Project Specific DP

Although not required for this decommissioning, Philotechnics routinely prepares a DP for any project or activity involving the possession, use of, or work with materials with the potential for exposure to ionizing radiation and prepared a DP for this project. The DP complied with Cayman's policy and procedural requirements and provided the overall guidance to execute the scope of work in a manner that protected workers, the public, and the environment.

Specific guidance for implementation of radiological safety operations was provided by Cayman's RSP.

1.4 Worker Exposure - As Low as Reasonably Achievable (ALARA)

It was the team's policy that all work with potential RAM or ionizing radiation be purposeful and performed in a manner that protected workers, members of the public, and the environment. Work involving radiological hazards did not begin unless that work could be performed in a safe and compliant manner.

Radiological work was planned and performed per Cayman's RSP and Radiation Safety Manual, 2017 Revision, to ensure worker's radiation exposures were maintained As Low AS Reasonably Achievable (ALARA); to minimize the creation and spread of surface contamination; to minimize the creation and spread of airborne RAM; and to minimize the creation of radioactive waste. The team endorsed and applied ALARA principles to radiological work so that all exposures to radiation were maintained ALARA.

1.5 Scope of Work

The radiological scope of work involved the following activities:

- Task-specific training of personnel
- Ordering, maintaining, function checking, and operating radiological survey instrumentation
- Performing FSS to ensure all impacted areas met the release criteria
- Managing records for radiological data gathered during site operations
- Writing, reviewing, and maintaining plans, procedures, instructions, and other documents in support of the radiological scope of work
- Disposing of Low-Level Radioactive Waste (LLRW), in a separate scope and mobilization

1.6 Quality Control and Auditing

To assure compliance and evaluate implementation, quality control (QC) measures included self-assessment and management reviews of all data and FSS implementation.

1.6.1 Self-Assessment, Management Reviews, and Audits

Periodic self-assessments and management reviews included evaluation of exposure rates, data, and efficacy of established radiological work practices, ALARA practices, and use and effectiveness of personal protective equipment (PPE).

1.6.2 Daily Instrumentation Check

Philotechnics' laboratory and field radiological instrumentation were used, operated, and maintained by project Health Physics Technicians (HPT)s under the supervision of the Project Manager (PM) and Cayman RSO for this project.

It is routine practice that each day a radiation instrument was used for making a field measurement; the instrument was checked for background and source response prior to use. Functional checks were performed daily or prior to use.

All instruments used had current annual calibration in accordance with the manufacturer's recommendations employing standards and sources traceable to the National Institute of Standards and Technology (NIST). Copies of instrument calibration certificates were maintained on site and are available in **Appendix C**.

1.6.3 Review of Radiological Records

Radiological instrumentation paperwork and radiological surveys were reviewed by the RSO or designee for completeness and accuracy. Copies of the records generated by this work remained on site for the duration of project activities.

1.7 Final Status Survey Implementation

FSS implemented the protocols and guidance provided in *MARSSIM* to ensure technically defensible data of sufficient quality and quantity were generated to release the facility for unrestricted use, and to ensure residual radioactivity had been reduced to levels that were ALARA.

1.8 Findings

Prior to removing the facility from Cayman's NRC-RML, the NRC requires an appropriate survey and report be submitted for review and approval. This report provides Cayman with appropriate information to request removal of the 5025 Building from their NRC-RML and terminate the license.

The survey and analytical data followed industry standard and NRC guidance and recommendations, and the following summarizes the independent conclusions representing Philotechnics' best professional judgment based on information and data available during the project.

Table 1-1 – Assessment Review

Assessment Component	Acceptable	Unacceptable
License Review & Historical Use	X	
Radiation Surveys		
A) Static Measurements – Hand-held instruments	X	
B) Static Measurements – Scintillation Counter	X	
C) Scanning Measurements – Hand-held instruments	X	

1.9 Conclusions and Recommendations

A review of all data collected, and analysis supports our professional opinion; the surveyed impacted areas of concern can be released for unrestricted use based upon the following:

- ***All scanning measurements were less than the established detection sensitivities to meet the release criteria and conservative ALARA goals in disintegrations per minute per 100 square centimeters (dpm/100 cm^2) and established using best industry practices.***

- ***All Final Status Survey static measurements were less than the release criteria and conservative ALAR goals.***
- ***All Final Status Survey wipe survey measurements were less than the conservative removable release criteria in dpm/100 cm^2.***

Based upon survey results, it is Philotechnics' professional opinion the 5025 Building is free of any residual radioactive contamination and it may be removed from Cayman's NRC-RML with no further action in accordance with 10 CFR §30.36 "*Expiration and termination of licenses and decommissioning of sites and separate buildings or outdoor areas*".

Prior to vacating the premises, Cayman will verify all labels, signs, or other similar markings indicating the presence of RAM are removed or obliterated. Additionally, no concerns requiring further investigation exist at this time.

2 FACILITY OPERATING HISTORY

The decommissioning process evaluated the property's environmental status for release of impacted areas to allow unrestricted use by current or future tenants. Philotechnics and Cayman performed an HSA to review facility operations as they pertained to RAM use and storage. Assessment activities related to the decommissioning of the facility included the following tasks:

- A visual survey of historic RAM storage areas in order to identify potential contamination and/or presence of RAM;
- Interviews with client personnel regarding the historical use of RAM;
- Review of existing documentation, as provided, regarding prior inspections, investigations, events or conditions at the facility related to RAM use, including RAM license, applications, amendment requests, incident reports, records of RAM delivered to and shipped from the site, RAM inventories and facility renovation records, radiological surveys of the facility and records of RAM shipments into and out of the site and the RSO provided relevant records;
- Direct surveys of all impacted areas with the use of portable hand-held radiation detection equipment to identify the presence of RAM; and
- Indirect surveys to test for removable contamination with the use of a scintillation counter and wipes taken throughout the impacted areas.

2.1 Licensed Operations

Mr. Ken Gavlik, Philotechnics, conducted interviews and correspondence with Elizabeth Hurst, B.S., Ph.D., Cayman RSO and Anita Cooney, CSP, CHMM, Cayman's Manager of Regulatory and Safety to acquire pertinent historical RAM use and storage information for the site. This interview and correspondence revealed the site was operated for receiving, and storage of radionuclides, along with research and development involving H-3, C-14, and P-32. While the facility was licensed to use I-125 and S-35, they were never received or used in the 5025 Venture Road facility.

Cayman also used task specific training, enhanced ventilation, and fume hoods to the degree necessary based on the level of use of RAM. Hoods were routinely checked for flow rates and proper sash height to verify proper operation. To ensure proper controls of materials during operations, users performed surveys of the areas, and waste containers prior to transfer to ensure areas were not inadvertently cross-contaminated and contamination was controlled.

The site's routine survey protocol was to perform contamination surveys after each use of the radioactive lab, and once every six months if the lab was not in use in identified locations such as work areas, surrounding floor, and small and large equipment that may have been touched during the experiment. Surveys were reviewed for consistency, anomalies, and outliers. None were noted. The results of the Cayman radiation meter and wipe surveys indicated all items were free from any residual contamination and at natural background levels.

According to Cayman there were never any spills, container deterioration/breakage, or other contamination events at the site. Leak tests were not required for facility operations.

RAM used and/or storage areas at the site are summarized in **Table 2-1 – Restricted Area Summary** below and identified on the building diagrams.

Table 2-1 - Restricted Area Summary

Cayman Chemical Ann Arbor		
Area	**Room**	**Historical Radionuclide usage**
Hot Lab	1357	C-14, H-3, P-32

2.2 License Number/Status/Authorized Activities

Cayman was authorized to possess the following radionuclides as summarized in **Table 2-2 – RAM License Possession Limits** below as referenced by RML 21-24683-01:

Table 2-2 – RAM License Possession Limits

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
A. Iodine-125	A. Prepackaged Units	A. 2.5 millicuries
B. Hydrogen-3	B. Prepackaged Units	B. 100 millicuries
C. Carbon-14	C. Prepackaged Units	C. 50 millicuries
D. Phosphorous-32	D. Any	D. 10 millicuries
E. Hydrogen-3	E. Any	E. 10 millicuries
F. Carbon-14	F. Any	F. 2 millicuries
G. Sulfur-35	G. Any	G. 20 millicuries

9. Authorized use:
   A. through C. For receipt, storage and redistribution of prepackaged units to persons specifically licensed for the type, form and quantity of byproduct material by the Nuclear Regulatory Commission or an Agreement State.
   D. through G. For research and development as defined in 10 CFR 30.4.

2.2.1 Ann Arbor

Cayman operated under NRC-RML Number 21-24683-01 with an expiration date of December 31, 2021. Current possession limits and copy of RML are provided as **Attachment A**.

2.3 Licensed Radionuclides Used or Stored at Cayman Chemical Ann Arbor

The following licensed RAM were used or stored at each site:

Table 2-3 - Radionuclides Used and/or Stored at the 5025 Building

Radionuclide	Half-Life	Half-Life >120 Days	Predominant Emissions	Physical Form
H-3	12.32 years	YES	Beta	Dispersible and Sealed-Prepackaged Units
C-14	5730 years	YES	Beta	Dispersible and Sealed-Prepackaged Units
P-32	14.27 days	NO	Beta	Dispersible

From the above radionuclides, P-32 possesses a short half-life <120 days and, although listed on the RML, I-125 and S-35 were never received or used at the facility. Therefore, I-125, P-32, and S-35 were eliminated as ROCs. Therefore, the only ROC for the purposes of FSS were C-14 and H-3.

Table 2-4 - Radionuclides of Concern for Decommissioning

Radionuclide	Half-Life	Half-Life >120 Days	Predominant Emissions	Physical Form
H-3	12.32 years	YES	Beta	Dispersible and Sealed-Prepackaged Units
C-14	5730 years	YES	Beta	Dispersible and Sealed-Prepackaged Units

Based on the ROC, the team based release criteria on C-14 for the most conservative building structural surface screening value for above ROCs, and also applied ALARA goals and investigation levels.

2.4 Previous Decommissioning Activities

Based on interviews and correspondence with Cayman there were no records of previous decommissioning activities performed at the site, with the exception of close-out surveys.

2.5 Radioactive Materials Spills

There was no record of any known significant spills at the site. Significant spills are defined as those spills that were not readily cleaned up by the researcher and/or caused contamination to be found during follow-up or routine contamination surveys in excess of regulatory limits.

2.6 Prior On-site Burials

There was no record of any on-site burials at the site.

3 FACILITY DESCRIPTION

The facility was divided into three functional areas: office (unrestricted non-radiologically impacted area), non-radiological labs (unrestricted non-radiologically impacted area and a radiological hot lab (radiologically impacted restricted area).

Packages arrived in transport area (room D-1350). Packages were not opened by receiving personnel. Authorized User who placed the order was alerted that the package had arrived. The RSO was notified if the Authorized User was unavailable; however, this was never the case. The Authorized User transported the sealed package to the hot lab and performed contamination checks. RAM was never repackaged or shipped out from this facility.

I-125 and S-35 were never received at this facility. Low energy beta emitters C-14 and H-3 were stored in a locked refrigerator or freezer, as appropriate. P-32 was placed in a plexiglass box at the appropriate storage temperature

3.1 Restricted Area

The impacted lab, Room D-1357, is ~ 410 ft^2 in area. A facility diagram is provided below.

The layout of the room and the initial SU classifications are provided in the floor plan below.

Table 3-1- 5025 Building Hot Lab Description

RSO	Building	Room	Area
Elizabeth Hurst, Ph.D.	5025 Building	1357	**~410 ft^2**

Figure 2 – Cayman Chemical – Ann Arbor Facility 5025 Building Layout

Figure 3 – Room 1357 Hot Lab Class 1 Survey Unit 1 Layout

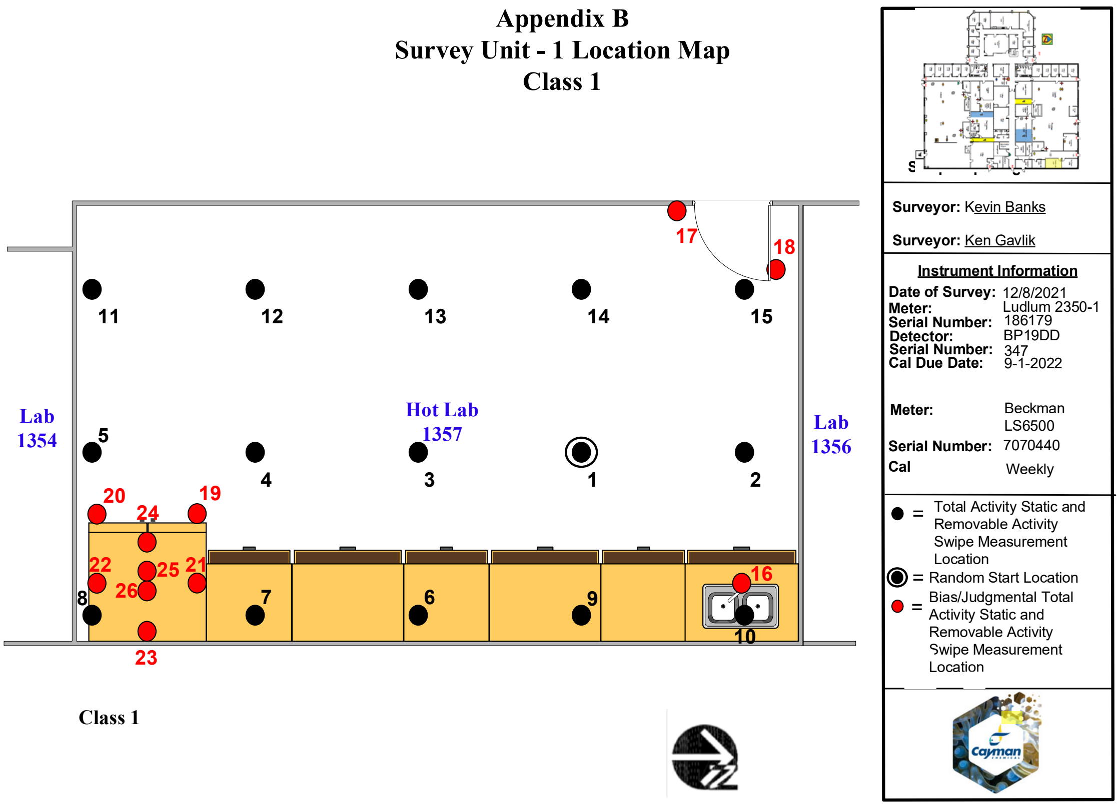
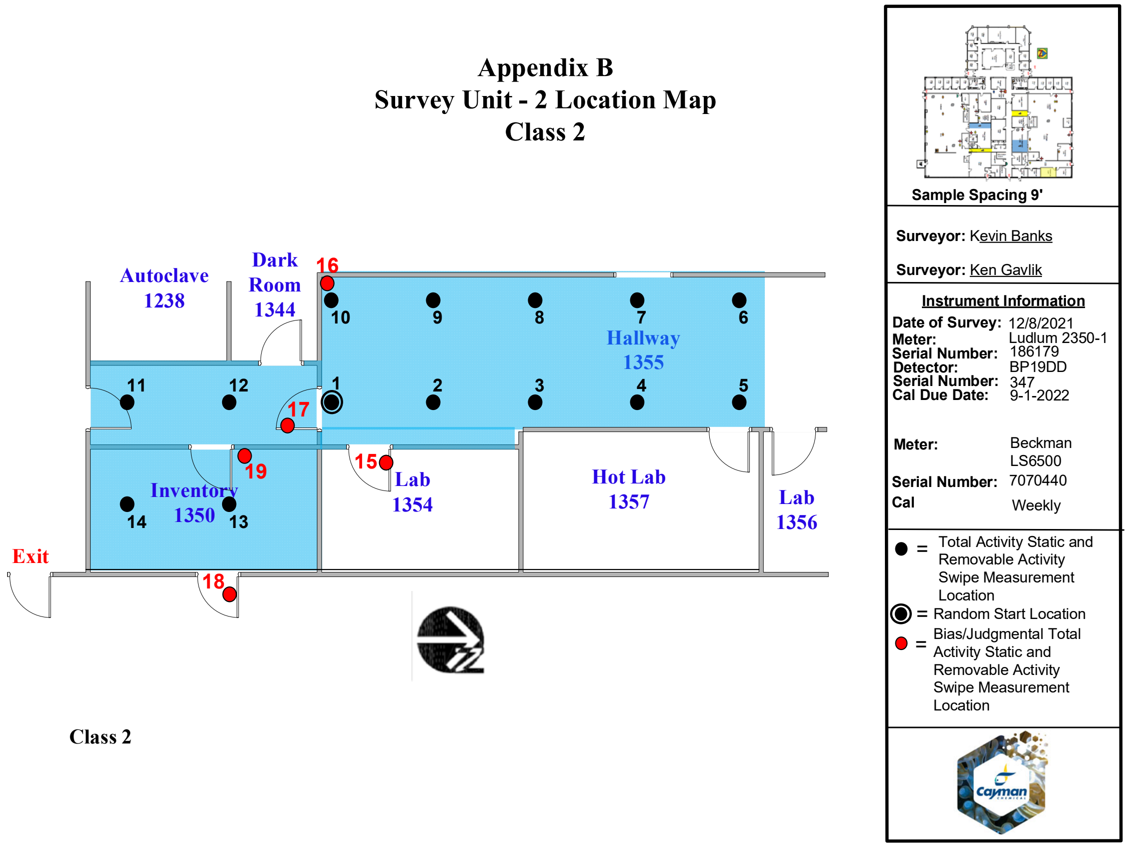


Figure 4 – Hot Lab Boundary Class 2 Survey Unit 2 Layout



3.2 Ownership

The building was leased by Cayman and will be returned to the owner after unrestricted release.

3.3 Population Distribution

Not Applicable – all impacted areas indoors.

3.4 Current/Future Land Use

Not applicable – all impacted areas indoors.

3.5 Meteorology and Climatology

Not applicable – all impacted areas indoors.

3.6 Geology and Seismology

Not applicable – all impacted areas indoors.

3.7 Surface Water Hydrology

Not applicable – all impacted areas indoors.

3.8 Ground Water Hydrology

Not applicable – all impacted areas indoors.

3.9 Natural Resources

Not applicable – all impacted areas indoors.

4 RADIOLOGICAL STATUS

The team expected the impacted areas to meet the release criteria and simply require a *MARSSIM*-based survey. The impacted areas were as expected, met the release criteria, and no remediation was necessary.

5 RADIONUCLIDES OF CONCERN

Radionuclides used and/or stored at the site as provided in **Table 2-3 – Radionuclides Used and/or Stored at the 5025 Building** above. ROC for the purposes of decommissioning were provided in **Table 2-4 - Radionuclides of Concern for Decommissioning** above.

6 RELEASE CRITERIA

The DCGL is the surface area concentration that could result in a TEDE equal to the release criterion for unrestricted use of 25 mrem/year specified in 10 CFR § 20.1402. The DCGL applicable to the average concentration over a SU unit is called the Derived Concentration Guideline Level Wide-Area ($DCGL_W$). In the case of non-uniform contamination, *MARSSIM* allows for evaluation of higher levels of activity over small areas using $DCGL_{EMC}$. The DSV is the NRC Staff developed screening value provided in *NUREG 1757 Consolidated NMSS Decommissioning Guidance*, **Appendix B Screening Values**, **Table B.1 Acceptable License Termination Screening Values of Common Radionuclides for Building-Surface Contamination** which correspond to levels of radionuclide contamination that would be deemed in compliance with the unrestricted use dose limit in 10 CFR §20.1402 to support implementation of the LTR, and to simplify decommissioning in cases where low levels of contamination exist to provide reasonable assurance that the dose criterion in 10 CFR §20.1402 will be met. For the purposes of this decommissioning, the DCGLs were set equal to the *NUREG 1757* DSVs for the most restrictive ROC C-14 and $DCGL_{EMC}$ was not utilized.

Due to the radiological cleanliness of the facility, based on the information provided by Cayman, and in an effort for the project team to ensure it applied ALARA approaches to minimize residual contamination, the $DCGL_W$ was used as a maximum value and small areas of elevated activity were not considered in the survey design.

In addition, the team implemented an ALARA Goal of C-14 surface contamination level in dpm/100 cm^2 equivalent to 1 mrem/year (3,700,000 dpm/100 cm^2 divided by 25 mrem or 148,000 dpm/100 cm^2) for FSS design. ALARA considered any detriments, such as death from transportation accidents, expected to potentially result from decontamination and waste disposal, and an appropriate survey and report were submitted for review and approval. The team utilized Cayman's most restrictive administrative removal contamination limit of three times the mean background in dpm/100 cm^2 to determine if the impacted areas were suitable for release for unrestricted use. Background was measured at locations constructed at the same time using similar materials. No surfaces or structures were identified as above release criterion.

Table 6-1 – NRC 25 mRem/year TEDE Equivalent Surface Contamination Limits and ALARA Goal

ROC	ALARA Goal TEDE Result per one (1) mRem/Year	NRC TEDE Criteria for Release for Unrestricted Use	DSV Equivalent for Release for Unrestricted Use
	dpm/100cm^2	mRem/Year	dpm/100cm^2
C-14	148,000	25	3.7E+06

Close out surveys performed by Cayman were reviewed, and the team did not expect any remediation to be required. No remediation was required for this decommissioning effort.

6.1 Screening Values

Cayman screening values for all radionuclides is listed in **Table 6-2**. The total activity values listed are maximum values and Philotechnics implemented practices to ensure all final readings are ALARA.

Table 6-2 – Default Screening Values for ROCs

Radionuclide	Total Activity $DCGL_W$ ($dpm/100cm^2$) [1]	Removable Activity $DCGL_W$ ($dpm/100cm^2$)[2]
Beta-Gamma Emitters	**3.7E+06**	**3 x Mean Background**

[1] – Cayman utilized C-14 screening value and implement practices to ensure all final readings are ALARA consistent with Table 6-1 ALARA Goal.

[2] – Cayman utilized its conservative site-specific removable activity limit.

7 ENVIRONMENTAL INFORMATION

This project did not affect quality of the human environment; did not affect species listed in Section 7 of the Endangered Species Act; and did not affect historic properties.

8 ALARA ANALYSIS

NUREG 1757, Volume 2, Appendix N states in part: *"For ALARA during decommissioning, all licensees should use typical good-practice efforts such as floor and wall washing, removal of readily removable radioactivity in buildings or in soil areas, and other good housekeeping practices. In addition, licensees should provide a description in the Final Status Survey Report (FSSR) of how these practices were employed to achieve the final activity levels."* Based on the contamination levels indicated during the HSA, and routine and close-out surveys, a quantitative ALARA analysis was not required.

9 PROJECT MANAGEMENT AND ORGANIZATION

The team performed all survey work under the direction of a PM. The onsite team consisted of the PM and an HPT.

In addition, the project team had the full support of the corporate expertise available from Philotechnics' corporate offices. These included the RSO (a Certified Health Physicist (CHP)), the Corporate Health and Safety Officer, and the Corporate Quality Assurance Manager.

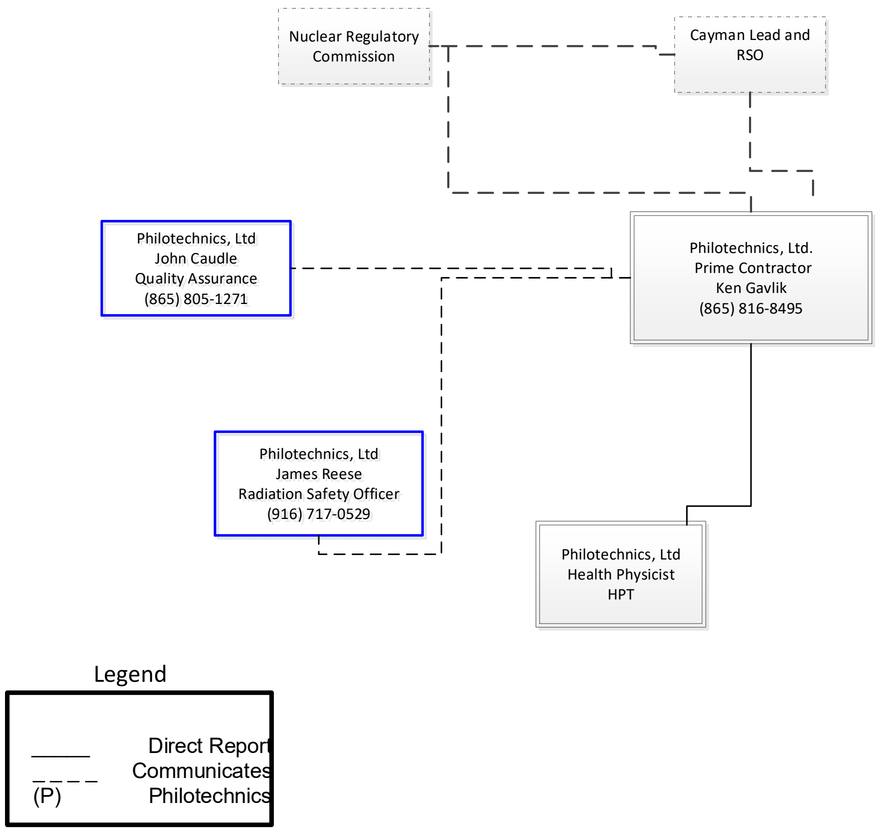
The following management structure was utilized for administration and implementation of the decommissioning.

Figure 9-1 – Team Experience on Similar Work

Name, Title / Role	Experience Highlights
Ken Gavlik • Project/Program Manager	• Over 25 years of experience in experience in radiation protection and radiological services, applied Health Physics, facility decommissioning, radiological and hazardous waste management. regulatory support and environmental compliance, with over 20 of those spent managing MARSSIM decommissioning projects. • Author of the Decommissioning Plan and Subject Matter Expert for NYC Office of Emergency Preparedness and Response Radiological Advisory Committee. • Personally designed, planned, and managed over 100 radiological services projects with many facilities released without question or comment from various regulatory authorities including Agreement States and the NRC. Projects include license termination and release for unrestricted use of two of the largest R&D facilities in the US, containing in excess of two million square feet of impacted areas each • BS with concentrations in Nuclear Engineering Technology and Radiation Protection • MBA • US Navy Submarine Veteran of the Navy Nuclear Power Program
Kevin Banks • Health Physicist/Health Physics Technician	• Over a decade of practical experience in health physics. • Comprehensive knowledge of regulatory requirements and recommendations in the field of decommissioning based upon NUREG 1757, MARSSIM and NRC regulations. • Managed in excess of 30 Final Status Surveys for the unrestricted release under NRC, CDPH RHB, and multiple Agreement State guidelines • Philotechnics Gamma Spectroscopy and Instrument lead. • BS Radiation Physics
William Button, • President Support	• President Philotechnics • Over 40 years of experience in Health Physics • BA • MS Nuclear Engineering • Post Graduate research Nuclear Chemistry
James Reese, CHP, RRPT • Program Manager • CHP • Support	• California License RSO • 35 years of experience in Health Physics; 5 years as Branch Chief for NRC Regions V and IV • Extensive experience in working and communicating with NRC, State, Local regulators for licensing and decommissioning activities • Extensive experience in MARSSIM site closures at complex and sensitive sites. • President of the Decommissioning Section of the Health Physics Society • Extensive experience working the universities to remove historically sensitive buildings from RMLs through the implementation of MARSSIM • MARSSIM Certification

Additionally, the Cayman Chemical management organization described in **Section 10**, provided relevant data and support, and made final decisions for the decommissioning effort:

Cayman Chemical
5025 Building
Radiological Decommissioning/ License Termination
Project - Organizational Chart



9.1 Project Manager

The PM oversaw all aspects of the project and was in direct contact with the designated client representative. The PM had the responsibility to ensure the clients project goals and milestones were met. Ken Gavlik was the PM.

9.2 HPT

The HPT doubled as the Project Health and Safety Officer (PHSO) and ensured all health and safety elements were implemented and enforced on site.

The HPT reported directly to the PM and implemented and enforced site health and safety procedures in the field. The HPT had full authority to issue stop work orders or evacuation orders where work operations or noncompliance(s) may threaten the health and safety of site workers or the public. The HPT had the responsibility and authority to perform the following:

- Ensuring compliance with project plans by means of daily site inspections
- Investigating all accidents, injuries, illnesses, near-misses, and other incidents
- Ensuring that project personnel were trained on the risks of hazardous substances on the project, maintaining the Safety Data Sheet (SDS) file to provide easy access to project personnel and performing inspections
- Ensuring that tailgate safety meetings were conducted on days that work was performed and that documentation of all meetings and any other additional training was completed
- Verifying that project safety equipment was properly inspected
- Coordinating site health and safety requirements
- Ensuring maintenance of all health and safety monitoring and PPE and directing site-monitoring activities
- Coordinating daily field activities
- Coordinating site safety and emergency response duties
- Verifying that all personnel had the necessary training and medical clearances
- Determining and posting routes to medical facilities and emergency telephone numbers and arranging for emergency transportation to medical facilities
- Maintaining training records and medical certifications for all on-site personnel
- Maintaining site control procedures
- Maintaining current records of certification for first aid and cardiopulmonary resuscitation for project field personnel
- Ensuring that planning documents were current and controlled
- Attending required scheduled and unscheduled meetings

Additionally, the HPTs performed radiological surveys in support of the project; monitored all radiological work to ensure it was performed safely and compliantly.

9.3 Offsite Support

The PM had access to Philotechnics' off-site corporate support structure which included:

James Reese, CHP, RRPT, Philotechnics' State of California RML (CA-RML) RSO. Mr. Reese brings 41 years of experience in leading professional organizations in the nuclear industry including 5 years as Branch Chief for the NRC. Mr. Reese brings expertise in regulatory affairs, radiation protection, operational health physics, *MARSSIM*, inspections and audits, training, licensing, radiological risk and pathway analysis, emergency preparedness, decommissioning, and transportation.

10 CAYMAN TASK MANAGEMENT

The project was conducted in accordance with the Cayman approved DP. All activities were approved and overseen by Cayman to ensure compliance with the facility NRC-RML. Project tasks were performed according to written plans and procedures to ensure they provided adequate worker protection and complied with the Cayman NRC-RML.

The following Cayman management organization provided relevant data and support, and made final decisions for this effort:

- Cayman RSO – Elizabeth Hurst, Ph.D., Manager of Assay Services and the current RSO. The RSO keeps and provides access to records relevant to this decommissioning effort and is the final decision maker for releasing the 5025 Building for unrestricted use.
- Cayman Manager of Regulatory and Safety – Anita Cooney is a Certified Safety Professional and Certified Hazardous Materials Manager and is the project coordinator for this decommissioning effort.

Survey packages were developed for each SU that contained specific survey instructions. Survey package preparation and completion were approved by the PM and RSO to ensure all survey requirements and Data Quality Objectives (DQO)s were met.

11 TRAINING

Team personnel working on the project job site received indoctrination, site-safety, and radiation awareness training. At a minimum team personnel will have had an occupational physical within the last 12 months and received training in the following:

- 40 Hour (And annual 8 Hour Refresher) Occupational Safety and Health Administration (OSHA) HAZWOPER
- HAZWOPER Supervisor for field supervisors
- All training described in this section

Each worker entering the job site received orientation training and acknowledge these requirements by signing the attendance sheet before working on the site. The job-specific orientation must be revised for any additional hazards identified.

11.1 Radiological Training

The team's radiological training was completed and documented. The PM maintained a copy of everyone's certification on site in the project file.

11.2 Project Specific Training

Prior to project start-up, personnel attended an initial project-specific training session. The training session included the following items:

- Review of all plans, the scope of work and planned work activities
- Review of chemical, physical, and radiological hazards associated with the project
- Discussion of use of PPE
- Project security control and operational work zones
- Emergency response, emergency egress and site evacuation procedures

11.3 General Safety Briefings

General safety meetings were held by the PM at the beginning of each work shift. The purpose of these meetings was to discuss project status, potential problem areas, general safety concerns, and to reiterate the requirements of all plans, procedures, tasks, and hazards.

11.4 Visitor Orientation

There were no visitors.

11.5 Transportation Training

No radioactive or hazardous materials were prepared for storage or transport.

12 SAFETY CONTROLS AND MONITORING FOR WORKERS

All FSS activities were conducted under Cayman's RSP.

12.1 Radiation Work Permits

No Radiation Work Permits were required.

12.2 Air Sampling Program

Air sampling was not required.

12.3 Respiratory Protection Program

No respiratory protection was required.

12.4 Internal Exposure

The project encountered no internal exposure hazards.

12.5 External Exposure

In accordance with 10 CFR 20.1502, adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in § 20.1201(a), are required to be monitored. An a priori assessment has been performed for this effort and determined that it was unlikely that workers would receive an external exposure in excess of 10 percent of the limits in § 20.1201(a), therefore personal dosimetry was not required.

12.6 Contamination Control Program

No remediation was required.

13 HEALTH AND SAFETY

Project health and safety addressed all typical radiological service project activities, and radiological and industrial hazards applicable to all workers and visitors to the site. Project health and safety complemented the project-specific Quality Assurance (QA) included in the DP, and was developed using the following documents (at a minimum). In case of a conflict, the more stringent criteria applied.

- US NRC Regulatory Guides.
- Cayman's RSP.
- Code of Federal Regulations, Titles 10, 29, 40 and 49**.**
- Cayman's Corporate Health and Safety Program.

14 QUALITY ASSURANCE

The DP included project-specific QA utilizing the guidelines of ***MARSSIM*** **Section 9**. The DP was reviewed and approved by Cayman prior to commencing decommissioning operations. The QA portions included the following:

- Description of the Quality Assurance and Quality Control goals, DQOs, procedures, and plans to be implemented for all decommissioning activities.
- Description of the methodology to ensure that all radiological survey data meet the 95% confidence level.
- Description of the sampling and analysis requirements.

The QA portions were developed and organized with emphasis given to maximizing worker safety, minimizing/eliminating off-site releases, and minimizing overall project costs. Quality documents included, but were not limited to:

- Training Records
- Survey Records
- Instrument Records
- Work Permits
- Medical Surveillance Records
- Audit Reports
- Shipping Records
- Work Procedures and Plans

15 ENVIRONMENTAL MONITORING AND CONTROL

All project activities were performed indoors, under strict controls, and in a manner that did not present an elevated risk of environmental releases above normal operations.

16 RADIOACTIVE WASTE MANAGEMENT PLAN

No waste was generated for this FSS project.

17 SCHEDULE

Project on-site field activities were conducted on December 7th and 8th, 2021.

18 INSTRUMENTATION

18.1 Instrument Calibration

All instruments used for radiation monitoring and decommissioning were calibrated on an annual basis by a third-party vendor (Griffin Instruments, Occupational Services Inc., Energy Solutions, Inc. or Environmental Restoration Group, Inc.**)** in accordance with the American National Standards Institute (ANSI) N323A-1997 standard. These calibrations included efficiency determination with the use of NIST traceable standards for radiation emission types and energies that provided detection capabilities like the ROC.

The instrument calibration included data pertinent to efficiency determination based upon the 2π particle fluence (e.g. β/min) of the calibration source.

18.2 Instrument Efficiency

Instrument efficiencies were provided with the calibration certificates from the calibration facility. Beta emitters were based upon the 2π particle fluence (e.g. β/min) from the calibration facility and the total surface activity, A_s, consistent with International Standard ISO 7503-1, "Evaluation of Surface Contamination," is calculated using the following equation:

$$A_s = \frac{R_{S+B} - R_B}{(\varepsilon_{tot})(W)}$$

Where:

R_{S+B}	=	the gross count rate of the measurement in counts per minute (cpm)
R_B	=	the background count rate in cpm
ε_{tot}	=	the 2π instrument or detector efficiency and 0.25 surface efficiency for beta emitters less than 400 KeV and all alpha emitters, and 0.5 surface efficiency for beta emitters greater than 400 KeV (unit less)
W	=	the area of the detector window (cm^2)

It is important to understand, the surface efficiency considered the increased particle emission due to backscatter effects, as well as the decreased particle emission due to self-absorption losses.

As recommended in ISO 7503-1, for beta particles in the energy range of 150 keV to 400 keV, a conservative value of 0.25 was used for ε_s activity calculations.

18.3 Functional Checks

Portable field instruments were response-tested daily or when in use**.**

Background and source readings are taken as part of the daily instrument check and compared with the acceptance range of ± 20 percent. The background, source check and field measurement count times for radiation detection instrumentation were specified by procedure to ensure that measurements were statistically valid. Background readings were taken as part of the daily instrument check and compared with the acceptance range for instrument and site conditions.

No instrument failed functional checks. Daily functional tests were conducted using a NIST traceable sources.

18.4 Determination of Count Times and Minimum Detectable Concentrations

Minimum counting times for background determinations and counting times for measurement of total and removable contamination were chosen to provide minimum detectable concentrations (MDC) that met the DQOs specified in the DP. Equations specified in *MARSSIM* guidance relative to building surfaces were modified to convert to units of $dpm/100cm^2$. **Table 14-2** below provides the counting times, efficiencies and MDCs for each instrument and type of background material.

As a conservative measure, ambient backgrounds (commonly referred to as instrument background - background determined without the surface material present to preclude interference from the naturally occurring radioactivity in the surface material) was taken at waist height in the center of the room and used for all structures and surfaces. Use of ambient backgrounds for structures and surfaces without the interference of surface material background emissions allowed for additional conservatism when subtracting background from the reported total activity and scan results.

Count times and scanning rates were determined using the following equations:

18.5 Total Activity Measurement (Static) Counting

Total activity measurement counting MDCs, at a 95 percent confidence level were 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*", Equation 6-7 (Strom & Stansbury, 1992):

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

Where:

MDC_{static} = minimum detectable concentration level in dpm/100 cm^2
B_R = background count rate in counts per minute
t_B = background count time in minutes
t_S = sample count time in minutes
ε_{tot} = total detector efficiency for radionuclide emission of interest (includes combination of instrument and surface efficiencies)
A = active area of the detector in cm^2

Calculations and results provided in **Appendix E – Minimum Detectable Concentration Measurement Results.**

18.6 Scan Surveys

Surface and structures scanning MDC at a 95 percent confidence level was calculated using the following equation, which is a combination of ***MARSSIM*** **Equations 6-8, 6-9** and **6-10** utilizing the methodology described in Section above and the following equation:

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

Where

d' = minimum detectable concentration level in dpm/100 cm^2
b_i = background counts during the observation interval
i = observation interval
p = surveyor efficiency (0.5)
ε_{tot} = total detection efficiency for radionuclide emission of interest includes combination of instrument and surface efficiencies)
A = active area of the detector in cm^2

Calculations and results provided in **Appendix E – Minimum Detectable Concentration Measurement Results.**

18.7 Smear Counting

The smear counting MDC at a 95 percent confidence level was calculated using the following equation, which is found in NUREG 1507, "*Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions,*" Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{Smear} = \frac{3 + 3.29\sqrt{B_R \cdot t_S \cdot (1 + \frac{t_S}{t_B})}}{t_S \cdot \varepsilon_{tot}}$$

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
ε_{tot} = total detector efficiency for radionuclide emission of interest (includes combination of instrument and surface efficiencies)

Calculations and results provided in **Appendix E – Minimum Detectable Concentration Measurement Results.**

18.8 Counting Uncertainty, Error Propagation and Confidence Interval

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

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

Where:

σ_{R_b} = Statistical counting uncertainty
C_{s+b} = gross counts of the sample (cpm)
T_{s+b} = Sample time (minutes)
C_b = Gross background counts (cpm)
T_b = Background count time (minutes)

Because calculations to determine the final total activity measurement results were based on dividing the net count rate by total efficiency, the uncertainty propagation formula to be used 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 total activity measurement result in dpm/100 cm^2
σ_{R_b} = Standard deviation of the net count rate
R_b = Net count rate
σ_E = Standard deviation of the instrument efficiency
E = Instrument 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 were presented as the result in dpm/100 cm^2 $\pm 1.96\sigma_A$.

Confidence interval and error propagation were insignificant, when compared to total activity results, and the ALARA Goals and release criteria. Therefore, the results were not included in this report.

18.9 Instrument Specifications

Instrumentation used for the decommissioning surveys is summarized in **Tables 18-1 and 18-2**. **Table 18-1**, Instrument Specifications, lists the standard features of each instrument such as probe size and efficiency. **Table18-2**, Instrument Operating Parameters, and sensitivities lists the typical operational parameters such as scan rate, count time, and the associated MDCs.

Table 18-1 – Instrumentation Specifications

Detector Model	Detector Type	Detector Area	Meter Model	Typical Total Efficiency
BP19DD Small Area Probe - Beta	Scintillation	100 cm^2	Ludlum 2350-1	4.35%
Ludlum 43-37-1 Large Area Probe - Beta	Gas Flow Proportional	821 cm^2	Ludlum 2350-1	9%
Beckman LS6500	Liquid Scintillation	N/A	Beckman	48% (H-3) 94% (C-14)

18.9.1 Typical Instrument Operating Parameters and Sensitivities

The table below lists the typical operational parameters such as scan rate, count time, and the associated MDCs.

Instrument efficiencies are described in **Instrument Efficiency** section above.

Site-specific background measurements of each surface type (e.g., concrete and tile) are conducted and used in calculating each instrument’s MDC. Scan rates and total activity measurement counting times are adjusted as necessary to satisfy the requirements identified the Data Quality Objectives.

Table 18-2 – Typical Instrument Operating Parameters and Sensitivities

Measurement Type	Detector Model	Meter Model	Scan Rate (in/s)	Count Time (s)	Background (cpm)	MDC (dpm/100cm^2)
Total Activity Small Area Probe - Beta	BP19DD	Ludlum 2350-1	N/A	60	450	2,337 (C-14)
Surface Scans Small Area Probe - Beta	BP19DD	Ludlum 2350-1	10	N/A	450	12,450 (C-14)
Surface Scans Large Area Probe - Beta	Ludlum 43-37-1	Ludlum 2350-1	10	N/A	1,150	215 (C-14)
Removable Beta Activity	Beckman LS6500	Beckman	N/A	60	21 (H-3) 10 (C-14)	36.5 (H-3) 22.8 (C-14)

19 PROJECT APPROACH

The following sections detail the order in which the FSS was performed. The team provided all personnel, qualified staff, on-site and off-site labor, materials, equipment, analytical services and other required resources to fully implement the DP as approved by Cayman in accordance with the RML requirements; NRC guidance documents for decommissioning utilizing industry standard practices; NRC guidelines, requirements, and recommendations; and all applicable federal, state, and local regulations.

Operations were compliant with Cayman's corporate plans and procedures where applicable. Records were maintained of all operations, activities, and personnel radiation exposures as required by 10 CFR 20, Subpart L, Records.

The team ensured safety and protections to prevent damage, injury, or loss to workers, the public, Cayman personnel or property, and the environment.

The team performed the decommissioning and quality compliance management for all site activities during the project.

The team worked closely with Cayman's management to ensure everyone was working towards the common goal to:

- Protect occupational workers and the public;
- Identify and control of radioactive commodities/items;
- Maintain custody and traceability of any identified radioactive commodities/items; and
- Design and perform the project in a manner to collect data of sufficient quality and quantity to provide Cayman with a technically defensible release of it facility.

QC measures, including self-assessment and management reviews were employed to assure compliance.

The project was conducted according to the DP approved by Cayman staff.

All aspects of the project were conducted in a manner to:

- Control the potential spread of contamination, and prevent cross-contamination,
- Protect the public and project personnel involved in the performance of decommissioning, and keep personnel exposure ALARA,
- Minimize the volume and types of waste generated,
- Ensure proper radiological controls were instituted to control materials and equipment within the site and prior to leaving radiologically controlled areas, and
- Perform segregation of radiological materials.

Work Breakdown Structure

The following provides the work breakdown structure:

19.1 Historical Site Assessment

Philotechnics, in conjunction with Cayman, verified the HSA prior to commencing field operations. The purpose of this verification was to verify the current status of each facility including potential, likely, or known sources of radioactive contamination by gathering data from various sources. This included physical characteristics of the site as well as information found in site operating records. The records review included NRC-RML, applications and amendment requests, radiological surveys, radionuclide receipt and distribution records, waste inventories, incident reports, facility renovation records, blueprints, plans and design specifications. Additional personnel interviews included radiation safety, operations, and facilities personnel. The HSA was used to design and develop the DP.

19.2 Pre-mobilization

The team prepared the required project plans and procedures, developed final survey packages, established vendor accounts, and procured equipment and supplies. Philotechnics submitted and attained approval by Cayman for the DP.

19.3 Mobilization

The team mobilized the crew and equipment to a work site. General and project specific training was conducted. Portable hand-held instruments were set up, and initial and daily response check paperwork completed. All mobilization activities were coordinated with Cayman. These activities included arranging for unobstructed access for Philotechnics personnel, and mobilization of equipment and miscellaneous materials.

19.4 Radiation Safety Training

Training was conducted by Cayman safety and the Philotechnics PM. Training included review of health and safety, tasks, hazards, associated precautions, procedures, emergency egress routes and assembly areas.

Each employee received orientation training and acknowledged these requirements by signing the attendance sheet before working on the site.

19.5 Characterization

Characterization surveys were designed in accordance with the guidance contained in ANSI N13.59, "Characterization in Support of Decommissioning" using the DQO Process (2008). Characterization obtained the necessary data for verification of decisions, development of the approach, design of the DP and provided data on:

- Determining the nature and extent of contamination at the site to decide whether the contamination exceeded release criteria;

- Identifying potential contamination – including radiological and non-radiological hazardous materials;
- Determining the concentration and distribution of these contaminants in building structures and surfaces;
- Assessing projected waste volumes and evaluating cleanup technologies;
- Identifying the appropriate radiological controls; and
- Providing any additional input for FSS design.

The accuracy needed for characterization depended on the decision made using the characterization data, and to generate sufficient data to plan. The design of the site characterization survey was based on the specific DQOs for the information to be collected and was planned, utilizing the HSA. Additionally, characterization was essential for the classification of wastes to demonstrate that transportation and disposal criteria have been met (e.g., waste acceptance criteria). A secondary, but no less important objective, was to use characterization data to support the design of FSS.

Characterization design and implementation was flexible, such that characterization efforts and scope could have been increased based on survey findings. That is, once implementation of the characterization plan had been initiated, deviations from the plan could be warranted if contamination levels encountered were significantly different than anticipated. Contamination levels were not significantly different than anticipated.

Characterization surveys were designed to ensure a seamless process and meet the same quality objectives as the FSS such that characterization data can be used as FSS data. Initial characterization survey results indicated that contamination was not present in excess of the release criteria, and data from the survey was used as part of the FSS.

The DP ensured characterization was designed and implemented for seamless process execution during a single field mobilization.

19.5.1 Building Structural Surfaces

The survey protocol for building surfaces consisted of performing scan surveys of accessible, and inaccessible surfaces by removing obstructions when warranted, with judgmental smears and static measurements in areas with the highest probability for residual radioactivity.

The purpose of scanning was to identify locations of elevated activity. No locations of elevated activity were identified. As previously discussed, characterization protocol included normally inaccessible areas such as under and within casework and shelving, the underside of benchtops, within drawers, surfaces under sink, sink drains, and sink traps, and on top of casework and shelves, etc.

19.5.2 Building Systems

Survey design for materials, equipment and systems (drains and Heat, Ventilation, Air Conditioning (HVAC)) were out of the scope of *MARSSIM*; however, for the purposes of identifying potential residual contamination a static (if geometrical considerations warranted) and removable measurement was collected at all system internal locations.

For the purposes of identifying potential residual contamination within these systems (ventilation and drain); scans, static measurements and removable contamination surveys were taken at system access points (existing or installed), system inlets, collection points and discharges to the extent possible due to geometric considerations and safety.

Surveys of building drain system internals consisted of surveys of accessible sink drains and sink drain traps. Removable contamination surveys of sink drains and sink drain traps were collected, since scan surveys and static measurements were not practical due to small geometry. Where the geometric configuration made direct measurements possible, such as sinks and ventilation ducts, direct measurements were performed.

No internal surfaces of exhaust ventilation systems outside the room were surveyed, as they were inaccessible, there were no filter housings, and access was unsafe due to inclement weather. The structural surfaces criteria were applied to these systems. System survey requirements are summarized in the table below. The frequency of the survey effort was dependent on the classification of the surrounding area.

Table 19-1 – Systems Survey Requirements

System	Class 1	Class 2	Class 3
Fume Hood Vent Ducts and Fans	100%	50%	10%
General Ventilation Exhaust Ducts and Fans	100%	50%	10%
Laboratory Drain Traps, Sumps, Pits	100%	50%	10%

The mechanical system survey frequencies described above were the minimum survey requirements. The survey package instructions provided guidance.

19.6 Removal of Furniture and Fixtures

Furniture and fixture removal was not necessary, with the exception of the fume hood baffles to access inaccessible areas, although it was **not probable** that RAM had migrated to inaccessible areas due in part because non-volatile forms were used, and no significant spills were recorded. No elevated activity was identified upon removal and survey of the baffles, fume hood internals, and fume hood exhaust ventilation from exit of fume hood to first major bend and low flow area.

19.7 Removal of Flooring

Removal of flooring was not warranted.

19.8 Remediation

No remediation was required.

19.9 Clearance of Materials and Equipment

The team used the guidance in NUREG 1575, Supplement 1, *MARSAME* to conduct radiological surveys to control the release of solid materials and equipment used.

19.10 Personnel Decontamination

Frisking personnel for surface contamination was performed. No personnel contamination of clothing or skin was identified.

20 Design and Performance of Final Status Surveys

FSS was performed to demonstrate that residual radioactivity in each SU satisfied the predetermined criteria for release for unrestricted use. FSS was conducted using the DQO process. Characterization survey data was used as FSS data to the maximum extent possible. FSS was 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 data information sheets.

20.1 Background Determination for Surfaces and Structures

The use of reference background areas or paired background comparisons was not necessary for the purposes of this plan. The best approach for this survey will be to determine compliance with the established DCGLs following subtraction of the mean of ambient area background.

This decision is based on the guidance provided in Section 12 of NUREG-1505, "A Nonparametric Statistical Methodology for the Design and Analysis of Final Decommissioning Surveys." This section states that better precision is possible if the average of the measurements made is subtracted from each measurement made. The Team collected ambient background measurements in an area which was built around the same time using similar building materials. An ambient reference background in counts per minute, for each instrument and instrument type was established by calculating the mean of multiple measurements. The established mean background value was subtracted from the applicable FSS gross measurement count rates (in cpm) to determine the net measurement count rate. Professional judgment was used to select locations of similar construction materials correlating to the building materials. These locations were selected in areas that were not impacted using RAM. Initially, twenty measurements for ambient were collected and evaluated for statistical confidence as described below.

NUREG 1505 does not provide a statistical method for calculating the variance of the background samples used to calculate N (number of measurements) as described in NUREG-1505. Therefore, the t-statistic test as described in NUREG/CR-5849, "*Manual for Conducting Radiological Surveys in Support of License Termination*," was used to establish the methodology for determining the reference material variance to be used for calculating N as discussed in NUREG-1505.

This calculation was performed to ensure the mean of the background measurements meets statistical requirements of a +/- 20 percent accuracy at the 95 percent confidence interval. The following formula (t-statistic test) was used to calculate the number of measurements needed to establish the desired accuracy of the mean.

$$n_b = \left[\frac{t_{95\%,df} \times S_x}{0.2 \times X_{B_m}} \right]^2$$

where:

n_b = the number of background measurements needed to meet the accuracy requirements

$t_{95\%,, df}$ = t statistic for 95 percent confidence interval with df degrees of freedom

S_x = the standard deviation of the initial background measurements

X_{Bm} = **mean** of the initial background measurements

$$n_b = \left[\frac{1.725 \times 17.1}{0.2 \times 449.8}\right]^2$$

$$n_b = 9.672$$

The calculated value n_b of 9.672 was less than twenty, therefore, no further background measurements were required.

20.2 Data Quality Objectives (DQO)

The following is a list of the major DQOs for the survey design described in this report:

- Static measurements were taken to achieve an MDC_{static} of less than 50% of the ALARA Goal or 74,000 dpm/100 cm^2.
- Scanning was conducted at a rate to achieve an MDC_{scan} of less than 50% of the ALARA Goal or 74,000 dpm/100 cm^2.
- Smear counting was conducted to achieve an MDC of less than DCGL.
- Individual measurements were made to a 95% confidence interval.
- Decision error probability rates were initially set at 0.05 for both α and β.
- The null hypothesis (H_0) and alternate null hypothesis (H_A) were that of NUREG 1505 scenario A:
- H_0 was that the SU does not meet the release criteria
- H_A was that the SU meets the release criteria
- Scoping and remedial action support surveys were conducted under the same quality assurance criteria as FSS such that the data was used as FSS data to the maximum extent possible.
- QA Surveys will be conducted at a rate of 5%.

20.3 Area Classifications

Initial classifications were determined based on the previous historical data.

20.3.1 Non-Impacted Area

Non-impacted areas were areas without residual radioactivity from licensed activities and were not surveyed during FSS. For the purpose of this plan, the following are initially classified as non-impacted: Building exterior, outside grounds, indoor areas other than those identified as use areas by license, and ceilings and roofs.

20.3.2 Impacted Areas

Impacted areas were those areas that had potential for containing contaminated material – were further subdivided into one of three classifications (NRC 2000a). Impacted areas were subdivided into Class 1, Class 2 or Class 3 areas. Class 1 areas had the greatest potential for contamination and therefore received the highest degree of survey effort for the FSS using a graded approach, followed by Class 2, and then by Class 3.

Impacted sub-classifications are defined, for the purposes of this plan, as follows:

20.3.2.1 Class 1 Area

Areas that have, or had, a potential for radioactive contamination or known contamination. Examples of Class 1 areas include: (1) site areas previously subjected to remedial actions; (2) locations where leaks or spills are known to have occurred; (3) former burial or disposal sites, and (4) waste storage sites.

The hot lab floor and walls less than two meters were conservatively classified as Class 1 areas.

20.3.2.2 Class 2 Area

These areas have, or had, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$. All rooms which have not undergone termination surveys previously, or have limited historical information available or data gaps, or have a potential for residual contamination that will not exceed the $DCGL_W$ are conservatively classified as Class 2 areas.

Areas bounding the hot lab and travel path floor and walls less than two meters were Class 2 areas.

20.3.2.3 Class 3 Area

Any impacted areas that are not expected to contain any residual radioactivity or are expected to contain levels of residual radioactivity at a very small fraction of the $DCGL_W$, based on site operating history and previous radiological surveys.

There were no Class 3 areas.

20.4 Survey Units

A SU was a geographical area of specified size and shape for which a separate decision was made whether that area met the release criteria. A SU is normally a portion of a building or site that was surveyed, evaluated, and released as a single unit. SUs were homogeneous in construction, and contamination and distribution.

The number of discrete sampling locations needed to determine if a uniform level of residual radioactivity existed within a SU did not depend on the SU size. However, the sampling density reflected the potential for small, elevated areas of residual radioactivity.

SUs were sized according to the potential for small, elevated areas of residual radioactivity.

Recommended maximum SU sizes for from *MARSSIM* are provided in **Table 20-1**.

Table 20-1 – Recommended Maximum Survey Unit Size Limits

Type of Survey Unit	Class 1	Class 2	Class 3
Structures	Up to 100 m^2	100 m^2 to 1,000 m^2	No Limit

Initial SUs for the facility are summarized in **Table 20-2**.

Table 20-2 – Initial Area Classifications

Cayman Chemical Ann Arbor Facility	
Room	**SU Classification**
Lab 1357 hot lab	1
Room 1350 Transport Area and Travel Path Hallway	2

20.5 Scan Surveys for Building Surfaces and Structures

Scan surveys were used to identify locations within the SU that exceeded the investigation level. Scan surveys were designed to detect small areas of elevated activity that were not detected by the measurements using the systematic pattern. No locations were identified that exceeded the investigation level. **Table 20-3** summarizes the percentage of accessible building structural surfaces scanned based on classification.

Table 20-3 – Scan Survey Coverage by Classification

Classification	Recommended Scan Coverage	Plan Coverage
1	100%	100%
2	10-100% (Judgmental)	100%
3	Judgmental	>25%

For the purposes of the FSS planning, Class 1 and Class 2 SUs received a 100% scan survey of all accessible surfaces. There were no Class 3 SUs. The scanning techniques selected represented the best reasonable effort based on the survey DQOs. For all classes, the surfaces to be scan surveyed will be those with the highest potential to contain residual contamination.

Floor areas near building entrances and exits received a 100% scan survey regardless of the area classification. These surveys provided indications of potential migration of residual contamination to the outside grounds.

No elevated activity was detected during the scan surveys.

20.6 Outside Surfaces and Structures

Outside surfaces and structures were not included in this scope of work; however, the Team paid special attention to all entrances, exits, and area access locations during the scan portion of the surveys to ensure materials were not inadvertently tracked to uncontrolled areas.

20.7 Total Surface Activity Measurements

Direct surveys (static measurements) were taken on building surfaces and system internals to the extent practical in impacted areas utilizing instrumentation of the best geometry based on the surface at the survey location.

Total surface activity measurements were acquired at each determined sample location. Scaler count times were determined based on the MDC_{static} of the applicable survey instrument.

Gross beta field measurements were converted to activity concentrations using the following equation:

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

Where:

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

20.8 Determining the Number of Samples

A minimum number of samples are needed to obtain sufficient statistical confidence that the conclusions drawn from the samples were correct. The number of samples depended on the relative shift (the ratio of the concentration to be measured relative to the statistical variability of the contaminant concentration). Initial calculations were performed to determine an estimated standard deviation and Lower Bound of the Gray Region (LBGR) for determination of the relative shift, and verified based on FSS results as calculated below.

The survey design for surfaces and structures was based on the Sign test. The minimum number of samples was obtained from *MARSSIM* tables or calculated using ***MARSSIM* Equation 5-2**.

20.8.1 Determination of Relative Shift

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

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

Where:

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

For the purpose of the DP, an estimated standard deviation was pre-determined based on the expected total activity levels at the time of the FSS. The LBGR was initially be set at one-half of the most restrictive ALARA Goal.

$$\Delta/\sigma_S = \frac{148{,}000 - 74{,}000}{4{,}500}$$

$$\Delta/\sigma_S = 16.4$$

This was recalculated based on the total activity levels at the time of the FSS. Once again, the LBGR was initially be set at one-half of the most restrictive ALARA Goal.

$$\Delta/\sigma_S = \frac{148{,}000 - 74{,}000}{717}$$

$$\Delta/\sigma_S = 206$$

20.8.2 Determination of Acceptable Decision Errors

A decision error was the probability of making an error in the decision on a SU by failing a unit that should pass (β decision error) or passing a unit that should fail (α decision error). *MARSSIM* uses the terminology α and β decision errors; this is the same as the more common terminology of Type I and Type II errors, respectively. The decision errors were 0.05 for Type I errors and 0.05 for Type II errors.

20.8.3 Determination of Number of Data Points

The number of direct measurements for a particular SU employing the Sign Test, was determined from ***MARSSIM*** **Table 5.5**, which was based on the following equation (***MARSSIM*** **equation 5-2**):

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

Where:

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

Note: SignP is determined from ***MARSSIM*** **Table 5.4**

MARSSIM recommends increasing the calculated number of measurements by 20% to ensure sufficient power of the statistical tests and to allow for possible data losses. ***MARSSIM*** **Table 5.5** "Values for N for use with the Sign Test" values include an increase of 20% of the calculated value and are used to determine the number of samples in each SU. In accordance with *MARSSIM*, the relative shift will round down to 3.0, and the number of samples required per SU was 14.

Project personnel took a conservative approach and **collected a minimum of 14 static and 14 removable systematic readings** (at the same location) in each SU using a systematic grid and random starting point, along with an additional five (5) judgmental readings per SU at areas of highest probability such as door handles, HVAC returns, sinks and drains, and additional locations determined for building structures and systems with an increased potential to contain residual surface contamination based on the technician's professional judgment,

20.9 Determination of Sample Locations

Determination of Class 1 SU sample locations was accomplished by first determining sample spacing and then systematically plotting the sample locations from a randomly generated start location. The random starting point of the grid provided an unbiased method for obtaining measurement locations to be used in the statistical tests. Random start calculations provided in **Appendix B**.

Similar systematic spacing methods were used for Class 2 SUs because there was still some probability of small areas of elevated activity. The use of a systematic grid allowed the decision-maker to draw conclusions about the size of the potential areas of elevated activity based on the area between measurement locations.

Survey protocols for all areas are summarized in **Table 20-4**.

Table 20-4 – Survey Sample Placement Overview

Survey Unit Classification		$DCGL_w$ Comparison	Elevated Measurement Comparison*	Measurement Locations
Impacted	Class 1	Yes	N/A	Systematic random
	Class 2	Yes	N/A	Systematic random
	Class 3	Yes	N/A	Judgmental
Non-Impacted		None	None	None

- \- The elevated measurement comparison is not used.

Class 1 SUs consisted of a single room or area. Class 2 SUs consisted of many rooms or areas. SU drawings do not display a "folded-out" view.

20.9.1 Determination of Class 1 and 2 Sample Locations

In Class 1 and 2 SUs, the sampling locations were established in a unique pattern beginning with the random start location and the determined sample spacing.

After determining the number of samples needed in the SU, 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 SU area
N = number of samples needed in the SU

Maps were generated of the SU's permanent surfaces included in the statistical tests (floors, walls, ceilings, fixed cabinetry, etc.). A random starting point was determined using computer-generated random numbers coinciding with the x and y coordinates of the total SU, see **Appendix B**. A grid was plotted across the SU surfaces based on the random start point and the determined sample spacing. A measurement location was plotted at each intersection of the grid plot.

20.10 Removable Contamination Measurements

Removable contamination measurements (smears) were collected at each static measurement location. All smears used to survey for removable contamination were dry smears and the same procedure was used for collecting both general and tritium smears.

The amount of removable RAM per 100 cm^2 of surface area was determined by wiping an area with filter or soft absorbent paper, applying moderate pressure, and accessing the amount of RAM on the wipe with an appropriate equipment of known efficiency.

General smears were counted at Philotechnics' facility liquid scintillation counter.

20.10.1 Surface of Building Mechanical System Internals

Survey design for systems was out of the scope of *MARSSIM*; however, for the purposes of identifying potential residual contamination within the systems, all system internal locations were surveyed as described in Section 15.5.2 above.

20.11 Investigation Levels for Surfaces and Structures

For Class 2 areas, neither measurements above the $DCGL_W$ nor areas of elevated activity were expected. Because the design for Class 2 was not driven by the elevated measurement, a 100% scan was not required; however, for conservatism was performed. Any indication of residual activity during the scan survey would have warranted further investigation and possible reclassification. There was no indication of residual activity.

Due to variations in background, realistic investigation levels for direct measurements on surfaces and structures were determined. The chosen investigation levels ensured areas had been properly classified and that the initial assumptions used in the survey design were adequate.

The survey investigation levels for surface and structure measurement are listed by classification in **Table 20-5**.

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Table 20-5 – Survey Investigation Levels

Survey Unit Classification	Flag Direct Measurement or Sample Result When:	Flag Scanning Measurement Result When:
Class 1	> ALARA GOAL	> ALARA GOAL
Class 2	>2x BKG	>2x BKG
Class 3	>MDC	>MDC

20.12 Final Status Survey Quality Assurance

The following sections outline our quality assurance protocols for surfaces and structures.

20.12.1 Surfaces and Structures

The number of required samples depended on the ratio involving the activity level to be measured relative to the variability in the concentration. Duplicate surveys and/or samples were collected. This duplicate was compared to the original survey as a quality control check.

This included reproducing a minimum of 5% of the scan surveys, total activity measurements, and removable activity measurements performed for FSS of surfaces and structures. The team failed conservative a reproduced five locations.

The QA surveys were performed by different technicians than those performing the original FSS. The QA surveys results were directly compared to the initial survey results. The goal of this comparison was to determine if the same decision would be made for the SU.

20.12.2 Data Validation

Field data was reviewed and validated to ensure:

- Completeness of forms and that the type of survey had correctly been assigned to each SU.
- The MDCs for measurements met the established DQOs; independent calculations were performed for a representative sample of data sheets and survey areas.

Instrument calibrations and daily functional checks had been performed accurately and at the required frequency.

21 Data Quality Assessment (DQA)

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

21.1 Preliminary Data Review

A preliminary data review was performed for each SU to identify any patterns, relationships or anomalies. Additionally, measurement data was reviewed and compared with the $DCGL_W$(s) and investigation levels to identify areas of elevated activity and confirm the correct classification of each SU. The following preliminary data reviews were performed for each SU:

- Calculations of mean, median, maximum, minimum, and standard deviation
- Comparison of SU mean and median to the $DCGL_W$
- Identification of each individual measurement above applicable $DCGL_W$
- Comparison of survey data with applicable investigation levels

21.2 Survey Documentation and Data Management

Each SU was surveyed under a survey package approved by the PM and specifying the survey protocol. The survey package contained the following:

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

Each static and removable contamination measurement location was assigned a unique alpha-numeric location code consisting of a sequence of identifiers to indicate specific information about that location, such as the building, SU, structural surface (floor, wall, bench top, etc.), structural material (concrete, cinderblock, sheetrock, etc.) and a numerically sequenced location number within the SU.

21.3 Data Validation

Field data was reviewed and validated to ensure:

- Completeness of forms
- Proper types of surveys were performed
- The MDCs for measurements met the established DQOs
- Independent calculations were performed on a representative sample of data sheets
- Satisfactory instrument calibrations and daily functionality checks were performed as required

Additionally, all FSS data was entered into the FSS data sheets. This provided the means to sort survey data, verify activity calculations, and to compute MDC and counting errors.

21.4 Determining Compliance for Surfaces and Structure Surveys

Scan surveys were completed for all SUs at the prescribed coverage.

Removable activity measurements were compared directly to the applicable investigation levels and DCGLs to determine if an area required further actions or surveys. All removable activity measurements collected during the FSSs were less than the applicable investigation levels and significantly less than the established DCGL.

All total surface activity measurements were compared directly to the DCGLs and investigation levels to determine if an area required further surveillance. All total surface activity measurements collected during FSSs were less than the DCGLs for total surface activity. No FSS measurements exceeded the investigation level for the applicable DCGLs. Due to the use of ambient backgrounds for all FSS results for conservatism, and not utilizing materials specific backgrounds, results were artificially elevated.

The table below details the calculated values for the mean, standard deviation, minimum, and maximum values for the surface and structures SUs.

Table 21-1 – Calculated Values for FSS Mean, Standard Deviation, Min and Max Ambient Background ONLY

Survey Unit	Beta dpm/100cm^2			
	Mean	Std. Dev	Min.	Max.[1]
1	698.05	717.09	-454.02	2,373.56
2	52.93	292.36	-477.01	580.46
QA	479.31	285.13	97.70	948.28

21.5 Verification of Number of Samples for Surface & Structures

A minimum number of samples were needed to obtain sufficient statistical confidence that the conclusions drawn from the samples were correct. The number of samples depended on the relative shift (the ratio of the concentration to be measured relative to the statistical variability of the contaminant concentration). The minimum number of samples was obtained from *MARSSIM* tables or calculated using equations in **Section 5** of ***MARSSIM***. For this project, the relative shift was originally estimated. To calculate the actual relative shift, data from the FSS was used. Once the actual relative shift was calculated, the number of samples required by *MARSSIM* was compared to the actual number of samples collected.

[1] Maximum values were determined using conservative ambient background, not material specific backgrounds.

As an additional conservative measure, the number of samples required was increased by Cayman and Philotechnics as an added ALARA measure.

21.6 Assessment and Interpretation of Survey Results

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

21.6.1 Preliminary Data Review

A preliminary data review was performed to identify any patterns, relationships or potential anomalies. Additionally, measurement data was reviewed and compared with the DCGLs and investigation levels to identify areas of elevated activity.
The following preliminary data reviews were performed:

- Calculations of the SU mean, median, maximum, minimum, and standard deviation for each type of reading and for unity.
- Comparison of the actual standard deviation to the assumed standard deviation used for calculating the number of measurements
- Comparison of survey data with applicable Investigation Levels.

21.7 Determining Compliance

For Class 1 and 2 areas, if it was determined that all total activity results were less than the applicable DCGL, then no further statistical tests were required. If any of the total activity measurements were greater than the $DCGL_W$, then the SU failed and the null hypothesis was not rejected.

The Sign test was used to determine the minimum number of sample locations. However, the Sign test was not performed in this survey design because the total activity DCGL was used as a maximum. If all measurements were less than the DCGL, performance of the Sign test was not necessary because the SU passed the Sign test.

Removable contamination measurements were compared directly to the applicable DCGL. No contingency was established for elevated removable contamination. Therefore, if any removable contamination was detected which exceeded the removable contamination DCGL, the SU was determined not to meet the release criterion. However, if all removable contamination measurements were less than the removable contamination DCGL, then compliance was based on total activity measurements.

Additionally, to demonstrate compliance, the maximum total activity concentration result in dpm/100 cm^2 for the most limiting ROC (C-14 for the highest TEDE per dpm/100 cm^2 of surface contamination), using the most conservative ambient background, was converted to a TEDE in mrem/year utilizing NRC DandD Version 2.4.0, and a comparison of DVS in dpm/100 cm^2 to TEDE of 25 mrem/year provided in NUREG 1757 Volume 1, Appendix B, Table B-1, "*Acceptable License*

Termination Screening Values of Common Radionuclides for Building-Surface Contamination" for the most conservative ROC, which equates to 3.7E+06 dpm/100 cm^2.

The maximum FSS total activity surface contamination result of **2,374 dpm/100 cm^2** results in a maximum as left radionuclide concentrations equal to a peak **TEDE associated with each SU of:**

- **1.76E-02 mrem/year** calculated using NRC DandD Version 2.4.0
- **1.60E-02 mrem/year** calculated using NUREG 1757, Volume 1, Appendix B, Table B-1

21.8 Mechanical System Survey Data Analysis

Survey design for systems was out of the scope of *MARSSIM*; however, for added conservatism, systems were surveyed as part of the FSS.

22 FINANCIAL ASSURANCE

Decommissioning was completed within the CDC's operating budget.

22.1 Cost Estimate

Not applicable.

22.2 Certification Statement

Not applicable.

22.3 Financial Mechanism

Not applicable.

23 RESTRICTED USE/ALTERNATE CRITERIA

Not applicable.

24 REFERENCES

- NRC Regulations 10 CFR 20 Subpart E
- NUREG-1575, “Multi-Agency Radiation Survey and Site Investigation Manual” (MARSSIM)
- NUREG 1575 Supp. 1, “Multi-Agency Radiation Survey of Material and Equipment Manual” (MARSAME)
- NUREG-1505, “A Nonparametric Statistical Methodology for the Design and Analysis of Final Decommissioning Surveys"
- NUREG 1507, “Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions”
- NUREG 1757, Volumes 1-3 “Consolidated NMSS Decommissioning Guidance,”
- Code of Federal Regulations (CFR), Title 10, Part 20, Standards for Protection Against Radiation, U.S. Nuclear Regulatory Agency, U.S. Government Printing Office, June 11, 2010, Washington, D.C., (August 2011).
- CFR, Title 29, Part 1910, Occupational Safety and Health Standards, U.S. Government Printing Office, Washington, D.C., July 1, 2003.
- CFR, Title 49, Part 172, Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans, Subpart H, Training, U.S. Department of Transportation, U.S. Government Printing Office, Washington, D.C., March 11, 2011, (August 2011).
- Philotechnics procedure, “Radiation Protection Program for Licensed Activities”.
- Cayman NRC-RML

APPENDIX A

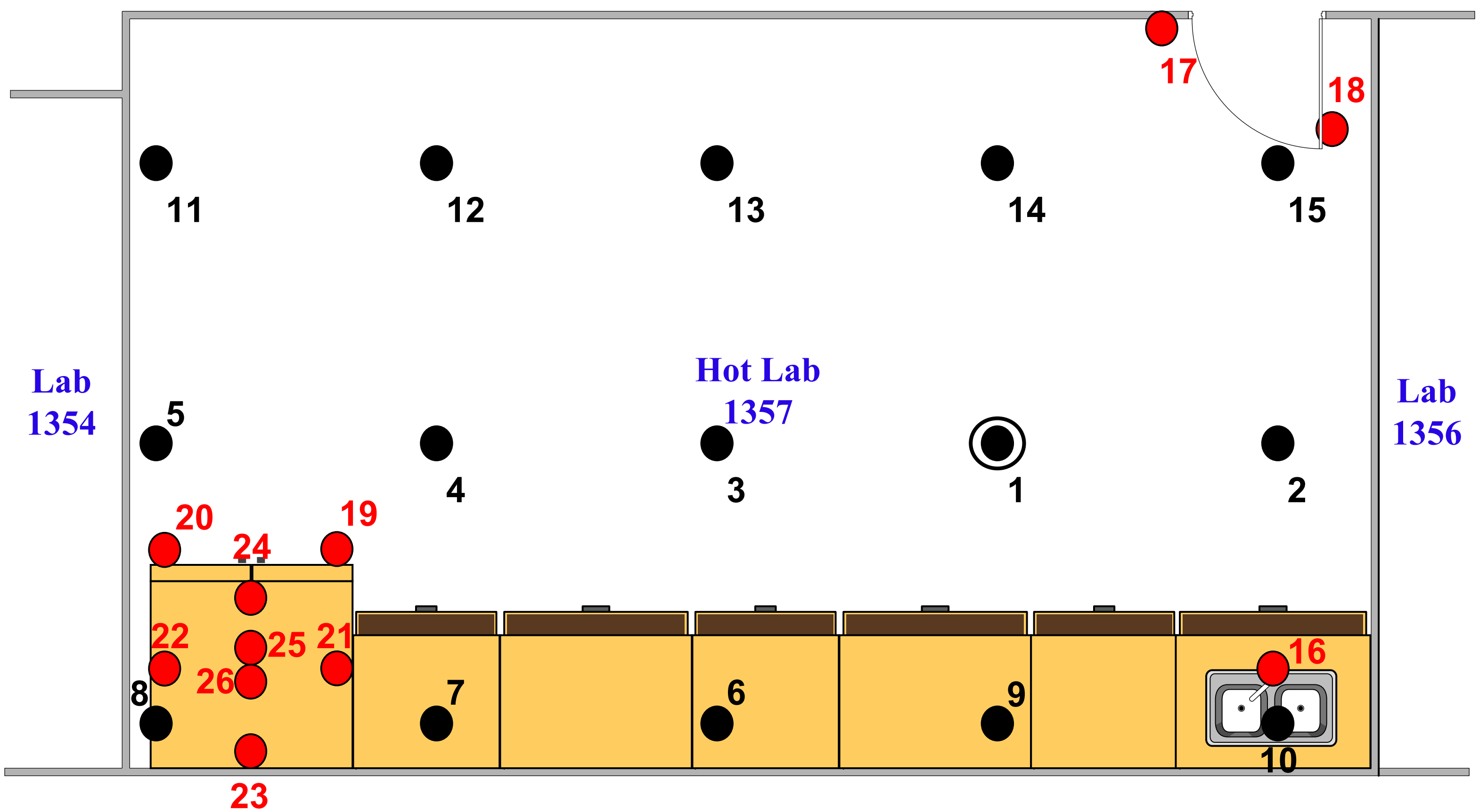
Facility Layout and Satellite View Identifying Impacted Areas

Appendix A - Cayman Chemical 5025 Building Satellite Image

Appendix A - Cayman Chemical 5025 Building Facility Layout

APPENDIX B
Survey Unit Layout and Survey Unit Maps

Appendix B
Survey Unit - 1 Location Map
Class 1



Class 1

Surveyor: Kevin Banks

Surveyor: Ken Gavlik

Instrument Information

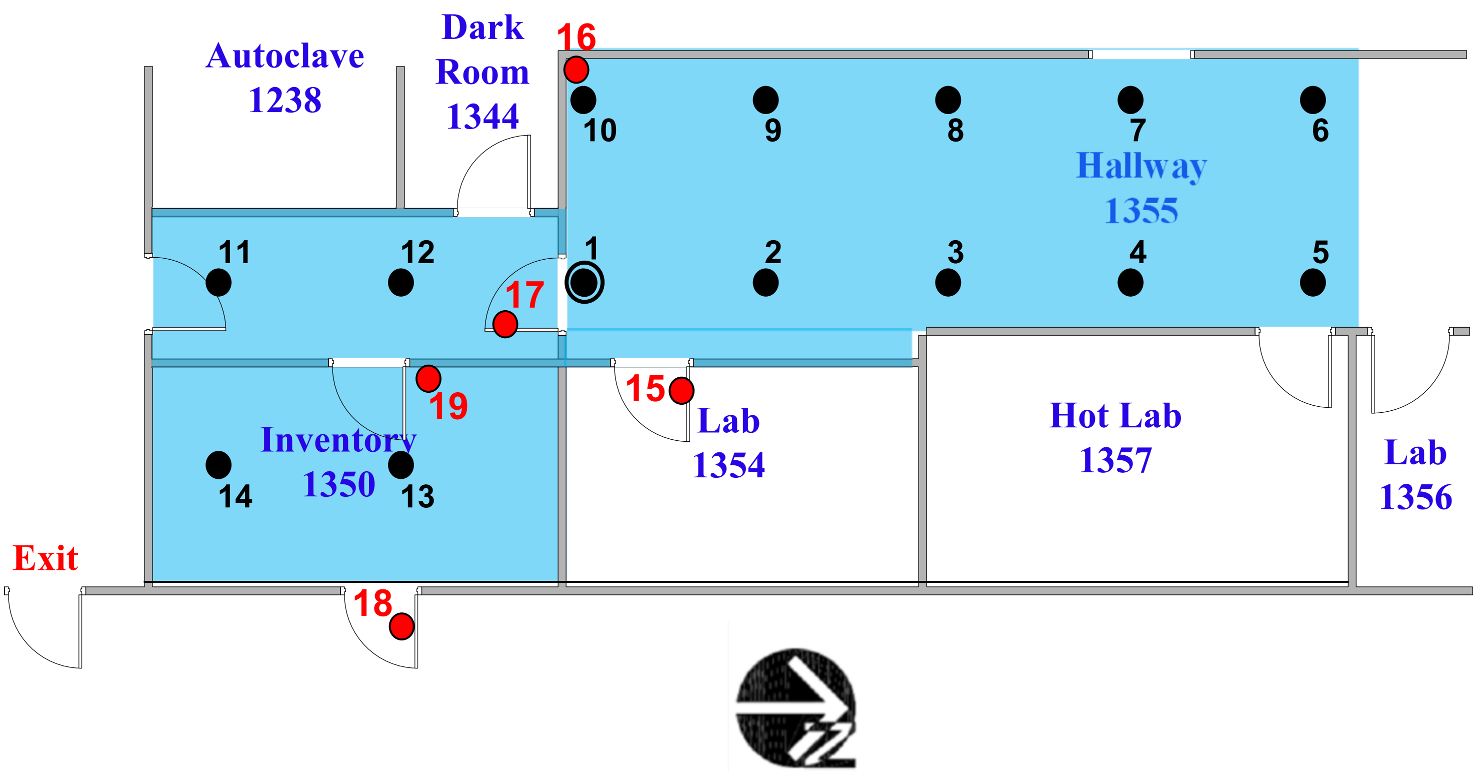
Date of Survey:	12/8/2021
Meter:	Ludlum 2350-1
Serial Number:	186179
Detector:	BP19DD
Serial Number:	347
Cal Due Date:	9-1-2022
Meter:	Beckman LS6500
Serial Number:	7070440
Cal	Weekly

● = Total Activity Static and Removable Activity Swipe Measurement Location

◉ = Random Start Location

● (red) = Bias/Judgmental Total Activity Static and Removable Activity Swipe Measurement Location

Appendix B
Survey Unit - 2 Location Map
Class 2



Class 2

Sample Spacing 9'

Surveyor: Kevin Banks

Surveyor: Ken Gavlik

Instrument Information

Date of Survey:	12/8/2021
Meter:	Ludlum 2350-1
Serial Number:	186179
Detector:	BP19DD
Serial Number:	347
Cal Due Date:	9-1-2022
Meter:	Beckman LS6500
Serial Number:	7070440
Cal	Weekly

● = Total Activity Static and Removable Activity Swipe Measurement Location

◉ = Random Start Location

● (red) = Bias/Judgmental Total Activity Static and Removable Activity Swipe Measurement Location

Cayman Chemical Company
5025 Building
Sample Location Worksheet

Building: 5025	Survey Unit: 01	Class: 1	Page 1 of 1

Survey Unit Area (ft²):	410.75	Maximum X-axis Dimension (ft):	27
Required Number of Samples:	14	Maximum Y-axis Dimension (ft):	16

Class 1 and Class 2 Calculations			
X Axis Random Number:[1]	0.341148624	X-Axis Start Location[2]:	**9**
Y Axis Random Number[1]	0.661290323	Y-Axis Start Location[2]:	**10**
		Sampling Spacing (ft):	**6**

Class 3 Calculations				
Survey Location Number	Random Numbers[3]		Locations (ft)	
	X	Y	X-Coordinate	Y-Coordinate
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**

Calculations Performed By: [signature]

Printed Name/Signature

Reviewed By: [signature]

Printed Name/Signature

Note 1: Random Numbers between 0 and 1 were generated using the =RAND() Function of MS Excel. The value of the calculation is saved using the F9 function rather than the formula to prevent recalculation during any document edit.

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

Note 3: Due to the layout of the survey unit surfaces, some randomly chosen survey location do not fall on a particular surface. In this case, extra random coordinates are generated to ensure the

Cayman Chemical Company
5025 Building
Sample Location Worksheet

Building: 5025	Survey Unit: 02	Class: 2	

Survey Unit Area (ft^2):	972.42	Maximum X-axis Dimension (ft):	60
Required Number of Samples:	14	Maximum Y-axis Dimension (ft):	27

Class 1 and Class 2 Calculations			
X Axis Random Number:[1]	0.638655462	X-Axis Start Location[2]:	**38**
Y Axis Random Number[1]	0.452830189	Y-Axis Start Location[2]:	**12**
		Sampling Spacing (ft):	**9**

Class 3 Calculations				
Survey Location Number	Random Numbers[3]		Locations (ft)	
	X	Y	X-Coordinate	Y-Coordinate
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**
			0	**0**

Calculations Performed By: [signature]

Printed Name/Signature

Reviewed By: [signature]

Printed Name/Signature

Note 1: Random Numbers between 0 and 1 were generated using the =RAND() Function of MS Excel. The value of the calculation is saved using the F9 function rather than the formula to prevent recalculation during any document edit.

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

Note 3: Due to the layout of the survey unit surfaces, some randomly chosen survey location do not fall on a particular surface. In this case, extra random coordinates are generated to ensure the

APPENDIX C

Certificates of Calibration

ISO 17025 Accredited

Occupational Services, Inc.

Certificate of Calibration

OCCUPATIONAL SERVICES, INC., RADIOACTIVE MATERIALS LICENSE NUMBER: 5149-37

CERT # ACT-1764

Manufacturer: Ludlum | Model: 2350-1 | Contact Name: Kevin Banks | Contact Email: kbanks@philotechnics.com

Customer: Philotechnics, LTD.

Calibration Site: 6397 Nancy Ridge Drive, San Diego, CA 92121

Department: N/A | Serial: 186179 | ID#: N/A

Batteries: Checked | Detector Voltage: 1775V | Report Number: 210901186176

Environmental Conditions: Temperature: 26.8 C   Pressure: 29.91 in Hg   Humidity: 44 %

Calibrated with a Ludlum Model 500-4 Pulse Generator s/n 334501 as per SOP-CAL-11. The estimated uncertainty of the measurement process is +/-3%, at the 95% confidence level. The standard measurement tolerance is +/- 20% relative to the reference standard. OSI performs radiation detection instrument calibrations according to ISO 17025-2017, ANSI/NCIS Z540-1-1994 and ANSI N323AB-2013.

Calibration Frequency: ☑ Annually ☐ Semi Annually ☐ Quarterly

RANGE	REFERENCE VALUE	AS FOUND VALUES	ACCEPTED or ADJUSTED VALUE	DIFFERENCE	% ERROR
cpm	cpm	cpm	cpm	cpm	
1000000	500000	500800	500800	800	0.16
100000	50000	50150	50150	150	0.3
10000	5000	5020	5020	20	0.4
1000	500	502	502	2	0.4

Notes: Detector 1: H.V set @ 1775V . Thres @ 100. Window is OFF. Th-230 dpm-13065 4,000 cpm effiiency 28%

Background: 350 cpm

Detector Type: DETECTOR 1: Ludlum 43-68 Alpha-Beta Gas Proportional Detector, s/n:PR114377
Background Reading: 350 cpm   Check Source Reading: N/A
Detector Efficiency: C-14
(24000 - 350 cpm) / (219558 dpm) = 10.8 %

Detector Type: DETECTOR 1: Ludlum 43-68 Alpha-Beta Gas Proportional Detector, s/n:PR114377
Background Reading: 350 cpm   Check Source Reading:
Detector Efficiency: Tc-99
(55000 - 350 cpm) / (218248 dpm) = 25.0 %

Source to detector surface distance is ≤ 1 cm.

Condition Received: ☑ In Tolerance ☐ Out of Tolerance

Condition Left: ☑ In Tolerance ☐ Out of Tolerance

Detector Exposure Orientation: ☑ N/A ☐ Parallel ☐ Perpendicular

Calibrated By: Marius Barron
Marius Barron

Q.A. Review: Chris Walton

Date of Calibration: 9/1/2021

Next Due Date: 9/1/2022

Issue Date: 9.2.21

The Alarm settings are "as found" or set as directed by the customer.

ISO 17025 Accredited
ANAB ACCREDITED ISO/IEC 17025 CALIBRATION AND TESTING LABORATORY
CERT # ACT-1764

Occupational Services, Inc.

Certificate of Calibration

OCCUPATIONAL SERVICES, INC., RADIOACTIVE MATERIALS LICENSE NUMBER: 5149-37

Manufacturer: Ludlum | Model: 2350-1 | Contact Name: Kevin Banks | Contact Email: kbanks@philotechnics.com

Customer: Philotechnics, LTD.

Calibration Site: 6397 Nancy Ridge Drive, San Diego, CA 92121

Department: N/A | Serial: 186179 | ID#: N/A

Batteries: Checked | Detector Voltage: 1400V | Report Number: 210901186176

Environmental Conditions: Temperature: 26.8 C Pressure: 29.91 in Hg Humidity: 44 %

Calibrated with a Ludlum Model 500-4 Pulse Generator s/n 334501 as per SOP-CAL-11. The estimated uncertainty of the measurement process is +/-3%, at the 95% confidence level. The standard measurement tolerance is +/- 20% relative to the reference standard. OSI performs radiation detection instrument calibrations according to ISO 17025-2017, ANSI/NCIS Z540-1-1994 and ANSI N323AB-2013.

Calibration Frequency: ☑ Annually ☐ Semi Annually ☐ Quarterly

RANGE	REFERENCE VALUE	AS FOUND VALUES	ACCEPTED or ADJUSTED VALUE	DIFFERENCE	% ERROR
cpm	cpm	cpm	cpm	cpm	
1000000	500000	500800	500800	800	0.16
100000	50000	50150	50150	150	0.3
10000	5000	5020	5020	20	0.4
1000	500	502	502	2	0.4

Notes: Detector 0: H.V set @ 1400V . Thres @ 100. Window is OFF.

Background: 3 cpm

Detector Type: DETECTOR 0: Ludlum 43-68 Alpha-Beta Gas Proportional Detector, s/n:PR114377	Detector Type: N/A
Background Reading: 3 cpm	Background Reading: cpm
Check Source Reading: N/A	Check Source Reading:
Detector Efficiency: Th-230	Detector Efficiency:
(2500 - 3 cpm) / 13065 dpm = 19.1 %	(- cpm) / dpm = %

Source to detector surface distance is ≤ 1 cm.

Condition Received: ☑ In Tolerance ☐ Out of Tolerance

Condition Left: ☑ In Tolerance ☐ Out of Tolerance

Detector Exposure Orientation: ☑ N/A ☐ Parallel ☐ Perpendicular

Calibrated By: *Marius Barron* Marius Barron

Q.A. Review: Chris Watson

Date of Calibration: 9/1/2021

Next Due Date: 9/1/2022

Issue Date: 9.2.21

The Alarm settings are "as found" or set as directed by the customer.

ISO 17025 Accredited

Occupational Services, Inc.

Certificate of Calibration

ANAB ACCREDITED ISO/IEC 17025 CALIBRATION AND TESTING LABORATORY
CERT # ACT-1764

OCCUPATIONAL SERVICES, INC., RADIOACTIVE MATERIALS LICENSE NUMBER: 5149-37

Manufacturer: Ludlum | Model: 2350-1 | Contact Name: Kevin Banks | Contact Email: kbanks@philotechnics.com

Customer: Philotechnics, LTD.

Calibration Site: 6397 Nancy Ridge Drive, San Diego, CA 92121

Department: N/A | Serial: 186179 | ID#: N/A

Batteries: Checked | Detector Voltage: 750V | Report Number: 210901186176

Environmental Conditions: Temperature: 26.8 C Pressure: 29.91 in Hg Humidity: 44 %

Calibrated with a Ludlum Model 500-4 Pulse Generator s/n 334501 as per SOP-CAL-11. The estimated uncertainty of the measurement process is +/-3%, at the 95% confidence level. The standard measurement tolerance is +/- 20% relative to the reference standard. OSI performs radiation detection instrument calibrations according to ISO 17025-2017, ANSI/NCIS Z540-1-1994 and ANSI N323AB-2013.

Calibration Frequency: ☑ Annually ☐ Semi Annually ☐ Quarterly

RANGE	REFERENCE VALUE	AS FOUND VALUES	ACCEPTED or ADJUSTED VALUE	DIFFERENCE	% ERROR
cpm	cpm	cpm	cpm	cpm	
1000000	500000	500800	500800	800	0.16
100000	50000	50150	50150	150	0.3
10000	5000	5020	5020	20	0.4
1000	500	502	502	2	0.4

Notes: Detector 2: H.V set @ 750V . Thres @ 100. Window is OFF. Th-230 dpm-13065 1,800 cpm effiiency 10%

Background: 450 cpm

Detector Type: DETECTOR 2: Thermo BP19DD s/n: 347	Detector Type: DETECTOR 2: Thermo BP19DD s/n: 347
Background Reading: 450 cpm	Background Reading: 450 cpm
Check Source Reading: N/A	Check Source Reading:
Detector Efficiency: C-14	Detector Efficiency: Tc-99
(10000 - 450 cpm) / 219558 dpm = 4.35 %	(37000 - 450 cpm) / 218248 dpm = 16.7 %

Source to detector surface distance is ≤ 1 cm.

Condition Received: ☑ In Tolerance ☐ Out of Tolerance

Condition Left: ☑ In Tolerance ☐ Out of Tolerance

Detector Exposure Orientation: ☑ N/A ☐ Parallel ☐ Perpendicular

Calibrated By: *Marius Barron*
Marius Barron

Date of Calibration: 9/1/2021

Next Due Date: 9/1/2022

Q.A. Review: *Chris Walton*

Issue Date: 9-2-21

The Alarm settings are "as found" or set as directed by the customer.

APPENDIX D

Instrument and Reference Background Documentation

Background Documentation

Fail Levels

Ld, system detection limit is the net count having 95% probability of being detected when a survey sample point contains activity at Ld, which translates to a 5% probability of falsely interpreting sample activity as activity due to background (NUREG-1507 Table 3-8)

$$L_d\,(cpm) = 3 + 4.65\sqrt{B} \qquad \text{(Eq. 7)}$$

Fail Level CPM = Bkg cpm + Ld cpm

		Scintillation Counter Counts (cpm)		
Sample	Time	Chan A (cpm)	Chan B (cpm)	Chan C (cpm)
1	1 min.	10	21	35
	Average:	**10.0**	**21.0**	**35.0**

	Beta β 347
	2350-1/BP19DD
	Ambient
	cpm
1	421
2	436
3	468
4	467
5	473
6	423
7	457
8	425
9	444
10	474
11	436
12	454
13	462
14	430
15	458
16	453
17	439
18	464
19	470
20	441
μ BKG	**449.8**
σ	**17.1**
3σ	**51.2**
μ+3σ	**500.9**

APPENDIX E

Minimum Detectable Concentration Results

Minimum Detectable Concentration (MDC) Static Count Calculations for Liquid Scintillation Counter

(95% confidence level via NUREG 1507 method)

$$MDC\,(dpm/100cm^2) = \frac{3 + 3.29\sqrt{(R_b)(T_{s+b})(1 + T_{s+b}/T_b)}}{(Eff.)(T_{s+b})} \qquad \text{(Eq. 1)}$$

Where:

Eff. = LSC total efficiency, Counter cpm/NIST Standard dpm
R_b = LSC background rate (cpm)
T_{s+b} = Sample count time (minutes)
T_b = Background count time (minutes)

Static Count MDC Calculations					
Nuclide	**Eff.**	**R_b**	**T_{s+b}**	**T_b**	**MDC (Static)**
H-3	48.0%	21.0	1	1	50.7 dpm/100 cm^2
C-14	94.0%	10.0	1	1	18.8 dpm/100 cm^2
I-125	50.0%	35.0	1	1	61.1 dpm/100 cm^2

Minimum Detectable Concentration (MDC) Static Count
Calculations for Hand-Held Monitors
(95% confidence level via NUREG 1507 method)

$$MDC\,(dpm/100cm^2) = \frac{3 + 3.29\sqrt{(R_b)(T_{s+b})(1 + T_{s+b}/T_b)}}{(Eff.)(T_{s+b})(probeareacm^2/100cm^2)} \qquad \text{(Eq. 2)}$$

Where:

Total Eff. = 4pi efficiency
R_b = Average background rate (cpm)
T_{s+b} = Sample count time (minutes)
T_b = Background count time (minutes)
P = Probe area (cm2)

Meter:	*2350-1/BP19DD*						
Nuclide	**Total Eff.**	**R_b**	**T_{s+b}**	**T_b**	**P**	**MDC (Static)**	
C-14	4.35%	449.8	1	1	100	2337.3 dpm/100 cm^2	Ambient

Meter:	*2350-1/43-37-1*						
Nuclide	**Total Eff.**	**R_b**	**T_{s+b}**	**T_b**	**P**	**MDC (Static)**	
C-14	9.18%	1146.7	1	1	821	213.0 dpm/100 cm^3	Floor

Scan Minimum Detectable Concentration (MDC)
Calculations for Hand-Held Monitors
(Scan MDA per NUREG-1575, NUREG-1507 methodology)

$$Scan\,MDC = \frac{MDCR}{\sqrt{p}\,(\varepsilon_i)(\varepsilon_s)\left(\frac{A}{100cm^2}\right)} \qquad \text{(Eq. 3)}$$

Where:

p = surveyor efficiency, per NUREG 1507 (0.5)
ε_i = total efficiency (4π geometry)
ε_s = surface efficiency, 0.5 for gammas and high energy betas > 400 KeV Emax and 0.25 for low energy betas < 400 KeV
A = probe active area (cm^2)

And,

$$MDCR = S_i\,(60\text{ sec}/\text{min})/i\text{ sec} \qquad \text{(Eq. 4)}$$

Where:

MDCR = Minimum detectable count rate (cpm)
S_i = source counts in time interval, i.

And,

$$S_i = d'\sqrt{B_i} \qquad \text{(Eq. 5)}$$

Where:

d' = 1.38 for 95% true positive scan detection rate, per, NUREG 1507, Table 6.1
B_i = Background counts in interval, i

And,

$$B_i = (P_b)(i)(1\text{ min}/60\text{ sec}) \qquad \text{(Eq. 6)}$$

Where:

P_b = probe background count rate (cpm)
i = observation interval

Scan Minimum Detectable Concentration (MDC)
Calculations for Hand-Held Monitors
(Scan MDA per NUREG-1575, NUREG-1507 methodology)

Specific Scan MDC calculation results:

2350-1/BP19DD	Ambient	
P_b =	449.8	cpm
i =	0.35	sec
B_i =	2.62	counts
d' =	1.38	
S_i =	2.24	counts
MDCR =	383.2	cpm

2350-1/43-37-1	Floor	
P_b =	1146.7	cpm
i =	10	sec
B_i =	191.12	counts
d' =	1.38	
S_i =	19.08	counts
MDCR =	114.5	cpm

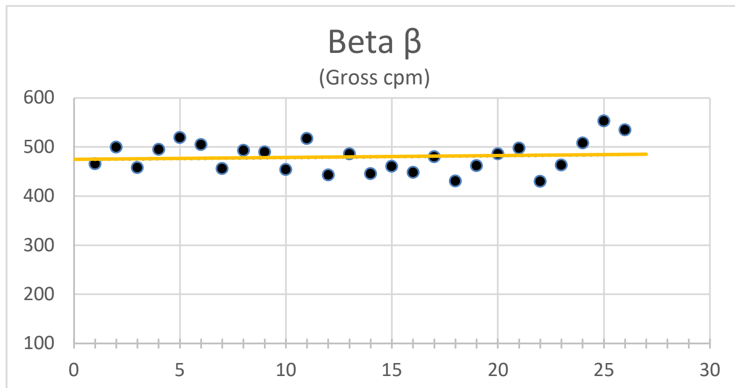
Scan MDC Calculations				
Meter:	2350-1/BP19DD			
Nuclide	**Total Efficiency**	**Area (cm2)**	**MDC (Scan)**	
C-14	4.35%	100	12457.5 dpm/100 cm^2	Ambient

Meter:	2350-1/43-37-1			
Nuclide	**Total Efficiency**	**Area (cm2)**	**MDC (Scan)**	
C-14	9.18%	821	214.8 dpm/100 cm^2	Floor

APPENDIX F

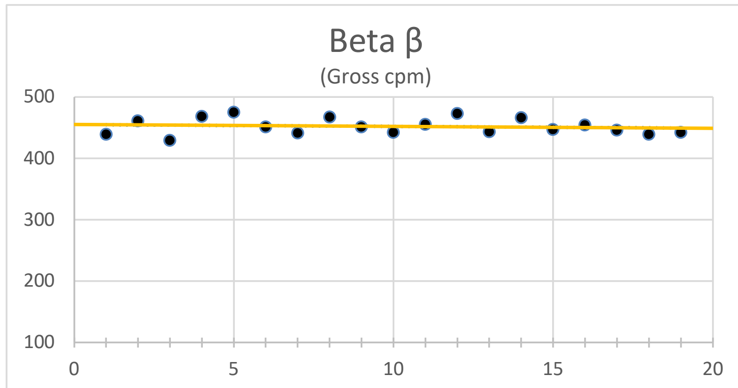
Total Activity Measurement DPM Calculations, Results

	Survey Unit 1	
Inst. SN#	347	
	Beta β	RESULT
1	<MDC	<DCGL
2	<MDC	<DCGL
3	<MDC	<DCGL
4	<MDC	<DCGL
5	1592	<DCGL
6	1270	<DCGL
7	<MDC	<DCGL
8	<MDC	<DCGL
9	<MDC	<DCGL
10	<MDC	<DCGL
11	1546	<DCGL
12	<MDC	<DCGL
13	<MDC	<DCGL
14	<MDC	<DCGL
15	<MDC	<DCGL
16	<MDC	<DCGL
17	<MDC	<DCGL
18	<MDC	<DCGL
19	<MDC	<DCGL
20	<MDC	<DCGL
21	<MDC	<DCGL
22	<MDC	<DCGL
23	<MDC	<DCGL
24	1339	<DCGL
25	2374	<DCGL
26	1960	<DCGL



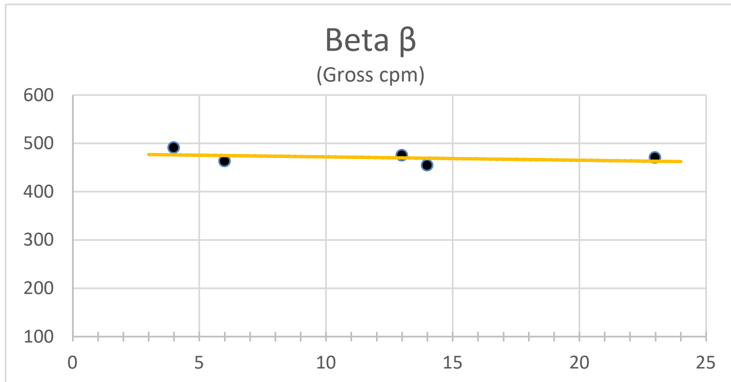
	DPM/100cm2
	Beta β
Median	764.37
Average	698.05
Std. Dev.	717.09
Minimum	-454.02
Maximum	2373.56

	Survey Unit 2	
Inst. SN#	347	
	Beta β	RESULT
1	<MDC	<DCGL
2	<MDC	<DCGL
3	<MDC	<DCGL
4	<MDC	<DCGL
5	<MDC	<DCGL
6	<MDC	<DCGL
7	<MDC	<DCGL
8	<MDC	<DCGL
9	<MDC	<DCGL
10	<MDC	<DCGL
11	<MDC	<DCGL
12	<MDC	<DCGL
13	<MDC	<DCGL
14	<MDC	<DCGL
15	<MDC	<DCGL
16	<MDC	<DCGL
17	<MDC	<DCGL
18	<MDC	<DCGL
19	<MDC	<DCGL



	DPM/100cm2
	Beta β
Median	28.74
Average	52.93
Std. Dev.	292.36
Minimum	-477.01
Maximum	580.46

	Survey Unit QA	
Inst. SN#	347	
	Beta β	RESULT
1	<MDC	<DCGL
2	<MDC	<DCGL
3	<MDC	<DCGL
4	<MDC	<DCGL
5	<MDC	<DCGL



	DPM/100cm2
	Beta β
Median	465.52
Average	479.31
Std. Dev.	285.13
Minimum	97.70
Maximum	948.28

APPENDIX G

Removable Activity Measurement DPM Calculations and Results

Scintillation Counter

CPM			Net DPM / 100 cm^2			Release Criteria DPM / 100 cm^2		
Chan A	Chan B	Chan C	H-3	C-14/S-35	Open	H-3	C-14/S-35	Open
Background Values			MDC Values			MDC Values		
21.0	10.0	35.0	50.7	18.8	61.1	63.0	30.0	105.0

Survey Unit 1

	Gross CPM / 100 cm^2			Efficiency				Net DPM / 100 cm^2			
Sample	Chan A	Chan B	Chan C	H#	H-3 Eff.	C-14 Eff.	I-125 Eff.	H-3	C-14/S-35	Open	Comment
1	23	11	31	69.1	47.4%	94.1%	50.0%	*4*	*1*	*-8*	<DCGL
2	27	13	32	64.7	48.3%	94.4%	50.0%	*12*	*3*	*-6*	<DCGL
3	19	13	50	61.4	48.9%	94.5%	50.0%	*-4*	*3*	*30*	<DCGL
4	19	8	36	67	47.8%	94.2%	50.0%	*-4*	*-2*	*2*	<DCGL
5	20	10	38	67.5	47.7%	94.2%	50.0%	*-2*	*0*	*6*	<DCGL
6	26	7	47	55.3	50.2%	94.8%	50.0%	*10*	*-3*	*24*	<DCGL
7	23	11	43	67.3	47.7%	94.2%	50.0%	*4*	*1*	*16*	<DCGL
8	19	6	37	63.7	48.5%	94.4%	50.0%	*-4*	*-4*	*4*	<DCGL
9	18	7	37	53	50.6%	95.0%	50.0%	*-6*	*-3*	*4*	<DCGL
10	21	9	44	54.3	50.4%	94.9%	50.0%	*0*	*-1*	*18*	<DCGL
11	28	13	51	67.1	47.8%	94.2%	50.0%	*15*	*3*	*32*	<DCGL
12	27	10	45	64.9	48.2%	94.3%	50.0%	*12*	*0*	*20*	<DCGL
13	22	16	45	55.1	50.2%	94.9%	50.0%	*2*	*6*	*20*	<DCGL
14	26	7	46	63.3	48.5%	94.4%	50.0%	*10*	*-3*	*22*	<DCGL
15	26	10	53	65.4	48.1%	94.3%	50.0%	*10*	*0*	*36*	<DCGL
16	27	12	57	64.3	48.3%	94.4%	50.0%	*12*	*2*	*44*	<DCGL
17	25	10	46	53.4	50.5%	94.9%	50.0%	*8*	*0*	*22*	<DCGL
18	21	14	43	63	48.6%	94.4%	50.0%	*0*	*4*	*16*	<DCGL
19	25	20	50	63.4	48.5%	94.4%	50.0%	*8*	*11*	*30*	<DCGL
20	23	20	57	65.4	48.1%	94.3%	50.0%	*4*	*11*	*44*	<DCGL
21	38	8	54	63.5	48.5%	94.4%	50.0%	*35*	*-2*	*38*	<DCGL
22	18	10	42	65.1	48.2%	94.3%	50.0%	*-6*	*0*	*14*	<DCGL
23	25	8	46	74.1	46.3%	93.9%	50.0%	*9*	*-2*	*22*	<DCGL
24	27	7	47	69.8	47.2%	94.1%	50.0%	*13*	*-3*	*24*	<DCGL
25	33	12	54	66.4	47.9%	94.3%	50.0%	*25*	*2*	*38*	<DCGL
26	35	11	52	71.5	46.9%	94.0%	50.0%	*30*	*1*	*34*	<DCGL

Survey Unit 2

	Gross CPM / 100 cm^2			Efficiency				Net DPM / 100 cm^2			
Sample	Chan A	Chan B	Chan C	H#	H-3 Eff.	C-14 Eff.	I-125 Eff.	H-3	C-14/S-35	Open	Comment
1	21	18	47	68.4	47.5%	94.2%	50.0%	*0*	*8*	*24*	<DCGL
2	19	8	35	65.5	48.1%	94.3%	50.0%	*-4*	*-2*	*0*	<DCGL
3	22	11	47	64.5	48.3%	94.4%	50.0%	*2*	*1*	*24*	<DCGL
4	25	10	46	62.7	48.7%	94.5%	50.0%	*8*	*0*	*22*	<DCGL
5	30	12	51	65.4	48.1%	94.3%	50.0%	*19*	*2*	*32*	<DCGL
6	26	12	49	64.7	48.3%	94.4%	50.0%	*10*	*2*	*28*	<DCGL
7	28	3	44	65.4	48.1%	94.3%	50.0%	*15*	*-7*	*18*	<DCGL
8	41	5	56	63.7	48.5%	94.4%	50.0%	*41*	*-5*	*42*	<DCGL
9	28	7	49	62.4	48.7%	94.5%	50.0%	*14*	*-3*	*28*	<DCGL
10	35	15	53	65.9	48.0%	94.3%	50.0%	*29*	*5*	*36*	<DCGL
11	12	12	53	66.9	47.8%	94.2%	50.0%	*-19*	*2*	*36*	<DCGL
12	23	11	52	66.7	47.8%	94.3%	50.0%	*4*	*1*	*34*	<DCGL
13	26	9	45	68.4	47.5%	94.2%	50.0%	*11*	*-1*	*20*	<DCGL
14	31	5	54	69.1	47.4%	94.1%	50.0%	*21*	*-5*	*38*	<DCGL
15	27	7	53	64.9	48.2%	94.3%	50.0%	*12*	*-3*	*36*	<DCGL
16	15	14	44	64.7	48.3%	94.4%	50.0%	*-12*	*4*	*18*	<DCGL
17	24	13	53	64.5	48.3%	94.4%	50.0%	*6*	*3*	*36*	<DCGL
18	37	7	52	64	48.4%	94.4%	50.0%	*33*	*-3*	*34*	<DCGL
19	35	8	52	65.5	48.1%	94.3%	50.0%	*29*	*-2*	*34*	<DCGL

QA

	Gross CPM / 100 cm^2			Efficiency				Net DPM / 100 cm^2			
Sample	Chan A	Chan B	Chan C	H#	H-3 Eff.	C-14 Eff.	I-125 Eff.	H-3	C-14/S-35	Open	Comment
1	20	15	48	75.2	46.1%	93.8%	50.0%	*-2*	*5*	*26*	<DCGL
2	27	14	51	68.8	47.4%	94.1%	50.0%	*13*	*4*	*32*	<DCGL
3	31	13	54	68.9	47.4%	94.1%	50.0%	*21*	*3*	*38*	<DCGL
4	21	8	41	69	47.4%	94.1%	50.0%	*0*	*-2*	*12*	<DCGL
5	18	18	47	69.9	47.2%	94.1%	50.0%	*-6*	*9*	*24*	<DCGL

APPENDIX H

Final DandD Model

DandD Building Occupancy Scenario

DandD Version: 2.4.0
Run Date/Time: 12/17/2021 5:12:03 PM
Site Name: Cayman Chemical Building 5025
Description: Total Effective Dose Equivalent in mrem/year based on the maximum toital activity result from the most conservative radionuclide of concern C-14
FileName:C:\Users\kegavlik\DandD_Docs\Appendix H - Cayman Chemical Total Activity TEDE Final DandD Model.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages of sampled values used for behavioral and metabolic type parameters
Averages of sampled values not used for derived behavioral or metabolic parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution	
14C	UNLIMITED	CONSTANT(dpm/100 cm**2)	
Justification for concentration: Maximum Final Status SUrvey total activity result in dpm/100 cm2 for the most conservative radionuclide of concern for the survey Carbon-14.		Value	2.37E+03

Chain Data:

Number of chains: **1**

Chain No. 1: **14C**
Nuclides in chain: **1**

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
14C	1	2.09E+06					5.64E-10	5.64E-10	1.39E-15	6.22E-18

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 **quantile value**

Nuclide	Surface Concentration (dpm/100 cm**2)
14C	2.37E+03

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution	
To:Time In Building	The time in the building during the occupancy period	CONSTANT(hr/week)	
Behavioral category: Default value used		Value	4.50E+01
Tto:Occupancy Period	The duration of the occupancy exposure period	CONSTANT(days)	
Behavioral category: Default value used		Value	3.65E+02
Vo:Breathing Rate	The average volumetric breathing rate during building occupancy for an 8-hour work day	CONSTANT(m**3/hr)	
Metabolic category: Default value used		Value	1.40E+00

RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	DERIVED(1/m)
Physical category: Default value used		
GO*:Ingestion Rate	Effective secondary ingestion transfer rate of removable surface activity from building surfaces to the mouth during building occupancy = GO * Fl	DERIVED(m**2/hr)
Behavioral category: Default value used		
Tstart:Start Time	The start time of the scenario in days	CONSTANT(days)
Program Control category: Default value used		Value 0.00E+00
Tend:End Time	The ending time of the scenario in days	CONSTANT(days)
Program Control category: Default value used		Value 3.65E+02
dt:Time Step Size	The time step size	CONSTANT(days)
Program Control category: Default value used		Value 3.65E+02
Pstep:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Program Control category: Default value used		Value 1.00E+00
AOExt:External Exposure Area	Minimum surface area to which occupant is exposed via external radiation during occupancy period	CONSTANT(m**2)
Behavioral category: Default value used		Value 1.00E+01
AOInh:Inhalation Exposure Area	Minimum surface area to which occupant is exposed via inhalation during occupancy period	CONSTANT(m**2)
Behavioral category: Default value used		Value 1.00E+01
AOIng:Secondary Ingestion Exposure Area	Minimum surface area to which occupant is exposed via secondary ingestion during occupancy period	CONSTANT(m**2)
Behavioral category: Default value used		Value 1.00E+01
AO:Exposure Area	Minimum surface area to which occupant is exposed during the occupancy period	DERIVED(m**2)
Behavioral category: Default value used		
Fl:Loose Fraction	Fraction of surface contamination available for resuspension and ingestion	CONSTANT(none)
Physical category: Default value used		Value 1.00E-01
Rfo:Loose Resuspension Factor	Resuspension factor for loose contamination	CONTINUOUS LOGARITHMIC(1/m)
Physical category: Default value used		

Value	Probability
9.12E-06	0.00E+00
1.10E-04	7.67E-01

		1.46E-04	9.09E-01
		1.62E-04	9.50E-01
		1.85E-04	9.90E-01
		1.90E-04	1.00E+00
GO:Loose Ingestion Rate	The secondary ingestion transfer rate of loose removable surface activity from building surfaces to the mouth during building occupancy	CONSTANT(m**2/hr)	
Behavioral category: Default value used		Value	1.10E-04

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.61E-02 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.50E-02 to 1.76E-02 mrem/year

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 quantile value

Concentration at Time of Peak Dose:

Nuclide	Surface Concentration (dpm/100 cm**2)
14C	2.37E+03

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	External	Inhalation	Secondary Ingestion
1.76E-02	5.36E-05	1.18E-02	5.74E-03

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways

	Dose
14C	1.76E-02
All Nuclides	1.76E-02

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	External	Inhalation	Secondary Ingestion
14C	5.36E-05	1.18E-02	5.74E-03

APPENDIX I

Total Activity Measurement Raw Results

Beta β BKG		347
Ambient		449.8
Efficiency		4.35%

Survey Unit	Location #	Sample Material	Beta Inst. SN	Reference Material	BKG Beta β cpm	Gross Beta β cpm	Net Beta β cpm	Net Beta β dpm
su1	1	Floor	347	Ambient	449.8	466	16.3	374
su1	2	Floor	347	Ambient	449.8	500	50.3	1,155
su1	3	Floor	347	Ambient	449.8	458	8.3	190
su1	4	Floor	347	Ambient	449.8	495	45.3	1,040
su1	5	Floor	347	Ambient	449.8	519	69.3	1,592
su1	6	Benchtop	347	Ambient	449.8	505	55.3	1,270
su1	7	Benchtop	347	Ambient	449.8	456	6.3	144
su1	8	Hood Floor	347	Ambient	449.8	493	43.3	994
su1	9	Benchtop	347	Ambient	449.8	490	40.3	925
su1	10	Sink	347	Ambient	449.8	454	4.3	98
su1	11	Floor	347	Ambient	449.8	517	67.3	1,546
su1	12	Floor	347	Ambient	449.8	443	-6.8	-155
su1	13	Floor	347	Ambient	449.8	486	36.3	833
su1	14	Floor	347	Ambient	449.8	446	-3.8	-86
su1	15	Floor	347	Ambient	449.8	461	11.3	259
su1	16	Sink Trap	347	Ambient	449.8	448	-1.8	-40
su1	17	Light Switch	347	Ambient	449.8	480	30.3	695
su1	18	Door Knob	347	Ambient	449.8	431	-18.8	-431
su1	19	Hood Knob	347	Ambient	449.8	462	12.3	282
su1	20	Hood Knob	347	Ambient	449.8	486	36.3	833
su1	21	Hood Side	347	Ambient	449.8	498	48.3	1,109
su1	22	Hood SIde	347	Ambient	449.8	430	-19.8	-454
su1	23	Hood Baffle	347	Ambient	449.8	463	13.3	305
su1	24	Hood Baffle	347	Ambient	449.8	508	58.3	1,339
su1	25	Hood Exhaust	347	Ambient	449.8	553	103.3	**2,374**
su1	26	Hood Exhaust	347	Ambient	449.8	535	85.3	1,960

Beta β BKG		347
Ambient		449.8
Efficiency		2.18%

Survey Unit	Location #	Sample Material	Beta Inst. SN	Reference Material	BKG Beta β cpm	Gross Beta β cpm	Net Beta β cpm	Net Beta β dpm
su2	1	Floor	347	Ambient	449.8	439	-10.8	-247
su2	2	Floor	347	Ambient	449.8	461	11.3	259
su2	3	Floor	347	Ambient	449.8	429	-20.8	-477
su2	4	Floor	347	Ambient	449.8	468	18.3	420
su2	5	Floor	347	Ambient	449.8	475	25.3	**580**
su2	6	Floor	347	Ambient	449.8	451	1.3	29
su2	7	Floor	347	Ambient	449.8	441	-8.8	-201
su2	8	Floor	347	Ambient	449.8	467	17.3	397
su2	9	Floor	347	Ambient	449.8	451	1.3	29
su2	10	Floor	347	Ambient	449.8	442	-7.8	-178
su2	11	Floor	347	Ambient	449.8	455	5.3	121
su2	12	Floor	347	Ambient	449.8	473	23.3	534
su2	13	Floor	347	Ambient	449.8	443	-6.8	-155
su2	14	Floor	347	Ambient	449.8	466	16.3	374
su2	15	Door Knob	347	Ambient	449.8	447	-2.8	-63
su2	16	Light Switch	347	Ambient	449.8	454	4.3	98
su2	17	Door Knob	347	Ambient	449.8	446	-3.8	-86
su2	18	Door Knob	347	Ambient	449.8	439	-10.8	-247
su2	19	Light Switch	347	Ambient	449.8	442	-7.8	-178

Beta β BKG		347
Ambient		449.8
Efficiency		2.18%

QA Survey Unit	Location #	Sample Material	Beta Inst. SN	Reference Material	BKG Beta β cpm	Gross Beta β cpm	Net Beta β cpm	Net Beta β dpm
su1	4	Floor	347	Ambient	449.8	491	41.3	948
su1	13	Floor	347	Ambient	449.8	475	25.3	580
su1	23	Hood Baffle	347	Ambient	449.8	470	20.3	466
su2	6	Floor	347	Ambient	449.8	463	13.3	305
su2	14	Floor	347	Ambient	449.8	454	4.3	98

ATTACHMENT A

Radioactive Materials License

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, ILLINOIS 60532-4352

AUG 2 5 2016

Dr. Elizabeth Hurst
Radiation Safety Officer
Cayman Chemical Company, Inc.
1180 East Ellsworth Road
Ann Arbor, MI 48108

SUBJECT: APPROVAL FOR RELEASE OF ELLSWORTH ROAD FACILITY FOR UNRESTRICTED USE

Dear Dr. Hurst:

Enclosed is Amendment No. 15 to your NRC Material License No. 21-24683-01 in accordance with your request dated June 16, 2016. Please note that the changes made to your license are printed in **bold** font.

An environmental assessment for this action is not required, since this action is categorically excluded under 10 CFR 51.22(c)(20)(iii).

A copy of this letter will be available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System (ADAMS), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

If you have any questions, please contact me at (630) 829-9870.

Sincerely,

Peter J. Lee, Ph.D., CHP
Materials Control, ISFSI, and
Decommissioning Branch

License No. 21-24683-01
Docket No. 030-29143
Enclosure: Amendment No. 15

NRC FORM 374

Amendment No. 15

U.S. NUCLEAR REGULATORY COMMISSION

MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 36, 37, 39, 40, and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. Cayman Chemical Company, Inc.	In accordance with letter dated **June 16, 2016,** 3. License number 21-24683-01 is amended in its entirety to read as follows:
2. 1180 East Ellsworth Road Ann Arbor, MI 48108	4. Expiration date December 31, 2021
	5. Docket No. 030-29143 Reference No.

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
A. Iodine-125	A. Prepackaged units	A. 2.5 millicuries
B. Hydrogen-3	B. Prepackaged units	B. 100 millicuries
C. Carbon-14	C. Prepackaged units	C. 50 millicuries
D. Phosphorus-32	D. Any	D. 10 millicuries
E. Hydrogen-3	E. Any	E. 10 millicuries
F. Carbon-14	F. Any	F. 2 millicuries
G. Sulfur-35	G. Any	G. 20 millicuries

9. Authorized use:

A. through C. For receipt, storage and redistribution of prepackaged units to persons specifically licensed for the type, form and quantity of byproduct material by the Nuclear Regulatory Commission or an Agreement State.

D. through G. For research and development as defined in 10 CFR 30.4.

CONDITIONS

10. Licensed material shall be used only at the licensee's facilities located at 5025 Venture Drive, Ann Arbor, Michigan.

11. The Radiation Safety Officer for this license is Elizabeth Meade, Ph.D.

MATERIALS LICENSE SUPPLEMENTARY SHEET	
	License Number 21-24683-01
	Docket or Reference Number 030-29143
	Amendment No. 15

12. Licensed material listed in Item 6 above is only authorized for use by, or under the supervision of, the following individuals for the materials and uses indicated:

Authorized Users	Material and Use
Levi Blazer	Hydrogen-3
Daniel Bouchar, Ph.D.	Hydrogen-3, carbon-14, and phosphorus-32
Elizabeth Meade, Ph.D.	Hydrogen-3, carbon-14, phosphorus-32, and sulfur-35
Jim Corrigan	Hydrogen-3
Rana Sidhu, Ph.D.	Hydrogen-3, carbon-14, and phosphorus-32
Daniel Tew	Hydrogen-3

13. Prepackaged units intended for redistribution shall not be opened by the licensee.

14. This license does not authorize commercial distribution of licensed material to persons generally licensed pursuant to 10 CFR Part 31 or to persons exempt from licensing pursuant to 10 CFR 30.18.

15. Licensed material shall not be used in or on humans except as provided otherwise by specific condition of this license.

16. This license does not authorize the manufacture and packaging of radiochemicals for distribution.

17. The licensee is authorized to hold radioactive material with a physical half-life of less than or equal to 120 days for decay-in-storage before disposal in ordinary trash provided:

    A. Before disposal as ordinary trash, byproduct material shall be surveyed at the container surface with the appropriate survey meter set on its most sensitive scale and with no interposed shielding to determine that its radioactivity cannot be distinguished from background. All radiation labels shall be removed or obliterated.

    B. A record of each disposal permitted under this License Condition shall be retained for three years. The record must include the date of disposal, the date on which the byproduct material was placed in storage, the radionuclides disposed, the survey instrument used, the background dose rate, the dose rate measured at the surface of each waste container, and the name of the individual who performed the disposal.

18. The licensee shall not use licensed material in field applications where activity is released except as provided otherwise by specific condition of this license.

19. The licensee is authorized to transport licensed material only in accordance with the provisions of 10 CFR Part 71, "Packaging and Transportation of Radioactive Material."

License Number
21-24683-01

Docket or Reference Number
030-29143

Amendment No. 15

MATERIALS LICENSE
SUPPLEMENTARY SHEET

20. Except as specifically provided otherwise in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents including any enclosures, listed below. The Nuclear Regulatory Commission's regulations shall govern unless the statements, representations and procedures in the licensee's application and correspondence are more restrictive than the regulations.

    A. Application dated June 27, 2011 (ML111810651)

    B. Application dated November 18, 2011 (ML113270273)

    C. Letter dated December 18, 2013 (ML13352A352)

    D. Letter dated January 8, 2014 (ML14008A388)

    E. Letter dated September 17, 2015 (ML15266A489)

    F. Letter dated **June 16, 2016** (ML16174A416)

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Date AUG 25 2016

By [signature]
Peter J. Lee, Ph.D., CHP
Materials Control, ISFSI, and
Decommissioning Branch
Region III

From:	Tomczak, Tammy
To:	Pavon, Martha
Cc:	Pavon, Sandy
Subject:	FW: NRC 314 Form for License No. 21-24683-01 (Cayman Chemical Company, Inc.)
Date:	Tuesday, December 21, 2021 10:39:25 AM
Attachments:	Cayman Chemical Company Inc Decommissioning and License Termination FSSR with Appendices and Attachment Rev 1 signed.pdf CaymanChem NRC Form 314 Dec2021 signed.pdf

Good morning, Sandy and Martha,

Can you please add the attached to ADAMS?

Thank you!
Tammy

From: Anita Cooney <acooney@caymanchem.com>
Sent: Tuesday, December 21, 2021 10:34 AM
To: Tomczak, Tammy <Tammy.Tomczak@nrc.gov>
Cc: Beth Hurst <bhurst@caymanchem.com>; Shannon Stacey <smstacey@caymanchem.com>
Subject: [External_Sender] NRC 314 Form for License No. 21-24683-01 (Cayman Chemical Company, Inc.)

Good Morning Ms. Tomczak,
I have attached a signed NRC 314 form requesting the termination of Cayman Chemical Company's NRC License No. 21-24683-01. I have also attached the fully executed Final Status Survey Report, which was prepared by Philotechnics, Ltd.

Please do not hesitate to contact me if you have questions or need additional information. I will be in the office through COB on December 23rd.

Happy Holidays!
Anita Cooney

Anita M. Cooney, CSP, CHMM
Manager of Regulatory and Safety
Cayman Chemical Company, Inc.
1180 E. Ellsworth Road
Ann Arbor, MI 48108

Direct: (734) 249-5560
Cell: (734) 718-6650
Fax: (734) 975-3990
Email: acooney@caymanchem.com
Web: http://www.caymanchem.com/

From: Tomczak, Tammy <Tammy.Tomczak@nrc.gov>
Sent: Wednesday, December 15, 2021 4:04 PM
To: Anita Cooney <acooney@caymanchem.com>

Cc: Beth Hurst <bhurst@caymanchem.com>
Subject: RE: FW: Renewal Reminder - License No. 21-24683-01 (Cayman Chemical Company, Inc.)

Good afternoon, Ms. Cooney,

You can email me the completed NRC 314. Once the case is assigned to a reviewer, you can either submit the report to them, or you can email it to me, and I'll make sure they get it.

Thank you,
Tammy

From: Anita Cooney <acooney@caymanchem.com>
Sent: Wednesday, December 15, 2021 2:56 PM
To: Tomczak, Tammy <Tammy.Tomczak@nrc.gov>
Cc: Beth Hurst <bhurst@caymanchem.com>
Subject: [External_Sender] FW: Renewal Reminder - License No. 21-24683-01 (Cayman Chemical Company, Inc.)

Good Afternoon Tammy,
Beth Hurst (our RSO) forwarded your email to me. Philotechnics completed a radiation survey at our facility December 7-8, 2021. Philotechnics has issued a DRAFT Final Status Survey Report. It is a 69-page report and Cayman has provided all required feedback, but I don't have a final report copy to attach to the NRC 314 form just yet. The report does indicate that all surveyed areas can be released for unrestricted use. I will have the waste disposal information tomorrow. I'm really hoping to have the final report to attach to the 314 form, but as I said, I don't have it just yet. I will be working through December 23rd, but I'm trying to get this to you ASAP. I will certainly keep you posted!

Thank you,
Anita Cooney

Anita M. Cooney, CSP, CHMM
Manager of Regulatory and Safety
Cayman Chemical Company, Inc.
1180 E. Ellsworth Road
Ann Arbor, MI 48108

Direct: (734) 249-5560
Cell: (734) 718-6650
Fax: (734) 975-3990
Email: acooney@caymanchem.com
Web: http://www.caymanchem.com/

From: Beth Hurst <bhurst@caymanchem.com>
Sent: Wednesday, December 15, 2021 9:20 AM
To: Anita Cooney <acooney@caymanchem.com>
Subject: FW: Renewal Reminder - License No. 21-24683-01 (Cayman Chemical Company, Inc.)

Hi Anita,

Just an FYI.

Beth

From: Tomczak, Tammy <Tammy.Tomczak@nrc.gov>
Sent: Tuesday, December 14, 2021 4:32 PM
To: Beth Hurst <bhurst@caymanchem.com>
Subject: RE: Renewal Reminder - License No. 21-24683-01 (Cayman Chemical Company, Inc.)

Good afternoon, Dr. Meade,

Just a friendly reminder, with the holidays approaching, and people taking time away from the office, I'm trying to get the paperwork as soon as possible.

Thank you,
Tammy

From: Tomczak, Tammy
Sent: Tuesday, October 26, 2021 9:25 AM
To: bhurst@caymanchem.com
Subject: Renewal Reminder - License No. 21-24683-01 (Cayman Chemical Company, Inc.)
Importance: High

Good morning, Dr. Meade,

Materials license (21-24683-01) is scheduled to expire on December 31, 2021. I am attaching the forms for either renewal or termination of your license. If you are planning on renewing your license, please complete Form 313.

If you choose to terminate your license, please complete Form 314.

Documentation can be faxed to our office at (630) 515-1078, or emailed to R3DNMSMAIL.Resource@nrc.gov. Please have this information to us no later than November 30, 2021.

Please do not hesitate to contact me if you have any questions, or require any additional information.

Thank you,

Tammy Tomczak
Licensing Assistant
630-829-9564