Final Status Survey Report
Scientific Operations
Aptuit, LLC

Kansas City, Missouri

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Acronyms and Abbreviations

ALARA	as low as reasonably achievable
API	Active Pharmaceutical Ingredients
Aptuit	Aptuit, LLC
AU	authorized user
^{133}Ba	Barium-133
^{14}C	carbon-14
^{45}Ca	calcium-45
CB&I	Chicago Bridge and Iron
CFR	Code of Federal Regulations
CHP	certified health physicist
Ci	curie(s)
cm^2	square centimeters
^{51}Cr	chromium-51
^{137}Cs	cesium-137
CTS	Clinical Trials Supplies
DCGL	derived concentration guideline level
dpm	disintegrations per minute
DQO	data quality objective
Duratek	GTS Duratek, Inc.
FSS	final status survey
FSSP	final status survey plan

FSSR	Final Status Survey Report
ft^2	square feet
GMP	Good Manufacturing Practice
^{3}H	tritium
HEPA	high efficiency particulate air
HMRI	Hoechst Marion Roussel, Inc.
HPLC	high performance liquid chromatography
HSA	historical site assessment
IPA	instrument performance assessment
IU	individual user
^{125}I	iodine-125
^{131}I	iodine-131
^{42}K	potassium-42
LAR	Lab Animal Resources
LBGR	lower bound of the gray region
LSC	liquid scintillation counter
m^2	square meters
μCi	microcuries
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mCi	millicurie
MDC	minimum detectable concentration
mL	milliliter

mrem	millirem
^{22}Na	sodium-22
^{63}Ni	nickel-63
NMR	nuclear magnetic resonance
NRC	U.S. Nuclear Regulatory Commission
^{32}P	phosphorous-32
QC	quality control
RSC	radiation safety committee
RSO	radiation safety officer
RSPM	Radiation Safety Program Manual
Shaw	Shaw Environmental, Inc.
^{35}S	sulfur-35
SO	Scientific Operations
^{99m}Tc	Technicium-99m
TEDE	total effective dose equivalent

Definitions

Assessment. The evaluation process used to measure the performance or effectiveness of a system and its elements. Assessment is an all-inclusive term used to denote any of the following: audit, performance evaluation, management systems review, peer review, inspection, or surveillance.

Background Radiation. Radiation from cosmic sources, naturally occurring radioactive material, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices or from nuclear accidents like Chernobyl which contribute to background radiation and are not under the control of the cognizant organization. Background radiation does not include radiation from source, byproduct, or special nuclear materials regulated by the cognizant Federal or State agency. Different definitions may exist for this term. The definition provided in regulations or regulatory program being used for a site release should always be used if it differs from the definition provided here.

Beta Radiation. An electron emitted from the nucleus during radioactive decay.

Class 1 Survey Units. Areas where contamination is known or suspected to exist, and insufficient evidence exists to classify the areas as Class 2 or Class 3 survey units.

Class 2 Survey Units. Areas where contamination is known or suspected to exist, but where there is no evidence of it exceeding the release criteria.

Class 3 Survey Units. Areas where contamination is either not believed to exist or exists at levels that are insignificant compared to release criteria.

Contamination. The presence of residual radioactivity in excess of levels which are acceptable for release of a site or facility for unrestricted use.

DCGL. A derived, radionuclide-specific activity concentration in a survey unit corresponding to the release criterion. The DCGL is based on the spatial distribution of the contaminant and hence is derived differently for the nonparametric statistical test ($DCGL_W$) and the Elevated Measurement Comparison ($DCGL_{EMC}$). DCGLs are derived from activity/dose relationships through various exposure pathway scenarios.

Decommissioning. The process of removing a facility or site from operation, followed by decontamination, and license termination (or termination of authorization for operation) if appropriate. The objective of decommissioning is to reduce the residual radioactivity in

structures, materials, soils, groundwater, and other media at the site so that the concentration of each radionuclide contaminant that contributes to residual radioactivity is indistinguishable from the background radiation concentration for that radionuclide.

Decontamination. The removal of radiological contaminants from a person, object or area to levels that are within established regulatory guidelines. Decontamination is sometimes used interchangeably with remediation, remedial action, and cleanup.

Detection Limit. The net response level that can be expected to be seen with a detector with a fixed level of certainty.

Detection Sensitivity. The minimum level of ability to identify the presence of radiation or radioactivity.

Direct Measurement. Radioactivity measurement obtained by placing the detector near the surface or media being surveyed. An indication of the resulting radioactivity level is read out directly.

DQA (Data Quality Assessment). The scientific and statistical evaluation of data to determine if the data are of the right type, quality, and quantity to support the intended use.

DQOs (Data Quality Objectives). Qualitative and quantitative statements derived from the DQO process that clarify study technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Exposure Pathway. The route by which radioactivity travels through the environment to eventually cause radiation exposure to a person or group.

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

Gamma Radiation. Penetrating high-energy, short-wavelength electromagnetic radiation (similar to X-rays) emitted during radioactive decay. Gamma rays are very penetrating and require dense materials (such as lead or steel) for shielding.

Graded Approach. The process of basing the level of application of managerial controls applied to an item or work according to the intended use of the results and degree of confidence needed in the quality of the results.

Grid. A network of parallel horizontal and vertical lines forming squares on a map that may be overlaid on a property parcel for the purpose of identification of exact locations.

Impacted Area. Any area that is not classified as non-impacted. Areas with a possibility of containing residual radioactivity in excess of natural background or fallout levels.

Investigation. An activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for character.

License Termination. Discontinuation of a license, the eventual conclusion to decommissioning.

Liquid Scintillation. Method of measuring beta activity where energy released during decay is converted into photons that can be measured in the form of light energy within a liquid media referred to as a scintillation cocktail. The energy emitted in the form of light is proportional to the rate of decay and can be reported isotopically as ^{3}H or ^{14}C in disintegrations per minute (dpm), or generally as counts per minute (cpm).

Lower Bound of the Grey Region (LBGR). The lower bound of a region in which the consequences of decision errors are relatively minor. (The upper bound of the grey region is the DCGL and the LBGR is a site-specific variable that provides an acceptable value for the relative shift).

Lower Limit of Detection (L_D). The smallest amount of radiation or radioactivity that statistically yields a net result above the method background. The critical detection level, L_C, is the lower bound of the 95 percent detection interval defined for L_D and is the level at which there is a 5 percent chance of calling a background value “greater than background”. This value should be used when actually counting samples or making direct radiation measurements. Any response above this level should be considered as above background; *i.e.*, a net positive result. This will ensure 95 percent detection capability for L_D. A 95 percent confidence interval should be calculated for all responses greater than L_C.

Minimum Detectable Concentration (MDC). The minimum detectable concentration (MDC) is the *a priori* activity level that a specific instrument and technique can be expected to detect 95 percent of the time. When stating the detection capability of an instrument, this value should be used. The *MDC* is the detection limit multiplied by an appropriate conversion factor to give units of activity.

Measurement. It is used interchangeably to mean: 1) the act of using a detector to determine the level or quantity of radioactivity on a surface or in a sample of material removed from a media being evaluated, or 2) the quantity obtained by the act of measuring.

MARSSIM. Multi-Agency Radiation Survey and Site Investigation Manual. A manual established by the U.S. Environmental Protection Agency (EPA), U.S. Nuclear Regulatory Commission (NRC), DOD, and DOE that provides a nationally consistent consensus approach to conducting radiation surveys and investigations at potentially contaminated sites. The approach is both scientifically rigorous and flexible enough to be applied to a diversity of site cleanup conditions.

Non-Impacted Area. Areas where there is no reasonable possibility (extremely low probability) of residual radioactivity. Non-impacted areas are typically located off-site and may be used as background *reference area*s.

Professional Judgment. An expression of opinion, based on technical knowledge and professional experience, assumptions, algorithms, and definitions, as stated by an expert in response to technical problems.

Quality Assurance (QA). An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the customer.

Quality Control (QC). The overall system of technical activities that measure the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer, operational techniques and activities that are used to fulfill requirements for quality. For this FSSR, QC measures include precision, accuracy, bias, sensitivity, representativeness, completeness, and comparability.

Radiation Safety Committee. Individuals within the Aptuit organization who develop policies and procedures for the implementation of the Aptuit Radioactive Materials License.

Radiation Safety Officer. The Aptuit staff member responsible, with the support of the Radiation Safety Committee, for the implementation of the facilities Radiation Safety Program.

Radiation Survey. Measurements of radiation levels associated with a site together with appropriate documentation and data evaluation.

Radioactivity. The mean number of nuclear transformations occurring in a given quantity of radioactive material per unit time. The International System (SI) unit of radioactivity is the *Becquerel (Bq*). The customary unit is the *Curie (Ci*).

Radiological Release. The release of materials/equipment/areas from radiological controls pertaining to radioactive materials. These radiological controls refer to either local requirements as established in the RSPM or license requirements as established in the Nuclear Regulatory Commission Radioactive Material License. The release from radiological controls is preceded by an assessment of the radiological conditions and confirmation that these conditions meet the requirements to be released from further controls.

Radionuclide. An unstable atom of any element that undergoes radioactive decay in order to achieve a more stable state.

Regulation. A rule, law, order, or direction from federal or state governments regulating action or conduct. Regulations concerning radioisotopes in the environment in the United States are shared by the EPA, the NRC, the U.S. Department of Energy (DOE), and many State governments. Federal regulations and certain directives issued by the U.S. Department of Defense (DOD) are enforced in the DOD.

rem (Radiation Equivalent Man). The conventional unit of dose equivalent. The corresponding International System (SI) unit is the *Sievert (Sv)*: 1 Sv = 100 rem.

Remedial Action. Those actions that are consistent with a permanent remedy taken instead of, or in addition to, removal action in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment.

Remediation. Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a site.

Removable Radioactivity. Surface activity that is readily removable by wiping the surface with an absorbent medium using moderate pressure and can be assessed with standard radiation detectors. It is usually expressed in units of dpm/100 cm^2.

Residual Radioactivity. Radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from activities under the cognizant organization's control. This includes radioactivity from all sources used by the cognizant organization, but excludes background radioactivity as specified by the applicable regulation or standard.

Sign p. The estimated probability that a random measurement from the survey unit will be less than the DCGL when the survey unit median is actually at the LBGR.

Survey. A systematic evaluation and documentation of radiological measurements with a correctly calibrated instrument or instruments that meet the sensitivity required by the objective of the evaluation.

Type I Error. A decision error that occurs when a survey unit is determined to be acceptable for release when it truly is not. This error is also called a Type A (alpha) error.

Type II Error. A decision error that occurs when a survey unit is determined to be unacceptable for release when it truly is acceptable. This error is also called a Type B (beta) error.

Wipe Test. A procedure in which a sampling material is rubbed on a surface and its radioactivity measured to determine if the surface is contaminated with removable radioactive material.

Executive Summary

This report is the culmination of the final status survey (FSS) conducted at Aptuit, LLC (Aptuit), a pharmaceutical research and development facility located at 10245 Hickman Mills Drive in Kansas City, Missouri. This FSS was performed using the guidance of the Multi-Agency Radiation Survey and Site Investigation Manual. The primary purpose of the FSS was to demonstrate that residual radioactivity in each survey unit satisfied the release criteria as established by the U.S. Nuclear Regulatory Commission (NRC) in the license termination rule (10 Code of Federal Regulations 20, Subpart E).

The FSS included the radiologically impacted areas of the Scientific Operations (SO) facilities of Aptuit. These areas include specific portions of B Building and the Waste Storage Building.

Radionuclides of concern in the SO facilities were tritium and carbon-14, both pure beta radiation emitters. As noted, the scope of the FSS includes specific portions of B Building and the Waste Storage Building having potentially impacted areas such as laboratories and support areas in which these radionuclides were used or stored. A total of eleven survey units were included in the FSS: five were Class 1, five were Class 2, and one was a Class 3 survey unit. The Decommissioning Plan (Shaw 2013) identified eight survey units based on scoping surveys. Upon conducting additional characterization surveys, walls above 2 meters and ceilings were added as Class 2 survey units in three of the laboratory areas bringing the total number of survey units to eleven.

The completed final status survey included scanning and systematic, random, and biased measurement locations. Biased locations were determined by field personnel using professional judgment. A minimum of 14 systematic measurements, consisting of beta direct measurements and wipe samples, were included within the Class 1 and Class 2 survey units. A minimum of 14 random measurements were made in each of the Class 3 survey units. Accessible floors and walls to a height of 2 meters from the floor were scanned in each Class 1 and Class 2 survey unit. Walls above 2 meters and ceilings were scanned in the Class 2 overhead survey units. One-hundred percent of the Class 1 survey units were scanned, and 12 – 66% of Class 2 survey units were scanned. Class 3 areas were scanned as determined by field personnel. Confirmatory surface soil sampling was conducted as a follow-up to the sampling efforts conducted in 2010.

To ensure that residual radioactivity was reduced to levels that were as low as reasonably achievable, final status release criteria were set at 10 percent of the NRC screening values given in Table H.1 of NRC's *Consolidated Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria,* NUREG-1757, Volume 2, Revision 1

(NRC 2006b) and all areas exceeding investigation levels were investigated and cleaned or removed if reasonably possible.

In addition to presenting the results of the FSS conducted of the SO facilities, this report provides a summary of the previous investigations, including the building systems that came from all potentially impacted historical use areas. Data from all former use areas was used in the dose assessment presented in Chapter 5.0.

This FSS, in conjunction with the final status survey report for the Clinical Trials Supplies (CTS) areas, represents a comprehensive investigation of the final status of the entire licensed site. The CTS facilities were decommissioned and final status surveys were performed in December 2011. The CTS Final Status Survey Report (FSSR) (Shaw 2012) was submitted to the NRC On February 27, 2012.

Upon final review of the data, the SO facilities, as well as all historical use areas at the site, meet the NRC criteria for radiological release established in the license termination rule (10 Code of Federal Regulations 20, Subpart E). This document demonstrates that the entire Aptuit site is in compliance with the regulatory release criteria and, upon NRC approval, can be released for unrestricted use and the Aptuit's NRC Radioactive Materials License Number 24-15595-01 can be terminated.

1 Introduction

1.1 Purpose

Aptuit, LLC (Aptuit), a pharmaceutical research and development facility located at 10245 Hickman Mills Drive in Kansas City, Missouri (Figure 1-1), has discontinued its Scientific Operations (SO) business and is seeking unrestricted release of the facility and termination of the U.S. Nuclear Regulatory Commission (NRC) license. The primary purpose of the final status survey (FSS) is to demonstrate that residual radioactivity in each survey unit satisfies the release criteria. This Final Status Survey Report (FSSR) describes the investigation performed at Aptuit SO facilities and provides a summary of the data that demonstrates that the entire Aptuit site meets the criteria for license termination.

Radioactive materials were used at the Aptuit facilities for synthesis of radiolabeled compounds and for pharmaceutical research, development, and analysis in accordance with NRC Radioactive Materials License Number 24-15595-01 (License) (Appendix A). The activities authorized under the license were performed by two separate business lines. The Clinical Trials Supplies (CTS) business line performed research and development and analytical procedures using radiolabeled compounds. The SO business line performed synthesis of radiolabeled compounds. The CTS facilities were decommissioned and final status surveys were performed in December 2011. On February 27, 2012 Aptuit submitted the Final Status Survey Report (FSSR) for CTS to the NRC requesting release of those areas for unrestricted use.

In November 2011, a records review, a site visit, and interviews were performed by Shaw Environmental, Inc. (Shaw). Results of the investigation were used in the planning for the FSS. The Decommissioning Plan (DP) was completed in August 2012 and was revised in February 2013 (Shaw, 2013). The DP included a discussion of the characterization survey (CS) and final status survey (FSS) planning. Decommissioning activities were conducted between January 17, 2013 and February 25, 2014. Decommissioning activities, performed in accordance with the DP, included characterization surveys, decontamination and demolition, waste disposal and final status surveys. The surveys were of sufficient scope to detect and quantify residual radioactivity present in the facility. Data collected during this investigation were used in the data assessment process. Results are presented in Chapter 3.0. This data, along with the data previously submitted to the NRC, were used to establish the final status of the Aptuit facilities.

Aptuit intends to establish, through a presentation of results from the FSS and prior investigations, that this facility meets the criteria for radiological release established in Code of Federal Regulations (CFR), Title 10, Part 20, Subpart E, "Radiological Criteria for License

Termination." This investigation process was completed using the guidance of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NUREG-1575).

The elements required for completion of the FSS are presented in subsequent sections of this report. Elements include:

- Establishing the data quality objectives
- Defining the areas (survey units) to be investigated
- Establishing the methods to be used in the collection and analysis of data
- Ensuring that data collected are of sufficient quality and quantity to make final status decisions with an acceptable probability of decision error.

1.2 Report Organization

The remainder of this introduction includes a description of the site and its history. Following this introduction, Chapter 2.0 presents a description of the performance of the FSS, including planning decisions and field work. Measurement results and sampling results are presented in Chapter 3.0. Chapter 4.0 is a description of the Health and Safety program in place during the performance of field activities. Chapter 5.0 contains the dose assessment. Conclusions and recommendations are found in Chapter 6.0. Chapter 7.0 contains a list of references.

1.3 Site Location and Description

Aptuit is a pharmaceutical research and development facility located at the following address:

Aptuit, LLC
10245 Hickman Mills Drive
Kansas City, Missouri 64134-0708

The site is situated in a campus-type setting which includes offices, warehouse space, manufacturing space, and laboratory space and is located on approximately 45.5 acres of land. Aptuit owned and occupied 7 (Buildings A, B, E, N, and P; the pH treatment building; and the security building) of 13 primary buildings in this industrial complex (Figure 1-1) adjacent to and just east of Interstate 435. In addition, Aptuit leases the North Hill Waste Storage Building from Sanofi-Aventis. This building was used for staging and storage of waste materials and contaminated equipment. The surrounding area is also primarily industrial.

Radioactive materials were used for synthesis of radiolabeled compounds and for pharmaceutical research and development. Radiosynthesis operations took place in the Active Pharmaceutical Ingredients (API) laboratory suite on the B2 level of the B-Building. The B2 level also contained support areas such as the radiation safety office and the filter room that services API. There was one legacy analytical laboratory on the B3 level of B-Building (B3-298). B-Building contained a potentially contaminated legacy exhaust system which serviced laboratories in the B-Building. Radioactive waste was staged in the North Hill Waste Storage Building. All former radioactive use and storage areas have been released with the exception of the CTS facilities, for which the FSSR (Shaw 2012) is undergoing NRC review.

Construction of the Aptuit facility started in 1965 as Marion Laboratories with A Building. B Building was built in 1972. An expansion of Production Operation (Building P) was completed in 2005, with an additional expansion on the north side of the building completed in 2008. A pH treatment building (constructed in 2000) is located on the western boundary of the Property. A pond located on the southeast corner of the site adjacent to Building N is listed in the National Wetlands Inventory. Tennis and basketball courts are located north of the pond.

Prior to construction of A Building in 1965, the Property was utilized for agricultural purposes. Since 1965, the facility has been operated for pharmaceutical research and development, sample analysis, and administrative functions. Company ownership was transferred from Marion Laboratories, Inc. to Marion Merrell Dow in 1989. Ownership was then transferred to Hoechst Marion Roussel, Inc. (HMRI) in 1995. In 1999, company ownership was transferred from HMRI to Quintiles, Inc. Aptuit took ownership from Quintiles, Inc. in 2005 and has maintained ownership to the present day. The facility license history is presented in Section 1.4.1.

The radiologically impacted areas associated with SO and specifically addressed in this FSSR comprise 7,720 square feet (ft^2) in B Building (on the B2 and B3 levels) and 1,930 ft^2 in the North Hill Waste Storage Building. Areas of each building where radioactive materials may have been used or stored as part of SO operations are shown on figures in Chapter 2.0. The radiologically impacted areas associated with CTS operations consisted of 38,300 ft^2 in portions of A, B, and E Buildings. The CTS FSSR (Shaw 2012) was submitted to the NRC in February 2012. This FSSR includes a description of previous investigations and a discussion of the investigations of site systems that serviced potentially impacted areas.

Drains to the sanitary sewer are located in bathrooms, janitor closets, and laboratories. The Kansas City, Missouri, Waste Water Department provides sewage disposal. Sewage from office areas runs directly to the city sewer. Sewage from the laboratory and production areas is first sent to the on-site pH treatment building and adjusted if necessary prior to release to the city

sewage system. Releases to the city sewage system are in compliance with the waste water permit and within the limits specified in 10 CFR 20, Subpart K – Waste Disposal. A discussion of the investigation of the drain system that flowed from all historical use areas is in Section 3.7.2.

1.4 Site History

1.4.1 Operational and License History

Radioactive materials have been used at the Aptuit facility for research purposes since the issuance of the License (License Number 24-15595-01) in the spring of 1973. The License has authorized fourteen radionuclides including: hydrogen-3 (^{3}H), carbon-14 (^{14}C), nickel-63 (^{63}Ni), phosphorus-32 (^{32}P), sulfur-35 (^{35}S), iodine-125 (^{125}I), iodine-131 (^{131}I), calcium-45 (^{45}Ca), chromium-51 (^{51}Cr), Technicium-99m (^{99m}Tc), sodium-22 (^{22}Na), potassium-42 (^{42}K), cesium-137 (^{137}Cs) and barium-133 (^{133}Ba). With the exception of ^{63}Ni, ^{133}Ba, and ^{137}Cs sealed sources, the License authorized the radionuclides in any form, and the authorized uses were research and development in the synthesis of labeled pharmaceuticals for nonhuman experimentation and in vivo and/or in vitro animal studies. There was very limited to no use of ^{32}P, ^{35}S, ^{45}Ca, ^{51}Cr, ^{99m}Tc, ^{22}Na, and ^{42}K. With the exception of ^{22}Na, these radionuclides have very short half-lives and would not constitute a contaminant of concern even if they had been used in recent years. ^{22}Na was authorized on Amendment 15 in January 1992. This radionuclide was no longer authorized as of Amendment 17 issued in September 1993. The license limit was 20 mCi. There is no record of use of ^{22}Na at the facility nor was it identified as a contaminant of concern in any previous site investigations. The short half-life (2.6 years), the time since ^{22}Na was authorized on the license (19.5 years), combined with a lack of evidence of any use effectively eliminates ^{22}Na as a contaminant of concern. Until 2008, the primary use was microcurie (μCi) to millicurie (mCi) quantities of ^{3}H and ^{14}C. Amendment 27 issued in 2008 authorized synthesis of radiolabeled compounds and increased the possession limits for ^{3}H and ^{14}C.

The License has been amended 37 times, primarily for address changes, changes in company ownership, and changes in the radiation safety officer (RSO). Other amendments include the addition or deletion of radionuclides (such as ^{63}Ni and ^{45}Ca) or their uses and changes in possession limits. The most significant amendment was Amendment 27 in 2008, which substantially increased License limits for ^{3}H and ^{14}C and authorized synthesis of radiolabeled organic compounds (SO business line). Synthesis operations were located in the API suite on the B2 level of Building B. License limits for ^{3}H and ^{14}C were increased from 1 and 2 curies (Ci), respectively, to 100 Ci for each. The license limit for ^{35}S was also increased from 70 mCi to 1.5 Ci.

Amendments 28 through 32 were to change authorized users and to add use and support areas. Amendment 33, issued January 4, 2012, was a change in ownership from Aptuit, Incorporated to Aptuit, LLC. Amendment 34 was a change in authorized users and a change in authorized use for ^{35}S and ^{125}I from “research and development” to “in storage incident to disposal”. Amendment 35 issued January 31, 2013 changed the authorized use of ^{3}H and ^{14}C to storage and use pending final decommissioning and termination of the license. Amendment 36 issued September 18, 2013, approved the decommissioning plan (DP) which described the decommissioning activities that were performed at the site. Amendment 37 dated December 19, 2013 lowered the license limits to 50 and 60 millicuries for ^{3}H and ^{14}C, respectively. These possession limits are below those requiring decommissioning financial assurance. The NRC cancelled and returned the financial assurance instruments to Aptuit.

The Aptuit Radiation Safety Program Manual (RSPM) (Aptuit 2008) established safe work practices for protection against ionizing radiation hazards. It identified the responsibility of various parties, including the RSO, the radiation safety committee (RSC), and users (authorized users [AU] and individual users [IU]). Various associated procedures were presented within the RSPM, such as procedures for training, shipping, storage, monitoring, and waste management.

The NRC has conducted a minimum of six facility inspections for which inspection reports were reviewed. These inspections occurred on December 18, 1985; April 24, 1991; July 17, 1996; February 15, 2002; February 27, 2007; December 3, 2010; and December 2, 2013. The inspections were examinations of the activities conducted under the License as they related to radiation safety, compliance with NRC rules and regulations, and the conditions of the License. The inspections consisted of examinations of procedures and representative records, interviews with personnel, observations by the inspector, and confirmatory surveys.

There was one violation noted from the 1985 inspection – failure to perform daily wipe tests during radioactive use periods. The 1991 inspection produced two violations. The first violation was identified as a repeat violation: not all areas authorized for the storage and use of radioisotopes were surveyed by the AU at the end of each day of activity. The second violation centered on a lack of records of surveys and wipe tests performed upon completion of use of radioisotopes for various laboratories in B Building.

Records for the 1996, 2002, 2007, and 2010 inspections indicate no violations were observed.

There was one violation noted from the 2013 inspection – transfer of a generally licensed device (Beckman Liquid Scintillation Counter LS6500) containing 30 μCi of Cesium-137 to a person who did not hold a specific license to receive the device.

In addition to the facility inspections, the NRC conducted a site visit on March 14, 2008 to discuss Aptuit's application for an amendment to the license to perform radiosynthesis operations. Previously the NRC had reviewed drawings of the proposed changes to the area before construction started. The visit included a tour of the facility to evaluate facilities and equipment in place to support the amendment request. As a result of the meeting, Aptuit revised the license amendment request to use a phased approach for increasing possession limits (i.e., increase possession limits to 100 Ci each for ^{3}H and ^{14}C instead of 5,000 and 500 Ci, respectively). It should be noted that the increased license limits were needed for radiosynthesis operations.

1.4.2 Description of Operations

Only AUs and IUs properly trained in accordance with the RSPM and License were permitted access to radioactive materials. Radioactive materials were used and stored in designated areas. Designated fume hoods were used for working with and storing radioactive materials. A list of the areas in the SO facilities, established as areas where use or storage of radioactive materials may have occurred, is presented in Table 1-1. Additional investigations, including historical survey records, license amendments, area drawings, and interviews, were used to establish the status (i.e., impacted or non-impacted) of areas that were in question and to establish additional survey requirements prior to final status determination.

The SO AUs conducted a variety of research, development, and synthesis activities involving the use of radioisotopes. To perform these activities, the AUs initiated the process for obtaining the required radionuclides. The AU cleared all purchases or shipments with the RSO to ensure License compliance. After approval by the RSO, the radioactive material was ordered and shipped to the attention of the RSO and notice was given to receiving personnel that a radioactive material delivery was expected. Upon delivery of the radioactive material, the packaged was surveyed using a hand-held detector (Geiger-Mueller) and a wipe test for removable activity. The results of the receiving survey were logged on a radioactive shipment report.

Although other radionuclides have been approved by the NRC and included in the License, the radionuclides most recently used in SO operations were ^{3}H and ^{14}C. The most recent use, until operations ceased in January 2012, was synthesis of radiolabeled compounds using millicurie (mCi) to curie (Ci) quantities of ^{3}H and ^{14}C. Radiosynthesis was authorized in 2008 (Amendment 27) and the license limits for ^{3}H and ^{14}C were increased to 100 Ci each. Prior to this time uses were limited to research and development and analysis using mCi quantities of ^{3}H, ^{14}C, and ^{125}I. There has been no use of radioactive materials, other than QA analysis and

what is incidental to preparation activities for decommissioning, since radiosynthesis operations ceased in January 2012.

1.4.3 Waste Handling and Disposal Procedures

The RSPM and procedures for working with radioisotopes describe the performance of laboratory monitoring and the segregation and handling of radioactive waste. Waste generated from experiments typically included contaminated paper, plastic, gloves, dry test tubes, liquid scintillation media, and aqueous and nonaqueous liquid wastes.

Isotopes with half-lives less than 120 days (e.g., ^{125}I) were allowed to decay in storage for a minimum of 10 half-lives in compliance with the License. When levels were indistinguishable from background, the radiological labeling was removed or destroyed and the material was disposed as nonradioactive waste.

Although sewer disposal of radioactive materials occurred in past operations in accordance with regulatory limitations, sewer disposal was not allowed in SO facilities as a routine disposal method. However, starting in 2011, effluent water samples have been collected for ^{3}H and ^{14}C analysis from the on-site pH lift station twice monthly. No activity has been detected above the sample detection limit in these samples.

The AUs segregated radiological waste according to form (dry active waste, liquid scintillation vials, and bulk liquid) and radionuclide content. The activity disposed was recorded. The RSO arranged for waste to be moved to the North Hill Waste Storage Building. Radioactive waste was shipped by a contracted radioactive waste management service.

1.4.4 Laboratory Radioactive Material Practices

The AUs were responsible for the use and control of radioactive materials within the work areas. Training for AUs included initial radiation safety training, orientation training on facility practices, and annual refresher classes. The RSO had the responsibility to ensure that all AUs had the appropriate training.

Instrument surveys were performed each day of use of radioactive materials in the API area. The AUs conducted the surveys by scanning use areas with a Geiger-Mueller detector and/or by collecting wipe samples. In addition to the day of use surveys, the RSO or his designee performed weekly wipe sampling in and adjacent to radiosynthesis areas and monthly in R&D areas. Inactive use areas (e.g. B3-298) were surveyed at six month intervals. Other areas

where radioactive materials were present or infrequently used that were surveyed include the North Hill Waste Storage Building, B2-103A, B2-112, and the cafeteria.

Contamination is defined in the RSPM as activity greater than 5,000 disintegrations per minute (dpm)/100 cm^2 average total activity (15,000 dpm/100 cm^2 maximum), and 1,000 dpm/100 cm^2 removable for ^3H and ^{14}C. However, in practice, Aptuit used as-low-as-reasonably-achievable (ALARA) action levels of 200 dpm/100 cm^2 for loose contamination and 2,000 dpm/100 cm^2 for total. Areas with activities exceeding either action level were cleaned until activity was below the action levels if possible. If the area could not be cleaned it was marked as contaminated.

1.4.5 Incidents of Spills or Potential Releases of Radioactive Material

Five documented radiological incidents were in areas covered by this FSSR. Each of those incidents is described separately in the following paragraphs.

There are two documented incidents in B3-298.

- On April 4, 2007, it was discovered that the tubing from a detector on a high-performance liquid chromatograph (HPLC) in B3-298 had become detached and had dripped on the floor. Surveys conducted after the tubing was reconnected indicated some ^{14}C contamination on a corner of the cabinet and on the floor. Attempts to decontaminate the area were unsuccessful. The contaminated areas were taped and labeled as radioactive. No contamination was found outside the immediate area of the spill. Contamination levels exceeded 100,000 dpm/100 cm^2. The spill involved ^{14}C in an organic solvent HPLC carrier. The total activity involved is not known.

- On July 26, 2010, the deionized water system in B3-298 leaked into the contaminated area under the bench. Water that leached from under the bench was contaminated. Water also leaked under the wall into the adjacent hallway. No contamination was found on the carpet in the hallway.

There have been two incidents in the Active Pharmaceutical Ingredients (API) area.

- On November 2, 2008 a spill occurred in the API area, originating in B2-166. The spill was a result of a hose, connecting tap water to a hot water bath, becoming disconnected in a chemical hood. The hot water bath was unattended during this leak and water flowed from the chemical hood and became contaminated with ^{14}C and ^3H as it flowed from the hood and into the laboratory. The spill resulted in

approximately 300 gallons of water being collected and another approximate 110 gallons being discharged through the sanitary sewer. Analytical results indicated that the water discharged to the sewer contained approximately 77 μCi of ^{14}C with ^{3}H at background levels. The average water discharge from the site at the time was 12,100 gallons per day. This results in an average concentration on the day of the incident of 1.7E-6 μCi/ml (3.6 dpm/ml) or a monthly average discharge of 5.6E-8 μCi/ml (0.1 dpm/ml).

The spill covered Laboratories B2-165, B2-166, B2-167, and B2-170. This spill migrated outside of Laboratory B2-166 to the adjacent linoleum floor tiles and carpeted cubicle area, resulting in contamination of the floor and furniture in the office area. Decontamination activities included stripping of the linoleum floors, removal and replacement of carpet tiles, and cleaning of furniture. Decontamination efforts were successful in reducing levels to below Aptuit's surface contamination limits. Total activity involve in the spill was estimated to be 1.01 mCi.

- On September 20, 2011, contamination was found in the hallway outside of the API laboratories after filling a radioactive waste disposal box. It is suspected that the contamination resulted from a leaking container that was placed into the box. The area was decontaminated successfully.

Surveys performed in the cafeteria (B3-275) on April 24, 2010 revealed elevated direct readings for ^{14}C on the floor (one spot) and table legs (two locations). One carpet tile was removed and disposed and the table legs were decontaminated. This survey was performed to determine if radioactive materials were being tracked from the radiosynthesis operations. After this initial survey, the cafeteria was put on a routine quarterly survey schedule and additional radiological controls were instituted in the radiosynthesis laboratories. During at least one following survey, elevated readings have been found on table legs that were subsequently decontaminated.

Other incidents have been reported during the facility's operating life; however, areas where those incidents occurred were previously surveyed and released from radiological controls.

1.4.6 Previous Investigations

The following is a summary of the decommissioning activities previously conducted at the site. All of these activities were performed under the Aptuit license.

L Building and LAR - GTS Duratek, Inc., 1999

Radiological site investigations were conducted by GTS Duratek, Inc. (Duratek) in 1999 in support of License transfer activities (Duratek, 1999a,b). Areas covered by these activities were in L Building and in the LAR section of B Building. Radionuclides of concern were ^{14}C and ^{3}H. Together, these two reports describe a concerted effort to identify and eliminate contamination that exceeded specified limits. The purpose of the surveys associated with the July report (Duratek, 1999a) was to locate and identify any areas of contamination on surfaces/structures (floors, benches, and hoods) within the laboratories to support the license transfer from HMRI to Quintiles. There were no specific guideline values utilized for the surveys since the facility was not being surveyed for release. Instead, flag values were implemented based upon the detection capability of the survey instrumentation and the facility radiological control criteria. For direct surface activity measurements, a flag value of 1,000 dpm/100 cm^2 was used for ^{14}C while a flag limit for total removable activity was set at 200 dpm/100 cm^2 for ^{3}H and ^{14}C combined.

Initial surveys were performed followed by cleaning activities. Cleaning activities were performed in an attempt to reduce radioactivity levels below the flag values. Follow-up surveys were then performed. Radioactivity levels could not be reduced to below the flag values in some cases. Hence, the activities associated with the November report (Duratek, 1999b) were performed.

For areas where radioactivity levels could not be reduced to below flag values prior to the issuance of the July report (Duratek, 1999a), the November report (Duratek, 1999b) stated that aggressive cleaning activities were performed, some equipment was removed, and areas were resurveyed. The purpose of the surveys associated with the November report (Duratek, 1999b) was "to verify that the areas or components were adequately decontaminated and that no spread of contamination occurred during the decontamination process."

B2-150A - Shaw, 2005

Shaw performed equipment and facility radiological release surveys in Laboratory B2-150A in April 2005 (Shaw, 2005). The release limit was 2,000 dpm/100 cm^2 for ^{3}H and ^{14}C. A grid was established on the floor and walls. A static count was performed and a wipe sample collected within each grid. Several areas within the laboratory exhibited

activity greater than the release limit. These areas were cleaned to below the release limit. Wipes were collected for ^{3}H, and all results were below the release limit.

L4-421 and L4-422 - Shaw, 2002

In the L Building (formerly an Aptuit facility), two laboratories were released from radiological controls in 2002 prior to release of the entire building in 2006. Laboratories L4-421 and L4-422 were released under the conditions of the License and following guidance in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC, 2000). The radionuclides of concern were ^{3}H and ^{14}C. The laboratories are adjacent and were considered one laboratory designated at L4-422 for purposes of the survey. The laboratories were divided into three Class 1 survey units because insufficient information was provided at that time to reduce the classification to Class 2 or Class 3. The DCGLs used during these surveys were 3.7E+06 dpm/100 cm^2 for total contamination and 3.7E+05 dpm/100 cm^2 for removable contamination. The survey consisted of 36 direct measurements and wipe samples in each survey unit. All direct measurements and wipe sample results were below the respective DCGLs. The highest direct measurement was 1960 dpm/100 cm^2 and the highest result for a smear in these survey units was 90.6 dpm/100 cm^2.

L5-526 - Shaw, 2006

Laboratory L5-526 in the L Building was released in 2006. An FSS was performed following MARSSIM guidance. The radionuclides of concern were ^{3}H and ^{14}C. Based on a lack of historical information the laboratory was considered a Class 1 survey unit. The DCGLs used during these surveys were 3.7E+06 dpm/100 cm^2 for total contamination and 3.7E+05 dpm/100 cm^2 for removable contamination with ALARA goals set at 2000 dpm/100 cm^2 total and 200 dpm/100 cm^2 removable. All direct measurements and wipe sample results were below the respective DCGLs and below the ALARA goals.

A3-367 - Shaw, 2006

Decommissioning activities including a final status survey (FSS) were conducted in Laboratory A3-367 in 2006 (Shaw, 2006). The FSS included surface scans, direct measurements, and wipe sampling. The radionuclides of concern were ^{3}H and ^{14}C. All direct measurements and wipe sample results were below the DCGLs and ALARA goals (2000 dpm/100 cm^2 total and 200 dpm/100 cm^2 removable). The data indicated that the laboratory was acceptable for unconditional radiological release.

L Building and Lab Animal Resources (LAR) Decommissioning, Shaw -2006

Shaw performed decommissioning activities in L Building and the Lab Animal Resources (LAR) section of B Building in 2006 in preparation for releasing those areas from radiological controls. Shaw performed a Historical Site Assessment (HSA) and planned and conducted a final status survey (FSS). The maximum systemic direct reading found during the LAR FSS was 14,342 dpm/100 cm^2. All FSS wipe samples were below 70 dpm/100 cm^2. A final status survey report (FSSR) was prepared and submitted to the NRC (Shaw, 2007). The DCGLs selected, based on NRC screening values and as low as reasonably achievable (ALARA) considerations, were 3.7E+05 dpm/100 cm^2 for total activity and 3.7E+04 dpm/100 cm^2 for removable activity. Being a separate building, the L Building was released from Aptuit's NRC Radioactive Materials License (Amendment 25), and LAR was released from radiological controls. L Building is no longer under Aptuit's control. The LAR area was renovated and now houses the API radiosynthesis laboratory and support areas.

Surface Soil Sampling – Shaw, 2010

At the request of Aptuit, Shaw performed limited soil sampling within the property boundaries of the Aptuit site. The purpose of the sampling was determine if any there were measurable levels of radioactive materials, specifically ^{14}C and ^{3}H in the surface soils attributable to air effluents from the B2 area stack.

All ^{14}C results were below the sample detection limits of 0.99 – 1.1 pCi/g. ^{3}H was detected above the sample detection limits (0.20 – 0.21 pCi/g) in two sampling locations, including one of the background locations. The results of the soil investigation indicate that there were no impacts to the surface soils (at the stated detection limits) that could be attributable to emissions from the API B2 stack (Shaw, 2010).

Aptuit CTS - Shaw, 2012

A final status survey (FSS) was conducted at Aptuit in 2011. The FSS included the radiologically impacted areas of the Clinical Trials Supplies (CTS) facilities of Aptuit. These areas included specific portions of A, B and E Buildings.

Radionuclides of concern in the CTS facilities were ^{3}H and ^{14}C. The scope of the FSS included specific portions of A, B and E Buildings having potentially impacted areas such as laboratories and support areas in which these radionuclides were used or stored. A

total of four survey units were included in the FSS: one was a Class 2 and three were Class 3 survey units. There were no Class 1 survey units.

The completed final status survey included scanning and systematic, random, and biased measurement locations. Biased locations were determined by field personnel using professional judgment.

To ensure that residual radioactivity was reduced to levels that were as low as reasonably achievable, final status release criteria were set at 10 percent of the NRC screening values given in Table H.1 of NRC's Consolidated Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria, NUREG-1757, Volume 2, Revision 1 (NRC 2006b).

The highest direct measurement was 1841 dpm/100 cm^2 and the highest result for a smear in these survey units was 24 dpm/100 cm^2. The FSS data demonstrate that the CTS facilities meet the NRC criteria for radiological release established in the license termination rule (10 Code of Federal Regulations 20, Subpart E). The data are presented in the Aptuit CTS Final Status Survey Report (Shaw, 2012). Data from this investigation was used in the dose assessment presented in Chapter 4.0. The FSSR is currently under NRC review.

The drainage and sewer pipe systems from historical use areas have been investigated and the results have been previously reported to the NRC in FSSRs (Shaw 2007, Shaw 2012) and the DP (Shaw 2013).

All exhaust systems coming from potentially impacted areas of the site were investigated. Legacy exhaust system components that had residual contamination above Aptuit's acceptable release limits (Table 1-2) were removed and disposed as radioactive waste. Legacy exhaust system components with residual contamination below acceptable release limits were left in place.

All drain pathways from locations controlled by the licensee to the sewerage system have been identified. The sewerage system from historical use areas has been investigated and has been determined to not have an impact on dose to the public.

The results of the exhaust and drain system investigations are discussed in greater detail in Section 3.7 of this FSSR.

All of the previously decommissioned areas were used for research and development in the synthesis of labeled pharmaceuticals for nonhuman experimentation and in vivo and/or in vitro animal studies. Radioisotopes were generally received as labeled organic compounds in an aqueous matrix. Typically, the isotopes were diluted into working solutions, and µCi quantities were used primarily as labels on pharmaceuticals. None of the previously decommissioned areas were used for radiosynthesis operations authorized by Amendment 27. Up until 2008, the primary use was µCi to mCi quantities of ^{3}H and ^{14}C.

Remediation efforts typically involved wiping contaminated surfaces with a water and detergent mixture. In some cases contaminated items and materials were removed and disposed as radioactive waste when cleaning efforts were unsuccessful. All radioactive materials generated during remediation efforts were managed and disposed as radioactive waste.

1.5 Potentially Exposed Populations

Since the facilities are industrial facilities located in an industrial area, activities similar to those of Aptuit are the most likely future activities. Therefore, the hypothetical building occupants are the most likely potentially exposed populations.

1.6 Summary of Remediation Activities

Remediation tasks were performed in B3-298, B2-103A, API (B2-155 through B2-170) and B2-112. These tasks included removal of contaminated systems and equipment, decontamination or removal of contaminated attached furniture, and decontamination or removal of floor and wall surfaces. These tasks were performed after removal of materials and unattached equipment. In addition, legacy exhaust ductwork was removed from some other areas and exterior and rooftop exhaust system components were removed. Remediation activities for each area are described below.

Decommissioning activities that could be performed prior to approval of the DP (i.e. decontamination and removal of lab furniture in B3-298) were performed in January 2013. All other remediation activities were performed after NRC approval of the DP on September 18, 2013. These activities occurred between October 21, 2013 and February 25, 2014. Remediation activities were performed in accordance with Aptuit WI-004, Rev. 1, General Decontamination and Decommissioning Activities. Radiation protection and control was provided in accordance with Aptuit WI-005, Rev. 1, Control of Radiological Work for Decommissioning Activities.

The general approach used during remediation activities included:

- Prior to decommissioning activities, the contents of the laboratories, including materials, equipment and chemicals were removed.
- Lab benches and other work surfaces were wiped down with an appropriate cleaner.
- Utility disconnections were locked out/tagged out (LOTO) and verified in accordance with 29 CFR 1910.147.
- Physical barriers were established to limit access to work areas and signage and/or yellow caution tape were placed around the work sites to provide a warning of the activities taking place.
- Waste containers were staged and material movement pathways were designated.
- Training for all D&D workers was presented and all worker training requirements were verified.
- Daily briefings were conducted prior to start of work to review specific work steps/tasks, to update any work requirements/conditions as applicable, and to review safety hazards and control methods.

If after the general decontamination efforts described above (i.e. surface washing and removal of readily removable radioactivity) , total or removable contamination exceeded the Aptuit ALARA goals of 37,000 dpm/100 cm^2 total or 3,700 dpm/100 cm^2 removable activity, then additional decontamination attempts (e.g. scrubbing, chiseling) or removal of the material, whichever was appropriate, was performed. If residual contamination remained after the more aggressive decontamination efforts, further attempts at reducing residual activity were not considered reasonable. The ALARA goals used above (37,000 dpm/100 cm^2 total or 3,700 dpm/100 cm^2 removable activity) for attempting more aggressive decontamination methods are approximately 1% of the NRC surface screening presented in Table H.1 of NUREG 1757 (NRC, 2006).

1.6.1 Laboratory B3-298

Surveys were performed on and around the laboratory tables, bench work and building surfaces in the vicinity of the known spill area. The laboratory table and bench work found to be contaminated were removed as radiological waste. Portions of bench work were found to be uncontaminated and were removed as laboratory debris. Sections of the contaminated laboratory flooring and adjacent flooring were removed and disposed of as radiological waste.

1.6.2 B2-103A, Incinerator

The incinerator in room B2-103A, along with the associated ductwork and stack, was removed and disposed of appropriately. Prior to removing the incinerator, an access hole to the waste container staged near Dock 5 was made by removing the ventilation louvers in the north wall of B2-103A. A wood frame and plastic containment was built from the access created in B2-103A to the waste containers.

After discussions with the demolition contractor, the use of a plasma cutter was evaluated for size reduction of the incinerator, stacks and other metal debris. The use of the plasma cutter, with additional fire and ventilation controls, was approved by the Aptuit Radiation Oversight Committee. The incinerator was size reduced into manageable pieces and surveyed. Incinerator pieces that met the free release criteria were disposed of as construction debris.

The ductwork and stack were removed, characterized, and disposed of appropriately. After the incinerator was removed, the floor was cleaned with a high efficiency particulate air (HEPA) filtered vacuum and surveyed.

A wall was removed from between Lab 157 and B2-103A to provide access to the waste containers. Radioactive waste from the API Laboratory Suite was removed from the building along this path.

1.6.3 API Laboratory Suite

The p-traps and drain lines from sinks in the API area were characterized in February to May 2013. Drain surveys included direct measurements on the open end of the drain line and over the open ends of the sink traps after they were removed. The contents of the traps were collected into a single container and characterized. The inside of each trap and the open end of the each drain line, after removal of the trap, was wiped with a cotton swab or paper smear. Based on the results of the investigation, there is low level residual contamination in the embedded drain lines within the API area. Surveys conducting downstream of the API area

indicate that the contamination does not extend to the drain system beyond that area. Based on an evaluation of the potential impact on dose to the public from residual contamination in the drain lines (see Section 3.7.2), the remaining drain lines were left in place.

Characterization surveys were conducted in the eighteen chemical fume hoods (CFHs) for hazard assessment and waste activity calculations. All utilities to the CFHs were verified to be LOTO and disconnected. Plastic sheeting was placed on the floor in the vicinity to collect any debris and protect the floor. The CFHs were disassembled using hand and power tools to pieces that were small enough to be transported to the radioactive waste container via the designated travel path. All CFH pieces were disposed of as low-level radioactive waste.

Following removal of the CFHs, the exhaust ductwork and snorkel exhausts were removed to the point where the ductwork entered the HEPA filter housing in B2-112. Plastic sheeting was placed on the floor below the ductwork to collect any debris and protect the floor. The ductwork was removed in approximately 5’ sections, as possible, using hand and power tools. Ductwork was surveyed either prior to removal, as possible, or after removal via access points generated during removal. All ductwork had the ends wrapped and taped prior to being transported to the radioactive waste container. All ductwork was disposed of as low-level radioactive waste.

After removal of the API exhaust ductwork, a section of legacy exhaust duct was discovered which opened in the ceiling of Laboratory B2-166. Historical documents and drawings were reviewed and a walk down of the system was conducted to determine the prior uses of this exhaust duct and where it terminated. It was determined that the duct had serviced Room 144 in the LAR section which was a non-impacted area during the decommissioning of LAR. This leg of the duct tied into the main exhaust line going to Exhaust Fans BR-EF 71A and BR-EF 71B. Although this line had previously serviced non-impacted fume hoods, it had become contaminated from pulling room air during operations in API. This exhaust line, from Laboratory B2-166 to where it tied into the main line on the B2 roof was removed following the same procedures used for the other ductwork. Results of surveys performed in the main line, in Exhaust Fans BR-EF 71A and BR-EF 71B, and the associated stack were below Aptuit acceptable release limits and therefore those systems remained in place.

The inactive utility service lines in the API area, including vacuum lines, water lines, and gas lines were LOTO, characterized and removed, as necessary. Surveys included the exterior surfaces of the lines and, after the lines were cut, samples were collected through the openings. Lines that were contaminated above acceptable release limits were removed and disposed as radioactive waste.

The active systems and components remaining in the API area including utility lines and lighting fixtures were surveyed and decontaminated as necessary. Insulation on the water lines in B2-166 was contaminated and was removed. All conduits, utility lines and light fixtures were surveyed and then decontaminated as necessary by wiping with a detergent solution. Systems and components that did not meet unrestricted release criteria were removed and disposed as radioactive waste.

After the rooms were cleared of equipment, hoods, bench tops, tables, and cabinets, a radiological survey was performed on building surfaces including walls, floors, and ceilings. Surface areas that exceeded the Aptuit ALARA goals were decontaminated or removed. The laminate flooring was removed from the laboratory areas and was disposed as radioactive waste.

1.6.4 B2-112 Filter Room

The HEPA filter housing for the API exhaust system was located in B2-112. The HEPA housing and associated ductwork was characterized and found to be contaminated throughout. The HEPA housing was equipped with a bag-in/bag-out containment system which was used for removal of the HEPA filters. After removal of the filters, a fixative was sprayed on the interior surfaces of the HEPA housing and allowed to dry. The HEPA housing was then size reduced using a reciprocating saw. The housing sections were wrapped in plastic and placed in the radioactive waste container.

The duct connecting the HEPA system, fans, and stack was disassembled, removed, and surveyed for radiological contamination. A heat exchanger in the exhaust system contained ethylene glycol. The ethylene glycol was removed and analyzed for radioactivity. The ethylene glycol was disposed as nonradioactive waste. A fixative was sprayed on the interior surfaces of the duct and other components and the pieces were covered with plastic prior to removing each section to the waste container. The heat exchanger, fans, and stack were located on concrete pads just outside of B2-112. The path from these components leading to the waste disposal area was also covered with plastic as an additional contamination control measure prior to the disposal of these pieces.

The concrete pad underneath the heat exchanger was discovered to be contaminated. Prior to decontamination, this pad was covered with plastic to prevent the further spread of contamination. The pad was decontaminated to below the Aptuit ALARA goals via chipping up the concrete with hand tools and employing a HEPA filtered vacuum to control the debris.

1.6.5 Legacy Exhaust and Exterior and Rooftop Exhaust Components

Previously identified B Building rooftop fan assemblies and associated exhaust duct and stacks were surveyed for radiological contamination, removed as necessary, and disposed of appropriately. The B Building rooftop exhaust systems that were removed are shown on Figure 1-2. Interior legacy exhaust systems that were removed are shown in Figures 1-3 and 1-4.

Prior to beginning the decommissioning work on the roof, the structural capacity of the roof was evaluated and deemed to be adequate for the weight of the work crew and their equipment by a structural engineer. The demolition contractor determined that the use of scaffolding would be better and safer than using a crane for removal of the rooftop components. Stack and exhaust system components were disassembled and lowered to the ground for survey. Stack sections that did not meet the radiological release criteria were placed in the radiological waste container for disposal. All API stack sections were disposed of as LLRW. The incinerator and rooftop stacks met the release criteria and were disposed of as construction debris.

1.6.6 HP Support Areas (B2-116, B2-117, B2-119)

The legacy exhaust ductwork was removed from the HP Support areas. These areas were surveyed for radiological contamination and were determined to require no further remediation efforts.

1.7 Applicable Regulations and Guidance Documents

Regulations and guidance documents that apply to the radiological release of the Aptuit SO facilities at 10245 Hickman Mills Drive in Kansas City, Missouri, include the following:

- 10 CFR 20, Subpart E. *Radiological Criteria for License Termination*.
- NUREG-1757, Vol. 1, Revision 2. *Consolidated NMSS Decommissioning Guidance, Decommissioning Process for Materials Licensees*.
- NUREG-1757, Vol. 2, Revision 1. *Consolidated NMSS Decommissioning Guidance, Characterization, Survey, and Determination of Radiological Criteria*.
- U.S. Nuclear Regulatory Commission (NRC), 2000, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1*, NUREG-1575, EPA 402-R-97-016, Department of Defense, et al., August.

2 Final Status Survey Methodology

2.1 Radionuclides of Concern

The radioactive contaminants of concern at the Aptuit SO facilities on Hickman Mills Drive in Kansas City, Missouri, were determined through personnel interviews and a review of the License, amendments, and other records as described in the HSA (Shaw, 2011). Although research activities at the Aptuit SO facilities utilized a variety of radionuclides in forms that may allow dispersal of those contaminants onto equipment and building surfaces, interviews and records indicate only ^{14}C, ^{3}H, and ^{125}I were used within the few years prior to the end of radiological activities. The last use of ^{125}I occurred in February 2010 and was limited to facilities that were part of Aptuit CTS. The low activity used, the short half-life of ^{125}I, and the fact that use was limited to the CTS facilities effectively removes it from consideration as a radionuclide of concern for this FSSR.

The License has over the years authorized fourteen radionuclides including: ^{3}H, ^{14}C, ^{63}Ni, ^{32}P, ^{35}S, ^{125}I, ^{131}I, ^{45}Ca, ^{51}Cr, ^{99m}Tc, ^{22}Na, ^{42}K, ^{137}Cs and ^{133}Ba. There was very limited to no use of ^{32}P, ^{35}S, ^{45}Ca, ^{51}Cr, ^{99m}Tc, ^{22}Na, and ^{42}K in the history of licensed activities. With the exception of ^{22}Na, these radionuclides have very short half-lives and would not constitute a contaminant of concern even if they had been used in recent years. ^{22}Na was authorized on Amendment 15 in January 1992. This radionuclide was no longer authorized as of Amendment 17 issued in September 1993. The license limit was 20 mCi. There is no record of use of ^{22}Na at the facility nor was it identified as a contaminant of concern in any previous site investigations. The short half-life (2.6 years), the time since ^{22}Na was authorized on the license (19.5 years), combined with a lack of evidence of any use effectively eliminates ^{22}Na as a contaminant of concern. Sources of ^{63}Ni and ^{137}Cs had only been used in sealed sources, not in open form. Leak tests indicate that the sources had remained intact. Therefore, ^{63}Ni and ^{137}Cs can be eliminated as radionuclides of concern.

The remaining two radionuclides (^{3}H and ^{14}C) are the only radionuclides of concern in the SO facilities at Aptuit. Both radionuclides are pure beta radiation emitters.

2.2 Final Status Survey

2.2.1 Purpose

The primary purpose of the FSS at Aptuit is to demonstrate that residual radioactivity in each survey unit satisfies the release criteria. Aptuit seeks the unrestricted release of the SO facilities from radiological controls and termination of NRC License No. 24-15595-01.

2.2.2 Data Quality Objective Summary

To ensure that the data collected during the FSS are useful to decision makers in subsequent phases of the investigative process, data quality objectives (DQOs) were established during survey planning and achieved during survey implementation. The DQO process established for the conduct of FSS activities is based on the guidance of MARSSIM (NRC, 2000). The sections below offer a discussion of the application of this process to data collection at Aptuit.

The Problem. Demonstrate that residual radioactivity in each survey unit satisfies the release criteria. In order to have an appropriate safety margin for the release of the facility, release criteria were establish at the target release dose limit of 2.5 mrem/year total effective dose equivalent (TEDE).

The Decision. Are the quantities, locations, and types of residual radioactive materials at the facilities acceptable for the facilities to be unconditionally released?

Decision Inputs. The data required to resolve the primary question include scanning (^{14}C), systematic (or random depending on survey unit classification) static (direct) measurements (^{14}C), and systematic wipe sampling (^{3}H and ^{14}C).

Study Boundaries. Areas included in this FSS are those associated with the Scientific Operations group. These areas have been placed into survey units based on the historical investigation and survey results. There were eight survey units identified in the DP (Shaw 2013). Upon conducting additional characterization surveys, walls above 2 meters and ceilings were added as Class 2 survey units in three of the laboratory areas bringing the total number of survey units to eleven (see Table 2-1).

Other radioactive material use and storage areas were addressed in the CTS FSSR (Shaw 2012).

Decision Rules. The decision rules and action levels for the FSS were based on the DCGLs for the contaminants of interest and the action levels for scan surveys. The DCGLs were based on Table H.1 of NUREG-1757, Volume 2 (NRC, 2006b).

Considering ALARA and the low levels of contamination expected at these facilities, the DCGL for total activity was established at 10 percent of the ^{14}C screening value, or 3.7E5 dpm/100 cm^2. Screening levels presented in NUREG 1757 are based on the assumption that the fraction of removable activity is equal to 10 percent. Therefore, 10 percent (the removable portion) of

the recommended DCGL for fixed activity, or 3.7E4 dpm/100 cm^2, is the DCGL for removable activity for ^{3}H and ^{14}C combined.

Gross beta surface activities measured with gas flow proportional detectors were compared to the DCGL to demonstrate compliance. Removable surface activity (^{3}H plus ^{14}C) results were compared with the removable activity DCGL.

Scan surveys were used during the FSS to detect small areas of elevated activity that are not detected by the systematic surveys. An investigation level was established for the scan surveys at which a location was identified for further evaluation. The FSS investigation levels are found in Table 2-2.

Decision Errors. The radiological data collected during characterization and the FSS must be of sufficient quality to support decision making. To ensure the quality of the survey data, data quality indicators for precision (bias), accuracy, representativeness, completeness, and comparability have been established and are identified in the following discussion.

Precision. For the FSS, replicates to measure operator precision were performed using the same instrument at the same location. One replicate direct reading was performed for every 20 direct readings taken. For contamination smears, sampling precision was checked through recounting of smears, and one smear was recounted for every 20 smears collected. RPD values were less than 20 for direct readings and less than 30 for smears except where noted.

Bias. Bias was determined by comparing the results obtained from spiked samples run with each batch of 20 samples. Bias was within 20 percent except where noted.

Accuracy. Laboratory QC requirements for this FSS were in accordance with existing QC requirements at Aptuit. Data used to determine accuracy included the chi square test and daily calibrations, as well as the spike recovery. Measurement accuracy was within 20 percent of the true value.

Representativeness. Sampling protocols were developed to assure that collected samples are representative of the media. Field handling procedures were designed to preserve the integrity of the collected samples. Proper field documentation was used to establish that protocols were followed and that sample identification and integrity were maintained.

Comparability. Data comparability was assured via the sampling design and application of appropriate QC requirements that employ established methods for collecting the samples, using

published and other documented methods for physical and radiological analyses, and documenting the methods used.

Completeness. The primary objective of this FSS is to demonstrate that residual radioactivity in each survey unit satisfies the release criteria. A certain amount and type of data must be collected for the survey to be valid. The number of samples needed to support the FSS was statistically determined and included a 20 percent margin of error based on MARSSIM guidance. The completeness goal for each survey unit was 90 percent both for field sampling using direct measurements and for wipe samples.

The importance of any lost or suspect data was evaluated in terms of the sample location, analytical parameter, nature of the problem, decision to be made, and the consequence of an erroneous decision.

Sensitivity. Instrument sensitivity was monitored through daily operational checks to verify performance. For the purpose of this FSS effort, the target detection limits listed (Table 2-3) corresponded to the recommended range of 10 to 50 percent of the DCGLw.

Optimizing Survey Design. When possible, the characterization survey was designed to meet the data quality objectives of the final status survey, thus accomplishing the objectives of both characterization and final status determination. Each survey unit was evaluated to determine the optimum survey design.

2.2.3 Establishing Final Status DCGLs

2.2.3.1 Rationale for DCGL Determination

As mentioned in Section 2.1, the radionuclides of concern within the study boundary of this FSS are ^{14}C and ^{3}H. Therefore, the selection of a DCGL was based on those two radionuclides.

The screening value for ^{3}H presented in Table H.1 of NUREG 1757 (NRC, 2006b) is 1.2E8 dpm/100 cm^2, and for ^{14}C, the screening value is 3.7E6 dpm/100 cm^2. The ^{14}C screening value was conservatively selected as the basis for determining the DCGLw.

Since direct reading instruments cannot reliably detect ^{3}H contamination, wipe samples were used to quantify removable ^{3}H and ^{14}C. Therefore, systematic direct measurements and wipe sample results are compared with DCGLs. Considering ALARA and the low levels of contamination expected at these facilities, the DCGL recommended in the DP (Shaw, 2013) for total activity was 10 percent of the ^{14}C screening value, or 3.7E5 dpm/100 cm^2. Screening levels

presented in NUREG 1757 were based on the assumption that the fraction of removable activity is equal to 0.1 (10 percent). Therefore, 10 percent (the removable portion) of the recommended DCGL for fixed activity, or 3.7E4 dpm/100 cm^2, was the recommended DCGL for removable activity for ^3H and ^{14}C combined.

2.2.3.2 Final Status DCGLs

The DCGLs recommended in the DP (Shaw, 2013) were adopted as the DCGLs for the FSS. Gross beta surface activity measured with gas flow proportional detectors was compared with the DCGL to demonstrate compliance. Removable surface activity (^3H plus ^{14}C) results were compared with the removable activity DCGL.

2.2.4 Quality Control

Quality control (QC) measures for this FSS included evaluation of precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity. A summary of the results of the QC measures is found in Section 3.8.

Daily instrument checks including source and background counts were performed, as documented in Appendix C. An automatic instrument performance assessment (IPA) was performed each day of liquid scintillation counter (LSC) operation. IPA monitors the system background, efficiencies for both ^3H and ^{14}C, Figure of Merit (E^2/B) and Chi-squared values for both ^3H and ^{14}C. IPA is performed using ^{14}C and ^3H quenched standards and a background standard. Instrument operation was within pre-established limits as documented on the LSC printouts attached to the survey results in Appendix D.

For FSS samples, QC samples consisting of background and $^3H/^{14}C$ spikes were counted with each LSC sample batch. Relative bias was determined by comparing the results obtained from the $^3H/^{14}C$ spike sample run with the sample batch. Bias measurements should be within plus or minus 20 percent.

Field paperwork was reviewed by the survey supervisor and the project health physicist or designee. During and after data collection, original DQO and survey objectives were reviewed with consideration for whether the data generated satisfactorily met the requirements.

Replicates to measure operator precision were performed using the same instrument at the same location. Survey planning called for at least one replicate direct reading to be performed for every 20 direct readings taken and the recounting of at least one wipe for every 20 wipes collected. However, one replicate direct measurement and one wipe recount was performed for

every survey unit; therefore, replicate measurements were performed for at least every 14 direct readings. Recounts of wipes were for the same locations and, therefore, at the same frequency as the direct readings.

Relative bias for wipe samples was determined by comparing the results obtained from $^{3}H/^{14}C$ spiked samples run with each batch of samples from a survey unit. Accuracy for wipe measurements was determined using the chi square test and daily calibrations, as well as spike recovery.

Field personnel followed measurement protocols established in the DP (Shaw 2013) to ensure that collected samples were representative of the media sampled. Data comparability was assured via the sampling design and application of appropriate QC requirements that employ established methods for collecting the samples, using published and other documented methods for radiological analyses, and documenting the methods used.

The number of samples needed to support the FSS was statistically determined for each survey unit and included a 20 percent margin of error based on MARSSIM guidance. The completeness goal for each survey unit was 90 percent for both field sampling using direct measurements and for wipe samples.

Instrument sensitivity was monitored through daily operational checks to verify performance.

2.2.5 Survey Classes

Preliminary area classifications were described in the SO DP (Shaw, 2013) and verified through characterization/final status surveys performed between January 2013 and February 2014. These surveys confirmed the assumptions used in survey planning. Upon additional characterization, three survey units were added in the API area once it was determined that the upper walls (above 2 m) and ceiling were impacted.

There were five Class 1 survey units. These survey units included analytical laboratory B3-298 and four survey units that made up the API area (B2-155 through B2-164, B2-165, B2-166, and B2-167/167A/170).

There were five Class 2 survey units (B2-155 though B2-164 overhead, B2-165 overhead, B2-166 overhead, B2-103A/112/116/117/119 and the North Hill Waste Storage Building). These areas had the potential for fixed contamination at levels that were well below the DCGL.

All other SO impacted areas were put into one Class 3 survey unit (B2 Dock 5 and API Common). These areas had little potential for contamination and routine surveys did not identify any contamination above Aptuit's acceptable surface contamination levels.

The suggested structure area limits for survey unit class as presented in the MARSSIM, Section 4.6, are:

- Class 1: Up to 100 square meters (m^2) of floor area
- Class 2: Between 100 m^2 and 1000 m^2 of floor area
- Class 3: Unlimited floor area.

The area classifications are listed in Table 2-1 and are presented on Figures 2-1 through 2-3. The SO survey units are described below.

2.2.5.1 Class 1 Survey Units

Class 1 survey units consist of impacted areas with the highest potential for contamination and the potential for small areas of elevated activity, and for which insufficient evidence exists to support reclassification as Class 2 or Class 3. Based on the site investigation and scoping surveys there are five Class 1 survey units in the SO facilities.

2.2.5.2 Class 2 Survey Units

Class 2 survey units consist of areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination but that are not expected to exceed the $DCGL_W$. Based on the site investigation there are five Class 2 survey units in the SO facilities.

2.2.5.3 Class 3 Survey Units

Class 3 survey units consist of impacted areas that are not expected to contain any residual radioactivity or that are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_w$, based on site operating history and previous radiation surveys. The remaining potentially impacted areas of SO are grouped into one Class 3 survey unit.

2.2.6 Number of Data Points

MARSSIM methodology was used to determine the number of samples needed. The process is described below.

The number of samples is based on the following factors:

- Statistical test used. The Sign test is used when the contaminant is not present in background, the contaminant is present at such a small fraction of the DCGLw as to be considered insignificant, or an average background is subtracted from each measurement. The Sign test will be used because average background will be subtracted from survey unit measurements.

- DCGLw = 3.7E5 dpm/100 cm^2.

- For survey planning the average and standard deviation (σ) of contamination in each of the survey units was based on reasonable assumptions. The details for survey unit design are presented in the Survey Unit Summary Reports for each survey unit (Appendix B).

- Acceptable Type I and Type II decision errors were both be set at 0.05.

- Lower bound of the gray region (LBGR) was set at 50% of the DCGLw or, 1.85E5 dpm/100 cm^2.

- The standard deviation, σ , was assumed to be 30%[1].
  1.85E5 X 0.3 = 5.55E4 dpm/100 cm^2.

- The relative shift (Δ/σ): $\Delta/\sigma = (DCGL_w - LBGR)/\sigma$

  $\Delta/\sigma =$ (3.7E5 – 1.85E5)/5.55E4 = 3.3

A relative shift of 3 was used in survey planning since the calculated value was >3 (ref MARSSIM Chapter 5)[2].

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[1] Abelquist, Decommissioning Health Physics, (Bristol UK, Institute of Physics Publishing), 272.

[2] *Multi-Agency Radiation Survey and Site Investigation Manual*, Rev. 1, August 2000, 5-32.

For $\alpha=\beta=0.05$ and a relative shift of 3, the number of samples (n) required for each survey unit (from Table 5.5 of MARSSIM) for the Sign test is 14 (including a 20% contingency). Therefore at least 14 measurements were made in each survey unit to meet the requirements of the statistical tests.

Characterization surveys had not been completed at the time the FSS was planned. The characterization surveys were designed to meet the DQOs of the FSS and, in some cases, were performed concurrently with the FSS. The results of the characterization surveys confirmed the assumptions used in FSS planning.

Judgmental surveys were also performed in some survey units in addition to the 14 random samples required for the statistical tests.

2.2.7 Survey Planning

FSS sampling locations were established for direct readings (for ^{14}C) and wipe samples (for ^{3}H and ^{14}C).

For the Class 1 and Class 2 survey units, a 1-meter-by-1-meter square reference coordinate system was established including the floors and the lower 2 meters of the walls and in some cases the grid extended to the upper walls and ceiling. A random start triangular sample grid system overlaid the square grid system, spacing the sample points based on the following equation:

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

where:

L = spacing between sample points

A = area of the survey unit

n = number of sample points.

For all survey units, the minimum number of sample points required to meet the statistical test for final status determination is 14.

Class 3 sampling locations were determined using randomly generated numbers. Random numbers between zero and one were generated. For the purpose of plotting the sampling locations onto a drawing, the southwest corner was selected as the origin. The length and width of the survey unit were each multiplied by randomly generated numbers to generate north and east coordinates. The coordinate pairs (one north, one east) were plotted until 14 pairs were found to be within the survey unit. Coordinate pairs that generated points outside the boundaries of the Class 3 survey units were deleted.

2.2.8 Instrumentation

Instrumentation used in the FSS is listed in Table 2-3. Detection sensitivities for the field instruments were determined following the guidance of NUREG-1507 (NRC, 1998) using nominal background data for the Ludlum detectors. Actual detection sensitivities are included in the survey forms in Appendix D.

Instrument setup was performed in accordance with Aptuit and/or manufacturer procedures. All instrumentation had current calibration in the past 12 months. Daily field performance checks were conducted in accordance with individual instrument use procedures. These performance checks were performed prior to daily field activities, any time the instrument response appeared questionable, and at the end of each day's use. The wipes were counted on site in Aptuit's LSC. An automatic IPA was performed each day of LSC operation. All data were obtained with instruments that satisfied the performance requirements.

2.2.9 Background Survey

Appropriate background locations were established to develop representative background values to use in the surveys. Background areas (non-impacted) were selected by the field crew according to building material and absence of radioactive materials and the use thereof. Areas within Aptuit facilities where radioactive materials use was known to have occurred were not considered acceptable for background areas.

Background measurements were collected on surfaces of material like that encountered in impacted areas. These values were used for background subtraction of direct readings of total surface contamination. Ten random background measurements were obtained for each survey instrument and as appropriate for each type of building material to be surveyed by that instrument. The count time for the background measurements was one minute, the same as the count time used in the survey. Corresponding background measurements were necessary for survey units that include the following types of materials:

- Lab floor (resin)
- Glass
- Concrete floor (painted)
- Metal
- Concrete floor (bare)
- Concrete block (painted)
- Fire retardant
- Carpet
- Tile
- Drywall

The mean of the corresponding representative samples was used as the background in each case.

2.2.10 Quality Checks

Daily field performance checks were conducted in accordance with individual instrument use procedures. These performance checks were performed prior to daily field activities, any time the instrument response appeared questionable, and at the end of each day's use. Only data obtained using instruments that satisfy the performance requirements were accepted for use in the evaluation. A summary of the QC checks is in Section 3.8.

Instrument response was continuously monitored during surveys through the use of the instrument audible signal.

2.2.11 Procedures

The FSS included scanning, direct measurements, and sampling (wipes). Surveys were performed in accordance with the work instructions contained in the DP (Shaw, 2013). A summary of the scan survey methodology for gross beta contamination is found in Section 2.2.12. Summaries of the direct measurement and wipe sampling methodologies are found in

Sections 2.2.13 and Section 2.2.14, respectively. A summary of the soil sampling method is found in Section 2.2.15.

Scans included floors and any remaining fixed furniture as well as walls up to 2 meters (in Class 1 and 2 survey units). Scans of walls above 2 meters and ceilings were included when these areas were impacted. Scan survey coverage varied with the survey unit classification. Recommended scan coverage as a function of survey unit classification is given in Section 2.5.5 of the MARSSIM (NRC, 2000), as follows:

- Class 1: 100 percent
- Class 2: 10 to 100 percent (10 to 50 percent for overhead survey units)
- Class 3: Judgmental.

There were five Class 1 survey units in the SO FSS. In the Class 1 survey units 100 percent of the impacted floors and walls were scanned. Scanning was performed in Class 2 and Class 3 survey units on a judgmental basis, meaning that the specific locations to be scanned and the surface coverage were determined in the field. In Class 2 areas, each 1-meter grid that contained a sample location (direct measurement/wipe) was scanned. In Class 3 areas, scanning was performed around or adjacent to each sample location. Areas exceeding the investigation level were flagged for follow-up and were further investigated.

Once scan surveys were completed, direct measurements and wipe samples were performed at measurement locations defined by the triangular sample grid in the Class 1 and Class 2 survey units. Direct measurements and wipe samples were performed at the randomly generated sample locations in the Class 3 survey units.

Based on the judgment of the survey team, biased scanning, sampling, and direct measurements were also conducted.

All wipe samples collected as part of this FSS were analyzed using Aptuit's on-site LSC.

2.2.12 Scan Surveys

Scan surveys were used to detect small areas of elevated activity that may not be detected by the systematic surveys. Scan surveys were not intended to be used directly as a quantitative measure for the purpose of determining final status. However, an investigation level was

established for the scan surveys at which a location of elevated activity would be identified for further evaluation. This level is defined as described in the decision rules in Section 2.2.2.

The general survey method for scans is as follows:

- Select a portable survey instrument(s) and determine that the instrument(s) is/are operating properly and calibrated as per manufacturer requirements and set up in accordance with the requirements of the Aptuit or manufacturer procedures.

- While moving the detector at a pace consistent with the calculated scan minimum detectable concentration (MDC), pass the detector over the surface to be surveyed, ensuring that the detector is as close as possible to the scanned surfaces. Locate the area of maximum count rate by using the audible response of the instrument. Record the range of count rates for each area surveyed and the location of any measurements that exceed the investigation level on the survey map. Flag or otherwise mark areas exceeding the investigation level for additional investigation. Note any anomalous readings on field paperwork.

2.2.13 Direct Measurements

The survey method for direct reading surface contamination is as follows:

- Select a portable survey instrument(s) and determine that the instrument(s) is/are operating properly and calibrated as per manufacturer requirements and set up in accordance with the requirements of the Aptuit or manufacturer procedures.

- Place the detector on the surface to be surveyed at the desired survey location. Start instrument count and count for time period required to meet MDC requirements of the survey plan. Record the direct surface readings at this position.

2.2.14 Wipe Samples

The survey method for low-energy beta wipes is as follows:

- Survey/Sampling Technician will change into new gloves as needed.

- Obtain prepared scintillation vials with 7 milliliters of scintillation cocktail added to each vial by the on-site laboratory.

  Note: Project requirements may dictate another sample media and configurations for special cases. In any case, the volume used in the prep blank, laboratory control sample, and spikes should be the same as that used for the samples.

- Remove a single smear and wipe the smear over an area of approximately 100 square centimeters (wipe a square area of approximately 4 inches by 4 inches or an "S" pattern approximately 16 inches long).

- Once the wipe is performed, quickly place smear into an individual prepped scintillation vial.

- The lid of the scintillation vial containing the smear will be marked with a number identifying the sample location. The vials will be transported to the laboratory for counting and activity determination.

2.2.15 Surface Soil Samples

The sampling method for surface soil samples is as follows:

- Soil samples shall be identified on a map showing systematic and bias sample locations and identification numbers

- Composite samples will be collected using a trowel or a hand shovel to take a representative sample to 6 inches in depth. The sample will then be placed in a metal bowl or new gallon sized zip lock bag to composite.

- After compositing, the soil sample will be placed in the appropriate lab container for analysis. Each container will be labeled using a permanent marker to include the sample identification number; sample time, date, and sample analysis.

- To prevent cross contamination between soil samples, sampling tools shall be decontaminated using soap and water. In addition, gloves will also be changed between each sample location.

- The outside of soil sample containers will be cleaned of any residual soil, and radiologically surveyed prior to analysis.

2.2.16 Documentation and Record Keeping

The surveys performed as part of this investigation were documented using the radiological survey forms. The survey forms (cover sheet, continuation sheet, and blank map forms) provided a standard format for documenting the data gathered during this investigation. These survey forms were completed by the surveyor in a timely manner and given to the Site Supervisor for review. The forms were consecutively numbered and noted in a survey log.

All records generated as a result of this investigation were maintained and stored in accordance with Aptuit and Shaw procedures.

2.2.17 Waste Management

Any radioactive waste produced as a result of the FSS process was managed in compliance with the Aptuit License and the DP. All radioactive waste was disposed of through Bionomics, the project waste disposal contractor. Nonradioactive, nonhazardous waste was disposed as trash.

3 Nature and Extent of Contamination

3.1 Introduction

Characterization surveys (CS) were designed to meet the DQOs of the FSS when possible and were performed immediately before or concurrently with the FSS. CS results were used to confirm that the survey units were properly classified and to validate the assumptions used in planning the FSS. The results of the characterization surveys are presented by survey unit in this chapter and in the final status summary reports in Appendix B.

A summary of the FSS results are presented by survey unit in this chapter. Final status survey summary reports for each survey unit are presented in Appendix B. FSS data are used to determine the final status of each survey unit (i.e., whether or not a survey unit is acceptable for unrestricted radiological release). In accordance with MARSSIM, systematic direct measurements are the primary data used in making that determination. However, since direct reading instruments cannot reliably detect ^{3}H contamination, wipe samples were used to quantify removable ^{3}H and ^{14}C. Therefore, systematic direct measurements and wipe sample results are compared with DCGLs. Scan survey results and results of judgmental surveys were reviewed by the project health physicist to determine if there was cause for additional sampling or remediation.

Sample locations and results are discussed as systematic and biased. Direct measurements and wipe samples were collocated for both systematic and biased locations.

Building systems (i.e., exhaust system, vacuum system, sinks, and drains) from all historical use areas have been investigated as described in Section 3.7 below.

The discussions in Sections 3.2 through 3.4 present results for each survey unit. The use of the unity rule for evaluating FSS results for multiple radionuclides and/or measurements is discussed in Section 3.5. Surface soil sample results are discussed in Section 3.6.

3.2 Class 1 Survey Units

There were five Class 1 survey units within the boundaries of this FSS. The API laboratory suite was divided into four Class 1 survey units (SU1-B2GMP, SU1-B2165, SU1-B2166, and SU1-B2AE). Analytical laboratory B3-298 (SU1-B3298) was also designated as a Class 1 survey unit due to the known area of contamination on the floor and bench top. Results of FSS samples collected and measurements performed within these Class 1 survey units are presented below. Maximum FSS results are presented in Table 3-1. Within these survey units,

systematic direct measurements were performed and systematic wipe samples were collected. One hundred percent of the surface area of the floors and walls (up to 2 meters) was scanned. Additional investigations were performed at locations that exceeded the scanning investigation level (>$DCGL_w$).

3.2.1 SU1-B2GMP

This survey unit consisted of rooms and laboratories B2-155 through B2-164 which made up the Good Manufacturing Practice (GMP) area of the API laboratory suite. This survey unit includes four GMP labs for the synthesis of radiolabeled compounds, their respective airlocks, and a common area that housed freezers for material storage.

Remedial Actions. Fume hoods, exhaust systems, accessible drain lines and lab furniture were removed to bare walls. The laminate flooring was removed and disposed as radioactive waste. No contamination levels above the ALARA goal were detected.

Characterization Survey. One hundred and five biased direct measurements and wipe samples were collected during the CS. The maximum direct measurement result was 21,862 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2. The CS confirmed the assumptions used in FSS planning. CS results are included in the FSS summary reports in Appendix B.

Scans. Scanning coverage consisted of 100 percent of the floor and walls up to 2 meters. Several grids had elevated counts above the action level of two times the material background but well below the DCGLw (<0.1 of DCGLw). The contamination was fixed. No further investigation or decontamination was warranted.

Systematic Direct Measurements. Seventeen systematic direct measurements were performed in this survey unit at locations shown on Figure 3-1. The maximum result was 13,683 dpm/100 cm^2. All measurement results were less than the DCGL of 3.7E5 dpm/100 cm^2.

Systematic Wipe Samples. Seventeen systematic wipe samples, collocated with the systematic direct measurements, were collected in this survey unit. All were analyzed for ^3H and ^{14}C. The maximum ^3H and ^{14}C combined wipe result was 90 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Biased Samples. No biased samples were collected during the FSS.

Statistical Evaluation of FSS Samples. All FSS measurement results were below the respective DCGLs and the unity rule was satisfied. Since all results were below the DCGLs, the Sign test was not performed. The measurement data support rejection of the null hypothesis, providing high confidence that survey unit SU1-B2GMP satisfied the release criteria. The survey unit summary report is included in Appendix B.

3.2.2 SU1-B2165

This survey unit was comprised of the QC laboratory (B2-165).

Remedial Actions. Fume hoods, exhaust systems, accessible drain lines and lab furniture were removed to bare walls. The laminate flooring was removed and disposed as radioactive waste.

Characterization Survey. Fifty-three biased direct measurements and wipe samples were collected during the CS. The maximum direct measurement result was 49,862 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2. The CS confirmed the assumptions used in FSS planning. CS results are included in the FSS summary reports in Appendix B.

Further remedial actions were conducted based on elevated characterization measurements. Wallboard and floor material that had elevated residual contamination were wiped down or removed. The maximum direct measurement result after remediation was 3,931 dpm/100 cm^2.

Scans. Scanning coverage consisted of 100 percent of the floor and walls up to 2 meters. Several grids had elevated counts above the action level of two times the material background but well below the $DCGL_w$ (<0.1 of $DCGL_w$). The contamination was fixed. No further investigation or decontamination was warranted.

Systematic Direct Measurements. Fourteen systematic direct measurements were performed in this survey unit at locations shown on Figure 3-2. The maximum result was 3,600 dpm/100 cm^2. All measurement results were less than the DCGL of 3.7E5 dpm/100 cm^2.

Systematic Wipe Samples. Fourteen systematic wipe samples, collocated with the systematic direct measurements, were collected in this survey unit. All were analyzed for ^3H and ^{14}C. The maximum ^3H and ^{14}C combined wipe result was 39 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Biased Samples. Six biased samples were collected during the FSS, which included direct measurements and wipe samples. The maximum direct measurement result was 5,927 dpm/100 cm^2. All measurement results were less than the DCGL of 3.7E5 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Statistical Evaluation of FSS Samples. All FSS measurement results were below the respective DCGLs and the unity rule was satisfied. Since all results were below the DCGLs, the Sign test was not performed. The measurement data support rejection of the null hypothesis, providing high confidence that survey unit SU1-B2165 satisfied the release criteria. The survey unit summary report is included in Appendix B.

3.2.3 SU1-B2166

This survey unit was the main radiosynthesis laboratory (B2-166) in the API area.

Remedial Actions. Fume hoods, exhaust systems, accessible drain lines and lab furniture were removed to bare walls. The laminate flooring was removed and disposed as radioactive waste. Wallboard and floor material that had elevated residual contamination were wiped down or removed.

Characterization Survey. Seventy-seven biased direct measurements and wipe samples were collected during the CS. The maximum direct measurement result was 99,799 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2. The CS confirmed the assumptions used in FSS planning. CS results are included in the FSS summary reports in Appendix B.

Further remedial actions were conducted based on elevated characterization measurements. Wallboard and floor material that had elevated residual contamination were wiped down or removed. The maximum direct measurement result after remediation was 23,012 dpm/100 cm^2.

Scans. Scanning coverage consisted of 100 percent of the floor and walls up to 2 meters. Several grids had elevated counts above the action level of two times the material background but well below the $DCGL_w$ (<0.1 of $DCGL_w$). The contamination was fixed. No further investigation or decontamination was warranted.

Systematic Direct Measurements. Fourteen systematic direct measurements were performed in this survey unit at locations shown on Figure 3-3. The maximum result was 17,075 dpm/100 cm^2. All measurement results were less than the DCGL of 3.7E5 dpm/100 cm^2.

Systematic Wipe Samples. Fourteen systematic wipe samples, collocated with the systematic direct measurements, were collected in this survey unit. All were analyzed for ^{3}H and ^{14}C. The maximum ^{3}H and ^{14}C combined wipe result was 75 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Biased Samples. One biased wipe sample was collected during the FSS. The wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Statistical Evaluation of FSS Samples. All FSS measurement results were below the respective DCGLs and the unity rule was satisfied. Since all results were below the DCGLs, the Sign test was not performed. The measurement data support rejection of the null hypothesis, providing high confidence that survey unit SU1-B2166 satisfied the release criteria. The survey unit summary report is included in Appendix B.

3.2.4 SU1-B2AE

This survey unit consists of B2-167/167A and B2-170. B2-167/167A is the access/egress for the API radiosynthesis suite. B2-170 housed the nuclear magnetic resonance (NMR) laboratory.

Remedial Actions. Accessible drain lines and lab furniture were removed to bare walls. The laminate flooring was removed and disposed as radioactive waste. No contamination levels above the ALARA goal were detected.

Characterization Survey. Thirty-four biased direct measurements and wipe samples were collected during the CS. The maximum direct measurement result was 12,688 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2. The CS confirmed the assumptions used in FSS planning. CS results are included in the FSS summary reports in Appendix B.

Scans. Scanning coverage consisted of 100 percent of the floor and walls up to 2 meters. Several grids had elevated counts above the action level of two times the material background but well below the $DCGL_w$ (<0.1 of $DCGL_w$). The contamination was fixed. No further investigation or decontamination was warranted.

Systematic Direct Measurements. Fourteen systematic direct measurements were performed in this survey unit at locations shown on Figure 3-4. The maximum result was 2,657 dpm/100 cm^2. All measurement results were less than the DCGL of 3.7E5 dpm/100 cm^2.

Systematic Wipe Samples. Fourteen systematic wipe samples, collocated with the systematic direct measurements, were collected in this survey unit. All were analyzed for ^{3}H and ^{14}C. The maximum ^{3}H and ^{14}C combined wipe result was 34 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Biased Samples. No biased samples were collected during the FSS.

Statistical Evaluation of FSS Samples. All FSS measurement results were below the respective DCGLs and the unity rule was satisfied. Since all results were below the DCGLs, the Sign test was not performed. The measurement data support rejection of the null hypothesis, providing high confidence that survey unit SU1-B2AE satisfied the release criteria. The survey unit summary report is included in Appendix B.

3.2.5 SU1-B3298

This is an analytical laboratory located on the B3 level of B Building. The only known use of radioactive materials was associated with a HPLC analyses.

Remedial Actions. A contaminated laboratory table and bench were removed as radiological waste. Portions of the bench were found to be uncontaminated and were removed as lab debris. Sections of the contaminated lab flooring and adjacent flooring were removed and disposed of as radiological waste.

Characterization Survey. Thirty-six biased direct measurements and wipe samples were collected during the CS. The maximum direct measurement result was 779 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2. The CS confirmed the assumptions used in FSS planning. CS results are included in the FSS summary reports in Appendix B.

Scans. Scanning coverage consisted of 100 percent of the floor and walls up to 2 meters. Several grids had elevated counts above the action level of two times the material background but well below the $DCGL_w$ (<0.1 of $DCGL_w$). The contamination was fixed. No further investigation or decontamination was warranted.

Systematic Direct Measurements. Fourteen systematic direct measurements were performed in this survey unit at locations shown on Figure 3-5. The maximum result was 455 dpm/100 cm^2. All measurement results were less than the DCGL of 3.7E5 dpm/100 cm^2.

Systematic Wipe Samples. Fourteen systematic wipe samples, collocated with the systematic direct measurements, were collected in this survey unit. All were analyzed for ^{3}H and ^{14}C. The maximum ^{3}H and ^{14}C combined wipe result was 20 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Biased Samples. No biased samples were collected during the FSS.

Statistical Evaluation of FSS Samples. All FSS measurement results were below the respective DCGLs and the unity rule was satisfied. Since all results were below the DCGLs, the Sign test was not performed. The measurement data support rejection of the null hypothesis, providing high confidence that survey unit SU1-B3298 satisfied the release criteria. The survey unit summary report is included in Appendix B.

3.3 Class 2 Survey Units:

There were five Class 2 survey units (SU2-B2GMPO, SU2-B2-165O, SU2-B2166O, SU2-B2, SU2-Hill) within the boundaries of this FSS.

Results of FSS samples collected and measurements performed within these Class 2 survey units are presented below. Maximum results are presented in Table 3-1. Within these survey units, systematic direct measurements were performed and systematic wipe samples were collected. In addition, each grid (i.e., 1-meter reference grid) that contained a sample location was scanned. This resulted in approximately 12-66% percent of the surface area being scanned. Survey units SU2-B2GMPO, SU2-B2-165O, and SU2-B2166O consisted of the walls above 2 meters and the ceiling, SU2-B2 consisted of the floors and walls (up to 2m), and SU2-Hill consisted of the floors and walls (up to 2 meters). Additional investigations were performed at locations that exceeded the scanning investigation level of two times the material background.

3.3.1 SU2-B2GMPO

This survey unit consisted of the walls above 2m and the ceilings in rooms and laboratories B2-155 through B2-164 which made up the Good Manufacturing Practice (GMP) area of the API laboratory suite.

Remedial Actions. Ceiling tiles were removed and insulation was removed from water lines.

Characterization Survey. Nineteen biased direct measurements and wipe samples were collected during the CS. The maximum direct measurement result was 13,057 dpm/100 cm^2.

All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2. The CS confirmed the assumptions used in FSS planning. CS results are included in the FSS summary reports in Appendix B.

Scans. Scanning coverage consisted of 12 percent of the walls above 2m and the ceilings. Several grids had elevated counts above the action level of two times the material background but well below the $DCGL_w$ (<0.1 of $DCGL_w$). The contamination was fixed. No further investigation or decontamination was warranted.

Systematic Direct Measurements. Fourteen systematic direct measurements were performed in this survey unit at locations shown on Figure 3-8. The maximum result was 1,135 dpm/100 cm^2. All measurement results were less than the DCGL of 3.7E5 dpm/100 cm^2.

Systematic Wipe Samples. Fourteen systematic wipe samples, collocated with the systematic direct measurements, were collected in this survey unit. All were analyzed for ^3H and ^{14}C. The maximum ^3H and ^{14}C combined wipe result was 76 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Biased Samples. No biased samples were collected during the FSS.

Statistical Evaluation of FSS Samples. All FSS measurement results were below the respective DCGLs and the unity rule was satisfied. Since all results were below the DCGLs, the Sign test was not performed. The measurement data support rejection of the null hypothesis, providing high confidence that survey unit SU2-B2GMPO satisfied the release criteria. The survey unit summary report is included in Appendix B.

3.3.2 SU2-B2165O

This survey unit was comprised of the wall above 2 m and the ceiling in B2-165 which was the QC laboratory for the API area.

Remedial Actions. Ceiling tiles were removed and insulation was removed from water lines.

Characterization Survey. No additional static locations were identified based on scans performed during the characterization and final status survey.

Scans. Scanning coverage consisted of 12 percent of the walls above 2m and the ceilings. One grid had elevated counts above the action level of two times the material background but

well below the $DCGL_w$ (<0.1 of $DCGL_w$). The contamination was fixed. No further investigation or decontamination was warranted.

Systematic Direct Measurements. Fourteen systematic direct measurements were performed in this survey unit at locations shown on Figure 3-6. The maximum result was 4,268 dpm/100 cm^2. All measurement results were below the MDC and less than the DCGL of 3.7E5 dpm/100 cm^2.

Systematic Wipe Samples. Fourteen systematic wipe samples, collocated with the systematic direct measurements, were collected in this survey unit. All were analyzed for ^{3}H and ^{14}C. The maximum ^{3}H and ^{14}C combined wipe result was 236 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Biased Samples. One biased wipe sample was collected during the FSS. The wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Statistical Evaluation of FSS Samples. All FSS measurement results were below the respective DCGLs and the unity rule was satisfied. Since all results were below the DCGLs, the Sign test was not performed. The measurement data support rejection of the null hypothesis, providing high confidence that survey unit SU2-B2165O satisfied the release criteria. The survey unit summary report is included in Appendix B.

3.3.3 SU2-B2166O

This survey unit consisted of the walls above 2 meters and the ceiling in the main radiosynthesis laboratory (B2-166) in the API area.

Remedial Actions. Insulation was removed from water lines and remaining conduit, service lines, and light fixtures were wiped down. All conduit and service lines that did not meet Aptuit's acceptable release criteria were removed and disposed as radioactive waste.

Characterization Survey. Forty-three biased direct measurements and wipe samples were collected during the CS. The maximum direct measurement result was 22,480 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2. The CS confirmed the assumptions used in FSS planning. CS results are included in the FSS summary reports in Appendix B. Any locations exhibiting readings above the ALARA goals were remediated to below those goals via the removal of material.

Scans. Scanning coverage consisted of 22 percent of the walls above 2m and the ceilings. Several grids had elevated counts above the action level of two times the material background but well below the $DCGL_w$ (<0.1 of $DCGL_w$). The contamination was fixed. No further investigation or decontamination was warranted.

Systematic Direct Measurements. Fourteen systematic direct measurements were performed in this survey unit at locations shown on Figure 3-7. The maximum result was 17,267 dpm/100 cm^2. All measurement results were below the MDC and less than the DCGL of 3.7E5 dpm/100 cm^2.

Systematic Wipe Samples. Fourteen systematic wipe samples, collocated with the systematic direct measurements, were collected in this survey unit. All were analyzed for ^3H and ^{14}C. The maximum ^3H and ^{14}C combined wipe result was 93 dpm/100 cm^2. All of the wipe results were below the MDCs and less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Biased Samples. Three biased wipe samples were collected during the FSS. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Statistical Evaluation of FSS Samples. All FSS measurement results were below the respective DCGLs and the unity rule was satisfied. Since all results were below the DCGLs, the Sign test was not performed. The measurement data support rejection of the null hypothesis, providing high confidence that survey unit SU2-B2166O satisfied the release criteria. The survey unit summary report is included in Appendix B.

3.3.4 SU2-B2

This survey unit consisted of several areas on the B2 floor and walls up to 2m of the B Building where radioactive materials were present, used, or stored. The individual rooms/areas making up this survey unit include B2-103A (old incinerator and waste staging area), B2-112 (HEPA filter room), B2-116 (LSC counting room), B2-117 (LSC waste storage), B2-119 (HP office) as shown on Figure 3-9. The total floor area of this survey unit is 381 m2.

Remedial Actions. The incinerator in room B2-103A, along with the associated ductwork and stack, was removed and disposed of appropriately. The HEPA housing and associated ductwork in B2-112 was removed and disposed of as radioactive waste.

Characterization Survey. Fifty-five biased direct measurements and wipe samples were collected during the CS. The maximum direct measurement result was 133,112 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2. The

CS confirmed the assumptions used in FSS planning. CS results are included in the FSS summary reports in Appendix B.

Further remedial actions were conducted based on elevated characterization measurements. Wallboard and floor material that had elevated residual contamination were wiped down or removed. The maximum direct measurement result after remediation was 15,393 dpm/100 cm^2.

Scans. Scanning coverage consisted of 50 percent of the floor and walls up to 2 meters. Several grids had elevated counts above the action level of two times the material background but well below the $DCGL_w$ (<0.1 of $DCGL_w$). The contamination was fixed. No further investigation or decontamination was warranted.

Systematic Direct Measurements. Fifteen systematic direct measurements were performed in this survey unit at locations shown on Figure 3-9. The maximum result was 4,173 dpm/100 cm^2. All measurement results were below the MDC and less than the DCGL of 3.7E5 dpm/100 cm^2.

Systematic Wipe Samples. Fifteen systematic wipe samples, collocated with the systematic direct measurements, were collected in this survey unit. All were analyzed for ^{3}H and ^{14}C. The maximum ^{3}H and ^{14}C combined wipe result was 151 dpm/100 cm^2. All of the wipe results were below the MDCs and less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Biased Samples. No biased samples were collected during the FSS.

Statistical Evaluation of FSS Samples. All FSS measurement results were below the respective DCGLs and the unity rule was satisfied. Since all results were below the DCGLs, the Sign test was not performed. The measurement data support rejection of the null hypothesis, providing high confidence that survey unit SU2-B2 satisfied the release criteria. The survey unit summary report is included in Appendix B.

3.3.5 SU2-Hill

This survey unit is the North Hill Waste Storage Building that was used for the staging and storing of waste and contaminated equipment.

Remedial Actions. A floor area was identified as being elevated, above twice materials background for scanning. Decontamination attempts in these areas included vigorous scrubbing with industrial towels and a cleaning detergent. However, there was no reduction of activity and the efforts were ceased. Because the activity represented only a fraction of the

DCGL (<1 percent of the $DCGL_w$) and was fixed, it was determined that further decontamination activities were unnecessary.

Characterization Survey. Eighty-one biased direct measurements and wipe samples were collected during the CS. The maximum direct measurement result was 77,175 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2. The CS confirmed the assumptions used in FSS planning. CS results are included in the FSS summary reports in Appendix B.

Scans. Scanning coverage consisted of 66 percent of the floor and walls up to 2 meters. One grid had elevated counts above the action level of two times the material background but well below the $DCGL_w$ (<0.1 of $DCGL_w$). Decontamination via vigorous scrubbing with industrial towels and a detergent solution was attempted to reduce levels to ALARA. There was no significant reduction in activity therefore further investigation or decontamination was not warranted.

Systematic Direct Measurements. Seventeen systematic direct measurements were performed in this survey unit at locations shown on Figure 3-10. The maximum result was 1,706 dpm/100 cm^2. All measurement results were less than the DCGL of 3.7E5 dpm/100 cm^2.

Systematic Wipe Samples. Seventeen systematic wipe samples, collocated with the systematic direct measurements, were collected in this survey unit. All were analyzed for ^3H and ^{14}C. The maximum ^3H and ^{14}C combined wipe result was 143 dpm/100 cm^2. All of the wipe results were less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Biased Samples. No biased samples were collected during the FSS.

Statistical Evaluation of FSS Samples. All FSS measurement results were below the respective DCGLs and the unity rule was satisfied. Since all results were below the DCGLs, the Sign test was not performed. The measurement data support rejection of the null hypothesis, providing high confidence that survey unit SU2-Hill satisfied the release criteria. The survey unit summary report is included in Appendix B.

3.4 Class 3 Survey Unit

There was 1 Class 3 survey unit within the boundaries of this FSS. This survey unit (SU3-B2) consists of potentially impacted areas on the B2 level of Building B. Results of samples collected and measurements performed within the Class 3 survey unit are presented below. Maximum results are presented in Table 3-1.

Two areas in B Building are included in the Class 3 survey unit, as shown in Table 2-2. These areas include API common area and a loading dock (Dock 5).

Within this survey unit, direct measurements were performed and wipe samples were collected at predetermined randomly selected locations (Section 2.2.7).

Remedial Actions. No remedial actions were performed.

Characterization Survey. One biased direct measurement and wipe sample were collected during the CS. The direct measurement result was 4,632 dpm/100 cm^2. The wipe result was less than the removable activity DCGL of 3.7E4 dpm/100 cm^2. No additional static locations were identified based on scans performed during the characterization and final status survey. The CS confirmed the assumptions used in FSS planning. CS results are included in the FSS summary reports in Appendix B.

Scans. Scanning coverage consisted of 54 percent of the floor. One grid had elevated counts above the action level of two times the material background but well below the $DCGL_w$ (<0.1 of $DCGL_w$). The contamination was fixed. No further investigation or decontamination was warranted.

Systematic Direct Measurements. Fourteen systematic direct measurements were performed in this survey unit at locations shown on Figure 3-11. The maximum result was 614 dpm/100 cm^2. All measurement results were below the MDC and less than the DCGL of 3.7E5 dpm/100 cm^2.

Systematic Wipe Samples. Fourteen systematic wipe samples, collocated with the systematic direct measurements, were collected in this survey unit. All were analyzed for ^3H and ^{14}C. The maximum ^3H and ^{14}C combined wipe result was 16 dpm/100 cm^2. All of the wipe results were below the MDCs and less than the removable activity DCGL of 3.7E4 dpm/100 cm^2.

Biased Samples. No biased samples were collected during the FSS.

Statistical Evaluation of FSS Samples. All FSS measurement results were below the respective DCGLs and the unity rule was satisfied. Since all results were below the DCGLs, the Sign test was not performed. The measurement data support rejection of the null hypothesis, providing high confidence that survey unit SU3-B2 satisfied the release criteria. The survey unit summary report is included in Appendix B.

3.5 Unity Rule

Since measurements were collected for more than one type of radiation (direct measurements for total ^{14}C and wipe samples for removable ^{3}H and ^{14}C) at the same locations, they were evaluated together using the unity rule to determine whether or not a survey unit meets the release criteria (i.e., the survey unit passes). The unity rule is satisfied when radionuclide mixtures yield a combined fractional concentration (sum of fractions) that is less than or equal to one. If all measurements in a given survey unit are below the release criteria and the unity rule is satisfied, the survey unit passes.

In order to evaluate the unity rule, the maximum direct measurement value and the maximum ^{3}H and ^{14}C values for each of the 14 systematic or random measurements in each survey unit were used. The sum of fractions did not exceed 0.002 for any of the survey units; therefore, the unity rule is satisfied.

3.6 Surface Soil Sampling

Surface soil samples were obtained on January 22, 2014 from a depth of 0-6" from a total of eight locations (KCMSS-1 through KCMSS-8) within the property of the Aptuit Facility. Two of the samples were collected from the prominent wind direction (north), three samples were collected from the other compass directions (south, east, and west), and the remaining three samples were collected in close proximity to where the exterior portions of the HEPA filter room ductwork and B2 stack were removed. In addition, two background samples (KCMSS-BKG-1 and KCMSS-BKG2) were collected within the property boundary at the same depths from the southeastern portion of the facility. Sample locations are shown on Figure 3-13.

Upon completion of the sampling activities, the soil containers were bubble wrapped and placed in a cooler for shipment via UPS to Test America Laboratories, Inc., Earth City, Missouri for analysis. Copies of the chain-of-custody and results from the lab are attached in Appendix G.

Soil samples were analyzed for ^{3}H by EPA Method 906.0 and for ^{14}C by LCS in accordance with EERF C-01. All ^{3}H results were below the MDC of 0.416 pCi/g to 0.493 pCi/g. ^{14}C above the detection limit (1.450 pCi/g to 1.530 pCi/g) was found at three of the sample locations

(KCMSS-6, 7.93 pCi/g; KCMSS-7, 3.32 pCi/g; KCMSS-8, 2.75 pCi/g). A summary of the results is presented in Table 3-2.

The samples taken at the 2010 sampling locations (KCMSS-1 through KCMSS-5) were all below their respective MDCs, thus confirming that there were no measurable levels of C-14 and H-3 at those locations. The samples with results above their respective MDCs (KCMSS-6 through KCMSS-8) were located near the recently removed stack, which had not been previously sampled. These results indicate some impact due to the B2 area stack; however all results were below the soil screening value of 12 pCi/g in NUREG 1757, Vol 2, Rev 1, Appendix H (NRC, 2006b).

3.7 Systems Investigation

All building systems that flow from historical use areas have been investigated. These systems include exhaust, drains, and vacuum lines.

3.7.1 Exhaust Ducts

The CTS HSA (Shaw 2011) identified the legacy exhaust systems that were potentially impacted. These systems came from radioactive material use areas in A and B Buildings. The investigation of these exhaust systems included surveys of potentially impacted exhaust lines that serviced the laboratory hoods, room exhaust lines, and rooftop components. Wipe samples and direct measurements were made inside exhaust ductwork and in fan port openings, the blowers for the fan, and on the fan blades. The exhaust system investigation was included as Appendix G (Ductwork Report) of the DP (Shaw 2013).

The results of the investigation revealed that the exhaust system components from potentially impacted areas of A Building were below Aptuit's unrestricted release limits and would be left in place.

The investigation of the B Building exhaust systems revealed that some of the exhaust system lines contained residual contamination below Aptuit's unrestricted release limits while others had residual contamination above unrestricted release limits. The exhaust system components (duct, fans, stacks) that were above unrestricted release limits were identified in the DP (legacy exhaust) and were removed as described in the DP. These components were disposed as radioactive waste. The exhaust system lines that were below unrestricted release limits were either left in place or disposed as construction debris.

The API exhaust system including fume hoods, ductwork, snorkel exhaust, HEPA housing, fans and stacks were removed as described in the DP. All API exhaust system components were removed, surveyed and disposed accordingly.

All exhaust systems coming from potentially impacted areas of the site were investigated. Legacy exhaust system components that had residual contamination above unrestricted release limits were removed and disposed as radioactive waste. Legacy exhaust system components with residual contamination below unrestricted release limits were left in place or disposed as construction debris. The entire API exhaust system was removed.

3.7.2 Drains

Historically, the disposal of licensed material via the sanitary sewerage system was used occasionally for the disposal of aqueous waste. However, sewer disposal was never a primary disposal option. The NRC noted on three inspection reports (No. 030-09415/1996-001, 030-09415/1991-001 and 030-09415/1985-001) that disposal to the sanitary sewer was within regulatory limits and confirmatory measurements made by the NRC inspectors in sinks were at background levels.

The drainage and sewer pipe systems from historical use areas have been investigated and the results have been previously reported to the NRC in FSSRs (Shaw 2007, Shaw 2012). The results of the previous investigations are summarized below.

Final Status Survey Report, Aptuit LAR and L Building (Shaw 2007)

This FSSR was for the L Building and the Lab Animal Resources (LAR) area which occupied a section of the second floor in B Building (B2).

Small quantities of radionuclides were disposed into the sewer system in aqueous liquids via sink drains and incidental disposal occurred as a result of equipment cleaning. Although floor drains existed in some laboratories, no spills were recorded that would impact floor drains. All drains located in or flowing from impacted areas were included in the site investigation and the results were reported in the FSSR. The results of the sink and drain investigation were used to determine if further investigation of the sewerage system was warranted.

There were 30 sinks included in the investigation of the sanitary sewerage system. Both direct measurements and wipe samples were collected. Results for the sinks were below Aptuit's unrestricted release limits.

A total of 21 drains were included in the investigation. Drain surveys included direct readings over the drains and wipes inside the drain openings. The highest direct reading, on a metal floor drain in the west end of B2-137A, was less than the DCGL. Removable contamination levels were below Aptuit's unrestricted release limits.

The conclusion of the drain survey was that no further investigation was needed. Upon acceptance of the FSSR by the NRC, L Building was released from the license via Amendment 25 and LAR was released from radiological controls. L Building is no longer under Aptuit's control. The LAR area was renovated and is part of the areas covered by the DP.

Final Status Survey Report, Aptuit Clinical Trial Supplies (Shaw 2012)

The FSSR for the Aptuit Clinical Trials Supplies (CTS) areas was submitted to the NRC in February 2012 (Shaw 2012). This FSSR included specific portions of A, B and E Buildings.

Drains to the sanitary sewer are located in bathrooms, janitor closets, and some laboratories. Sewage from office areas runs directly to the city sewer. Sewage from the laboratory and production areas is first sent to the on-site pH treatment building and adjusted if necessary prior to disposal to the city sewerage system.

Sewer disposal of radioactive materials has occurred in CTS areas in accordance with regulatory limitations. Small quantities were disposed into the sewerage system in aqueous liquids, and incidental disposal occurred as a result of equipment cleaning. These releases were carefully monitored to ensure compliance to regulatory limits. Records indicate that monthly releases of ^{3}H and ^{14}C were typically less than 1 millicurie.

An investigation of drain systems that flowed from CTS impacted areas was conducted in November 2011. Biased surveys and sampling were conducted of the drains (sink and floor) and sinks. Drain surveys included direct measurements on the drains (when accessible) and over the open ends of the sink traps after they were removed. The contents of the traps were collected into a single container. The contents were analyzed for ^{3}H and ^{14}C. No activity above background was detected in the trap liquids. The inside of each trap was wiped with a cotton swab and the swabs were counted by LSC for ^{3}H and ^{14}C. All drain and trap smear results and all direct measurements were below Aptuit's unrestricted release limits.

Starting in 2011 and continuing until operations ceased, effluent water samples were collected for ^{3}H and ^{14}C analysis from the on-site pH lift station twice monthly. No activity above the analytical detection limit has been detected in the pH lift station samples indicating that there is no leaching of radioactive materials from the system.

Based on the results of the drain investigation and the effluent water samples there is no indication of radiological impacts to the drain system servicing CTS areas that could significantly impact a potential dose to a member of the public.

In addition to the drain investigations that were described above, the drains from areas covered by the DP (B3-298 and API) have been investigated.

There are two drain lines that come from the API area. The north bound line comes from laboratories 155 to 163 and the south bound line services the remaining laboratories in API. Water from sink drains and floor drains in the API laboratories goes to an on-site pH treatment building, where it is adjusted if necessary prior to disposal to the city sewerage system. There are no holding tanks between the drains and the pH treatment building for the south bound line. A mixing pit was discovered during the walk down of the north bound line. The mixing pit is in the line prior to the pH treatment building.

Drain disposal of radioactive materials was not allowed in the API laboratories and the first rinse of glassware was collected and disposed as radioactive waste. Water from soaking baths was assayed with disposal dependent on analytical results. Starting in 2011 and continuing until operations ceased, effluent water samples were collected for ^{3}H and ^{14}C analysis from the on-site pH lift station twice monthly. No activity above the analytical detection limit has been detected in these samples. However, contamination in the API laboratory sinks was found during the weekly routine surveys, and some of the highest results from the scoping survey conducted on December 15, 2011 were in the sinks, indicating the potential for contamination in the drains.

Due to the potential for there to be residual contamination in the sewerage system, the drains coming from impacted areas covered by the DP were investigated in accordance with Aptuit Work Instruction WI-007, Rev. 1, *Radiological Characterization of Systems, Surfaces, and Equipment for Decommissioning Activities at Aptuit, LLC*. These areas include lab B3-298 and the impacted areas of the B2 level of Building B (i.e. API). There are no drains in the North Hill Waste Storage Building. The investigation included surveys and sampling of sink traps and drains, floor drains, access points in the drain lines (cleanouts, manhole, mixing pit) and the pH Treatment Building.

After sink traps and drains were investigated, access points to the sewerage system (e.g., cleanouts, manholes, p traps) were located on facility engineering drawings. Walk downs were then conducted with facility maintenance personnel to physically locate access points in the drain lines that represent potential pathways to the public sewerage system. These access points, shown on Figure 3-12, were surveyed and sampled. Access points in the drain lines included cleanouts, a manhole, and the mixing pit. Surveys and sampling were also performed in the pH treatment building.

The results of the sewerage system investigation are presented below.

B3-298 – This lab contains two lab sinks and a cup sink in the hood. Drain surveys included direct measurements in the sinks and over the open ends of the sink traps after they were removed. The contents of the traps were collected into a single container. The contents were analyzed for ^{3}H and ^{14}C. No activity above background was detected in the trap liquids. The inside of each trap was wiped with a cotton swab and the swabs were counted by LSC for ^{3}H and ^{14}C. All drain and trap smear results and all direct measurements were below Aptuit's unrestricted release limits.

B2-API – The p-traps and drain lines from sinks were investigated in February to May 2013. Drain surveys included direct measurements on the open end of the drain line and over the open ends of the sink traps after they were removed. The contents of the traps were collected into a single container. The inside of each trap and the open end of the each drain line, after removal of the trap, was wiped with a cotton swab or paper smear. The wipe samples were counted by LSC for ^{3}H and ^{14}C. The highest results were obtained from a sink trap and drain line in Lab B2-166. The sinks, traps and associated accessible drain lines to the floor penetration were removed and were disposed as radioactive waste. The highest removable activity measurements in remaining accessible drain lines were 2016 dpm removable ^{3}H and 7001 dpm removable ^{14}C. Activity measured in remaining drain lines is presented in Table 3-3.

North and South drain lines – The north bound drain line goes to the mixing pit and then connects to the main line going to the pH Treatment Building. Sludge samples were collected at depths of surface to three feet, three to six feet, six to nine feet, and below nine feet. There was no activity above background detected in any of the sludge samples. The drain line that travels south out of the API area was sampled at two cleanouts in the boiler room and in a manhole after the line exits the building. Wipe samples were collected in the influent and effluent lines coming into and exiting the manhole. All wipe sample results were below Aptuit's unrestricted release limits.

pH Treatment Building - Water from sink drains and floor drains in the API laboratories goes to an on-site pH treatment building, where it is adjusted if necessary prior to disposal to the city sewerage system. Starting in 2011, effluent water samples have been collected for ^{3}H and ^{14}C analysis from the on-site pH lift station twice monthly. No activity above the analytical detection limit has been detected in these samples. An investigation of the pH Treatment Building was conducted on April 30, 2013. The investigation included direct scans and wipes of building surfaces and on sampling equipment. Sludge and water samples were collected from the treatment pits. No activity above background was observed during surface scans. All wipe sample results were below Aptuit's unrestricted release limits. No elevated activity was detected in the sludge or water samples.

Evaluation

Based on the results of the investigation, there is low level residual contamination in the embedded drain lines that service the API area. Surveys conducted downstream of the API area indicate that the contamination does not extend to the drain system beyond that area.

Aptuit has evaluated the potential impact on dose to the public from residual contamination in the embedded or buried drain lines in the API area. The potential exposure to a renovation worker removing embedded or buried sewer lines was evaluated using RESRAD-Build, Version 3.5. A building renovation worker represents the exposure scenario that would result in the highest potential dose from residual contamination in the API drain lines. The Building Renovation Scenario described in the User's Manual for RESRAD-Build Version 3 (ANL 2003) was used for the basic input parameters. The default parameter values for the building renovation scenario are included with the RESRAD-BUILD output files (Appendix F). The site specific input parameters that were used are also included in the appendix. Tritium sources have to be run separately in RESRAD-BUILD so the total dose to the renovation work is the ^{14}C dose plus the ^{3}H dose. Both runs are included in the appendix.

The total potential dose from residual contamination in the drain lines to a member of the public (i.e. a renovation worker) is less than 0.1 mrem. Impacts to the sanitary sewerage system beyond the B2-166 drain lines are negligible. Based on this evaluation, the residual contamination in the drain line, in conjunction with other residual contamination at the facility, will be less than that permitted by 10 CFR 20.1402, therefore the remaining drain lines were left in place.

Conclusion

All drain pathways from locations controlled by the licensee to the sewerage system have been identified. The sewerage system from historical use areas has been investigated and has been determined to not have an impact on dose to the public. The sewerage system from areas covered by the DP has been investigated and an evaluation of the results using RESRAD-BUILD demonstrates a potential dose to a member of the public of less than 0.1 mrem. The dose to a member of the public from residual contamination in the drain lines, in conjunction with other residual contamination at the facility, is less than the regulatory limits as permitted by 10 CFR 20.1402. The potential dose from residual contamination in the drain lines is included in the dose assessment section of this FSSR.

3.7.3 Vacuum lines

A central vacuum system serviced the API area hoods although, reportedly, the system was not used routinely (vacuum provided by portable vacuum pumps instead) for radiosynthesis operations. However, due to the possibility that the vacuum system could have become contaminated it was investigated as described in the DP. Two elevated locations were identified during this investigation, and were removed and disposed of as low-level radioactive waste.

3.8 Quality Control Summary

As described in Section 2.2.4, QC measures for this FSS included evaluation of precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity.

Replicates to measure operator precision were performed using the same instrument at the same location. For wipes, sampling precision was checked through recounting of wipes. Relative percent difference values were within the limits described in Section 2.2.4 for all direct measurements, and for all but one of the recounted wipes. The relative percent difference for the recounted wipe sample in SU2-B166O was 50%, however the sample values represented only a small fraction of the DCGLs and were therefore determined to be insignificant.

Relative bias for wipe samples was determined by comparing the results obtained from a $^{3}H/^{14}C$ spiked sample run with each batch of samples. All bias measurements were within the limit of plus or minus 20 percent described in Section 2.2.4.

Accuracy for wipe measurements was determined using the chi square test and daily calibrations as well as spike recovery. Average recovery for wipe results was within the plus or minus 20 percent limits described in Section 2.2.4.

Field personnel followed measurement protocols established in the DP and presented in Appendix E to ensure that collected samples were representative of the media sampled. A review of field documentation revealed that protocols were followed and that sample identification and integrity were maintained.

Data comparability was assured via the sampling design and application of appropriate QC requirements that employ established methods for collecting the samples, using published and other documented methods for radiological analyses, and documenting the methods used.

The number of samples needed to support the FSS was statistically determined and included a 20 percent margin of error based on MARSSIM guidance. The completeness goal for each survey unit was 90 percent for both field sampling using direct measurements and for wipe samples. Review of the field and laboratory documents revealed that all data were usable.

Instrument sensitivity was monitored through daily operational checks to verify performance. The target detection limits were met for all instruments used in the performance of the FSS. All data were obtained with instruments that satisfied the performance requirements.

The data generated meet the QC requirements established for the project (see Section 2.2.4).

4 Health and Safety

Decommissioning activities were conducted under a comprehensive site-specific safety and health plan (Shaw 2012a) and decommissioning plan (Shaw 2013). These plans described the safety, health, and radiological safety programs used for this project. Major elements of these programs included:

- Training required for site decommissioning workers included current OSHA 8-hr refresher training, radiation safety training, and site D&D awareness training. Training for all site decommissioning workers was verified prior their participation in decommissioning tasks.

- Daily Tailgate Briefings to review the job hazards and control methods, review lessons learned, and to discuss ongoing activities. Daily briefings were conducted every day of field activities.

- Radiological surveys were conducted to assess radiation hazards and to verify the effectiveness of radiological controls. Survey results were used in preparing radiation work permits and to determine if additional controls were needed to mitigate radiation hazards.

- Radiation Work Permits were used to document task specific radiation hazards and to specify hazard control methods. All workers entering a potentially contaminated area were required to read and sign the RWP and to enter access and egress times.

- Although an evaluation of maximum potential exposures demonstrated that monitoring of internal dose was not required, decommissioning personnel participated in the bioassay program which consisted of baseline and weekly analysis of urine samples. All decommissioning personnel participated in the bioassay program. There were no results above the evaluation level and no dose assigned to project personnel.

There were no accidents or injuries reported. The radiation protection program was effective at maintaining dose to workers and the public as low as reasonably achievable.

5 Dose Assessment

5.1 Exposure Setting

The Aptuit facilities are located on a 45.5 acre campus-type setting in an industrial area of Kansas City, Missouri. The site is adjacent to and just east of Interstate 435. The Aptuit facilities consist of offices, laboratories, and support areas.

The dose assessment takes into consideration all historical use areas under Aptuit's control including building systems that flowed from those areas.

5.2 Exposure Pathways

As described in Section 1.5, the laboratory worker is a reasonable potential future receptor due to the location (industrial area) of the facilities and the industrial-use purpose. The building renovation worker is also considered a potential future receptor for residual contamination in the API area drain lines. The exposure pathways for both potential future receptors are inhalation of resuspended surface contamination and inadvertent/incidental ingestion of removable surface contamination.

5.3 Sources of Exposure

Radionuclides approved for use by the NRC through license amendments are described in Section 1.4.1. Although Aptuit had the potential to utilize a variety of radionuclides in forms that potentially allowed dispersal of those contaminants onto equipment and building surfaces, the only remaining radionuclides of concern are ^{14}C and ^{3}H (See Section 2.1). These radionuclides do not present an external exposure hazard therefore the potential pathways of exposure are inhalation and ingestion.

5.4 Quantification of Exposure

It was determined during the DQO process that the objectives of the survey design presented in Section 2.2.2 were fulfilled. Therefore, data from the FSS were of sufficient quality and quantity to make final status determination. Residual radioactivity levels do not result in an annual dose that would exceed the 10 CFR 20, Subpart E criteria for release of the Aptuit SO facilities for unrestricted use. No measurement exceeds the DCGL.

The sewerage system from historical use areas was investigated. The results indicate that there is no impact to annual public dose from this system. The sewerage system from areas covered by the DP has been investigated. Low level residual contamination exists in some

embedded/buried drain lines in the API area. An evaluation of the dose from the residual contamination using RESRAD-BUILD demonstrates a potential annual dose to a member of the public of less than 0.1 mrem using very conservative assumptions. The annual dose to a member of the public from residual contamination in the drain lines, in conjunction with other residual contamination at the facility, is less than the regulatory limits as permitted by 10 CFR 20.1402.

The exhaust system from historical use areas (legacy ductwork) was investigated. Exhaust system components that exceeded Aptuit's unrestricted release limits were removed. The exhaust system from the API area was removed including external components. There is no impact on annual dose to the public from remaining exhaust system components.

As reported in a letter to the NRC dated July 26, 2012, Aptuit provided the annual dose estimate from the results of the characterization and FSS for the CTS facilities. With the exception of one discrete point in the class 2 survey of a walk in freezer, no contamination was found above the MDC of the survey instrument. This reading found in the B3-268F was 1841 dpm/100 cm^2. An equal activity of tritium is assumed to be present in addition to the measured value of ^{14}C. Assuming these values cover one entire square met grid and comparing them to the screening values in table B.I of NUREG 1757 as well as the area covered by this document (3558.18 m^2), respective TEDE values for tritium and ^{14}C would be 3.5E-6 mrem per year and 1.1E-7 mrem per year. Combined, these values result in a TEDE of 3.6E-6 mrem per year from the CTS laboratories.

The annual dose from residual contamination in the SO facilities was calculated using version 2.1.0 of the NRC Decontamination and Decommissioning (DandD) software. Default input parameters were used. The maximum direct reading measurement (22,480 dpm/100 cm^2) from the FSS was used as the concentration of ^{14}C over an unlimited area. The maximum ^{3}H smear result (245 dpm/100 cm^2) from the FSS was used as the input value for ^{3}H concentration over an unlimited area. The ^{3}H dose from the DandD run was 4.95E-05 mrem per year and the ^{14}C dose was 1.53E-01 mrem per year for a total dose from residual contamination of 1.53E-01 mrem per year from the SO facilities. Since the maximum results for ^{3}H and ^{14}C were used as input into DandD, the calculated dose is a conservative estimate of the potential dose to a building occupant.

Total annual dose from the site is the sum of the dose contributions described above from residual contamination in the API embedded drain lines, CTS facilities, and SO facilities. The total annual dose from the site is less than 0.25 mrem.

Aptuit achieved a decommissioning goal below the annual dose limit through the selection of conservative DCGLs that are less than 10 percent of the screening values and through the implementation of a radiological control program during decommissioning activities that ensured that annual doses to workers and the public were ALARA. The DCGLs, 3.7E+05 dpm/100 cm^2 for total activity and 3.7E+04 dpm/100 cm^2 for removable activity ^3H and ^{14}C combined, would equate to a dose of 2.5 mrem per year, therefore the annual doses to the average member of the critical group are ALARA.

6 Conclusions and Recommendations

Upon completion of on-site FSS data collection, the data were analyzed to ensure that all objectives of the DP (Shaw, 2013) were completed. The data were reviewed according to the methods described in MARSSIM (NRC, 2000). Data presented in Appendix D were collected according to MARSSIM and the requirements of the DP. Table 3-1 presents the maximum direct readings and wipe results, all of which are less than the respective DCGLs. In accordance with Table 8.2 of MARSSIM, statistical tests were not performed on the data since all measurement results were below the DCGLs (NRC, 2000).

6.1 Conclusions

It is concluded that all objectives of the DP were completed and all work activities were performed as described in the DP. The data collected have been analyzed and are of sufficient quality and quantity to make facility release decisions with an acceptable probability of decision error.

According to Appendix N of NUREG 1757, "In light of the conservatism in the building surface and surface soil generic screening levels developed by NRC, NRC staff presumes, absent information to the contrary, that licensees who remediate building surfaces or soil to the generic screening levels do not need to provide analyses to demonstrate that these screening levels are ALARA" (NRC, 2006b). For ALARA considerations, another level of conservatism was introduced by using 10 percent of the ^{14}C screening value presented in NUREG 1757 (NRC, 2003), or 3.7E5 dpm/100 cm^2 for fixed activity and 10 percent of that screening value for removable activity for both ^{3}H and ^{14}C. The removable screening value was based on the more conservative ^{14}C screening value instead of using the screening value for ^{3}H. All sample results (systemic, random, and biased directs measurements and wipe results) were less than 1 percent of the respective screening values.

It is also concluded that there are no residual radioactivity levels that exceed the DCGLs. Therefore, there are no residual radioactivity levels, distinguishable from background, that would result in a TEDE to an average member of the critical group that would exceed 25 mrem per year as established in 10 CFR 20, Subpart E.

Measurements were collected for more than one type of radiation (direct measurements for total ^{14}C and wipe samples for removable ^{3}H and ^{14}C) at the same locations; therefore, the measurements were evaluated together using the unity rule to determine whether or not a survey unit meets the release criteria (i.e., the survey unit passes). The unity rule was satisfied for all survey units.

All exhaust and drainage systems that came from radioactive material use areas were investigated during the course of site decommissioning. These investigations occurred during decommissioning activities associated with both CTS and SO areas. Results of the investigations have been previously reported to the NRC in FSSRs (Shaw 2007, Shaw 2012) and the DP (Shaw 2013). Investigations and remediation that occurred after submittal of the DP are summarized in Section 3.7 of this FSSR. All potentially impacted exhaust systems were identified and those found to be contaminated above Aptuit's acceptable release limits were removed. All potentially impacted drain pathways were identified and investigated. A section of the buried/embedded drain system from the API area was found to contain residual radioactivity but was left in place due to the low potential dose contribution to a member of the public.

The results of the exhaust and drain system investigations are discussed in greater detail in Section 3.7 of this FSSR.

6.2 Remediation Requirements

The residual radioactivity levels are well below the DCGLs and have been reduced to ALARA. Building structures and system and component surfaces that had residual activity were decontaminated to reduce residual activity levels as far below applicable release limits as was reasonably achievable. Typical good practice efforts such as floor and wall washing and removal of readily removable radioactivity were used. If after these efforts, total or removable contamination exceeded the Aptuit ALARA goals (See Table 6-1), then an additional decontamination (e.g. scrubbing with solvent or detergent wetted rag) or removal of the material, whichever was deemed appropriate, was performed. Further attempts at reducing residual activity were not considered reasonable.

Since residual radioactivity was reduced to levels that were ALARA there is no requirement for additional remediation of the Aptuit facilities.

6.3 Final Status Determination

This report has been prepared according to MARSSIM and the Consolidated Decommissioning Guidance (NRC, 2006a; 2006b). The Aptuit SO facilities meet the criteria for radiological release established in 10 CFR 20, Subpart E, "Radiological Criteria for License Termination" and the specific criteria for radiological release of a facility under the NRC regulations, specifically: 1) residual radioactivity distinguishable from background radiation results in a TEDE that does not exceed 25 mrem per year to an average member of the critical group; and 2) the residual radioactivity has been reduced to levels that are ALARA, as defined in 10 CFR 20.1003. All

measurements in each survey unit were below the release criteria, the unity rule was satisfied and residual activity was reduced to levels that are ALARA; therefore, each survey unit passed. It is determined that the final status of the Aptuit SO facilities on Hickman Mills Drive in Kansas City, Missouri, is acceptable for unrestricted radiological release. In addition, as detailed in the CTS FSSR (Shaw 2012), all measurements in each survey unit in the CTS facilities were below the release criteria and the unity rule was satisfied. Based on the combined FSSRs for the site, it is determined that the final status of the Aptuit LLC facilities on Hickman Mills Drive in Kansas City, Missouri, is acceptable for unrestricted radiological release.

7 References

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APPENDIX A

APTUIT RADIOACTIVE MATERIALS LICENSE

APPENDIX B

SURVEY UNIT SUMMARY REPORTS

APPENDIX C

DAILY INSTRUMENT CHECKS

APPENDIX D

FINAL STATUS SURVEY RESULTS

APPENDIX E

WORK INSTRUCTIONS

APPENDIX F

RESRAD-BUILD REPORTS

APPENDIX G

SURFACE SOIL SAMPLING RESULTS

TABLES

Table 1-1
Impacted Areas within the SO Facilities
Final Status Survey Report
Aptuit, LLC

Impacted Areas	Survey Unit
B3-298	SU1-B3298
B2-155 thru B2-164	SU1- B2GMP
B2-165	SU1-B2165
B2-166	SU1-B2166
B2-167/167A/170	SU1-B2AE
B2-155 thru B2-164 Overhead	SU2-B2GMPO
B2-165 Overhead	SU2-B2165O
B2-166 Overhead	SU2-B2166O
B2-103A/112/116/117/119	SU2-B2
Rad Waste Storage on the Hill	SU2-Hill
B2 Dock 5/API Common	SU3-B2

Table 1-2
Aptuit Acceptable Surface Contamination Levels
Final Status Survey Report
Aptuit, LLC

^{3}H (dpm/100 cm^2)	^{14}C (dpm/100 cm^2)
≤1000 removable	≤1000 removable[a,d]
	≤5000 average[a,b]
	≤15000 maximum[a,c]

[a] As used in this table, dpm (disintegration per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation. For example for ^{14}C, using published efficiency for a PGM detector (5%) with a 15 cm^2 probe and a background count rate of 40 cpm, it is possible to detect <5000 dpm/100 cm^2 with the probe stationary and <13,000 dpm/100 cm^2 while scanning. Under these conditions, a reading of 2X background is approximately 5000 dpm/100 cm^2.

[b] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[c] The maximum contamination level applies to an area of not more than 100 cm^2.

[d] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

Table 2-1
Area Classifications for SO Facilities
Final Status Survey Report
Aptuit, LLC

Survey Unit	Areas in Survey Unit	Classification
SU1-B3298	B3-298	Class 1
SU1- B2GMP	B2-155 thru B2-164	Class 1
SU1-B2165	B2-165	Class 1
SU1-B2-166	B2-166	Class 1
SU1-B2AE	B2-167/167A/170	Class 1
SU2-B2GMPO	B2-155 thru B2-164 Overhead	Class 2
SU2-B2165O	B2-165 Overhead	Class 2
SU2-B2166O	B2-166 Overhead	Class 2
SU2-B2	B2-103A/112/116/117/119	Class 2
SU2-Hill	Rad Waste Storage on the Hill	Class 2
SU3-B2	B2 Dock 5/API Common	Class 3

Table 2-2
FSS Investigation levels
Final Status Survey Report
Aptuit, LLC

Survey Unit Classification	Flag Direct Measurement or Sample Result When:	Flag Scanning Measurement When:
Class 1	>$DCGL_w$ (>370,000 dpm/100 cm^2 total)	>$DCGL_w$
Class 2	> 0.5 $DCGL_w$ (>185,000 dpm/100 cm^2 total)	>2X material background
Class 3	>0.1 $DCGL_w$ (>37,000 dpm/100 cm^2 total)	>2X material background

Table 2-3
Detection Sensitivities for Radiation and Contamination Survey Instruments
SO Facilities
Final Status Survey Report
Aptuit, LLC

Description	Application	MDC	Scan MDC
Ludlum Model 2360 Scaler/ratemeter with Model 43-68 GFPD (with 0.4 mg/cm^2 window)	Scanning[1] and static surveys for ^{14}C	<600 $dpm/100\ cm^2$	<2000 $dpm/100\ cm^2$
Ludlum Model 2360 Scaler/ratemeter with Model 43-37 GFPD (with 0.8 mg/cm^2 window) floor monitor	Floor scanning[1] for ^{14}C	<300 $dpm/100\ cm^2$	<1000 $dpm/100\ cm^2$
Packard TriCarb 2900 TR liquid scintillation counter	Removable ^{3}H and ^{14}C contamination	<30 $dpm/100\ cm^2$	NA

[1]Based on nominal background values of 200 and 600 cpm for the 43-68 and 43-37, respectively. Scan speed is 1 detector width per second.

cm^2 – Square centimeters.
dpm – Disintegrations per minute.
mg – milligrams.

Table 3-1
Maximum Results for FSS Direct Measurements and Wipes
Final Status Survey Report
Aptuit, LLC

Survey Unit	Maximum Direct Reading	Maximum ^{3}H Wipe Result	Maximum ^{14}C Wipe Result
	net dpm/100 cm^2		
Class 1 Survey Units			
SU1-B3298	455	17	9
SU1-B2GMP	**13683**	17	**76**
SU1-B2165	**3600**	17	**29**
SU1-B2166	**17075**	**37**	**46**
SU1-B2AE	**2657**	15	19
Class 2 Survey Units			
SU2-B2GMPO	**1135**	17	**74**
SU2-B2165O	**4268**	19	**224**
SU2-B2166O	**17267**	**36**	**87**
SU2-B2	**4173**	**33**	**118**
SU2-Hill	**1706**	**78**	**65**
Class 3 Survey Units			
SU3-B2	614	16	12

Notes:
dpm - Disintegrations per minute.
cm^2 - Square centimeters.
Bold value indicates a result above the MDC

Table 3-2
Surface Soil Sample Results
Final Status Survey Report
Aptuit, LLC

Sample Number	% Moisture	^{14}C			^{3}H		
		pCi/g	Qual	MDC	pCi/g	Qual	MDC
KCMSS-1	23%	0.517	UH	1.49	0.0417	UH	0.450
KCMSS-2	17%	0.651	UH	1.47	0.243	UH	0.446
KCMSS-3	35%	-0.406	UH	1.46	0.000	UH	0.493
KCMSS-4	21%	-0.562	UH	1.45	0.300	UH	0.473
KCMSS-5	16%	-0.290	UH	1.47	0.120	UH	0.438
KCMSS-6	10%	7.93	H	1.50	0.204	UH	0.416
KCMSS-7	14%	3.32	H	1.53	0.0331	UH	0.427
KCMSS-8	20%	2.75	H	1.50	0.0342	UH	0.446
KCMSS-BKG-1	21%	-0.797	UH	1.49	0.320	UH	0.463
KCMSS-BKG-2	21%	-0.140	UH	1.45	0.000	UH	0.443

U - Result is less than the sample detection limit

H - Sample was prepped or analyzed beyond the specified holding time

Table 3-3
Activity Measured in Remaining Drain Lines
Final Status Survey Report
Aptuit, LLC

	Total dpm/100 cm^2			Removable ^3H dpm/100 cm^2			Removable ^{14}C dpm/100 cm^2		
	Min	Max	Median	Min	Max	Median	Min	Max	Median
Drains	437	69336	6608	3	2016	310	0	7001	760

Table 6-1
Aptuit ALARA Goals
Final Status Survey Report
Aptuit, LLC

	Total	Removable (dpm/100 cm^2)
Aptuit ALARA Goals	~37,000 ^{14}C	3,700 ^{3}H + ^{14}C
Aptuit ALARA Goals (gross cpm w/43-68)	5000[a]	NA

[a] 5000 gross cpm is approximately 40,000 dpm/100 cm^2 or 1% (0.25 mrem) of the NRC dose limit for unrestricted release

FIGURES

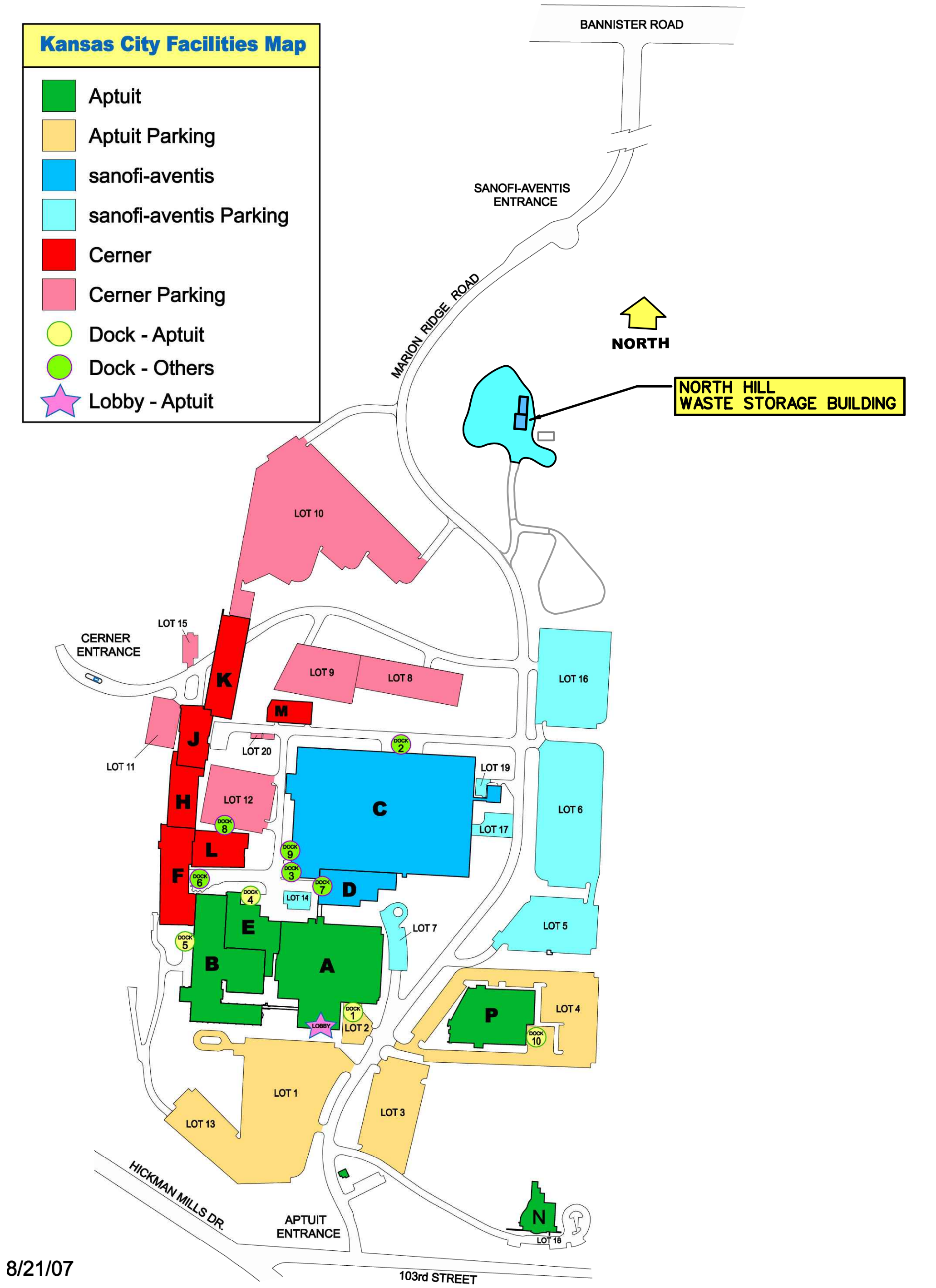
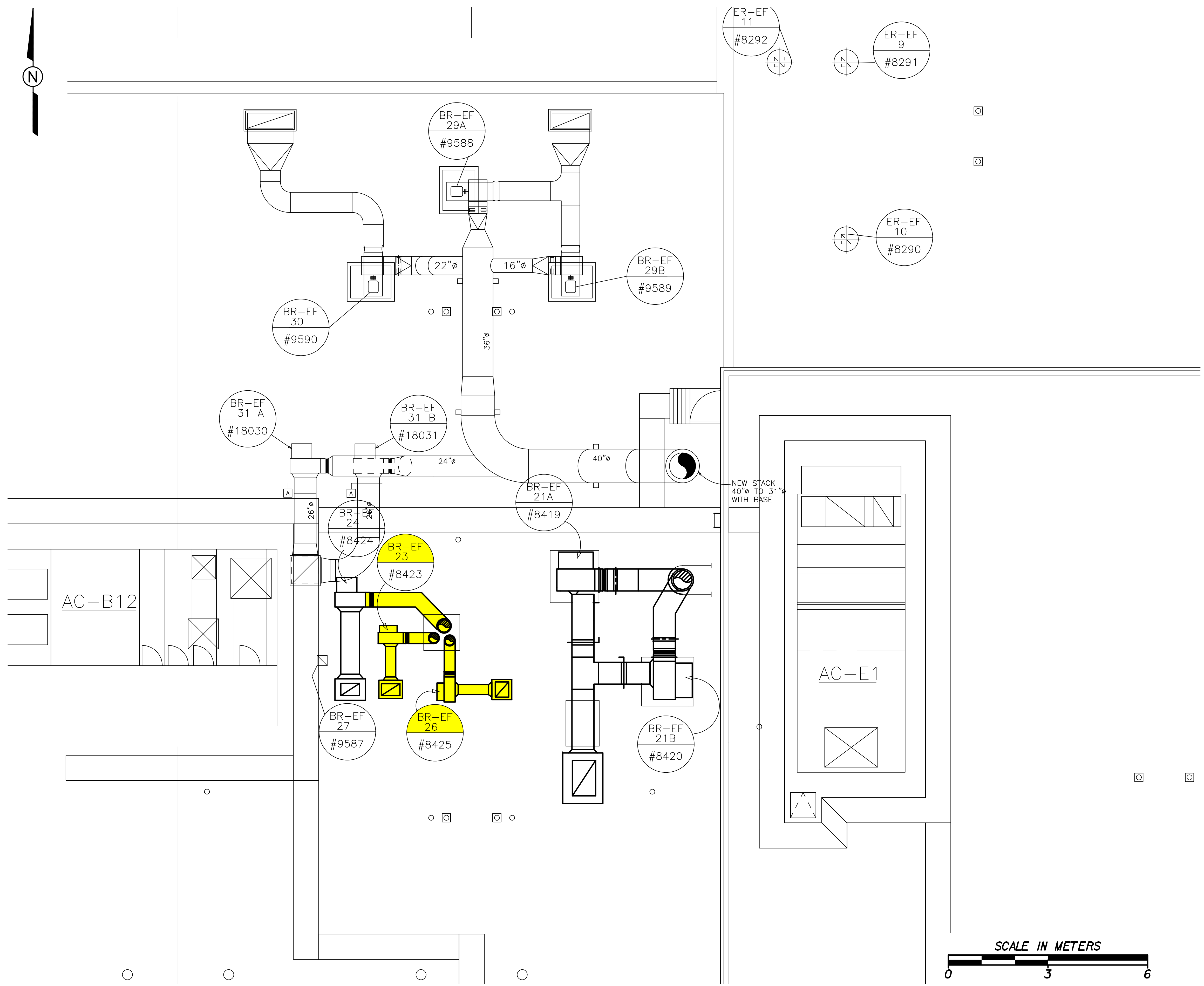


FIGURE 1-1
APTUIT FACILITY SITE DRAWING

FINAL STATUS SURVEY REPORT
APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)



LEGEND:

EXHAUST COMPONENTS THAT WERE REMOVED

FIGURE 1-2
EXHAUST SYSTEMS
REMOVED, B BUILDING ROOF

FINAL STATUS SURVEY REPORT
APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 3 6

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

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LEGEND:

EXHAUST DUCTWORK THAT WAS REMOVED

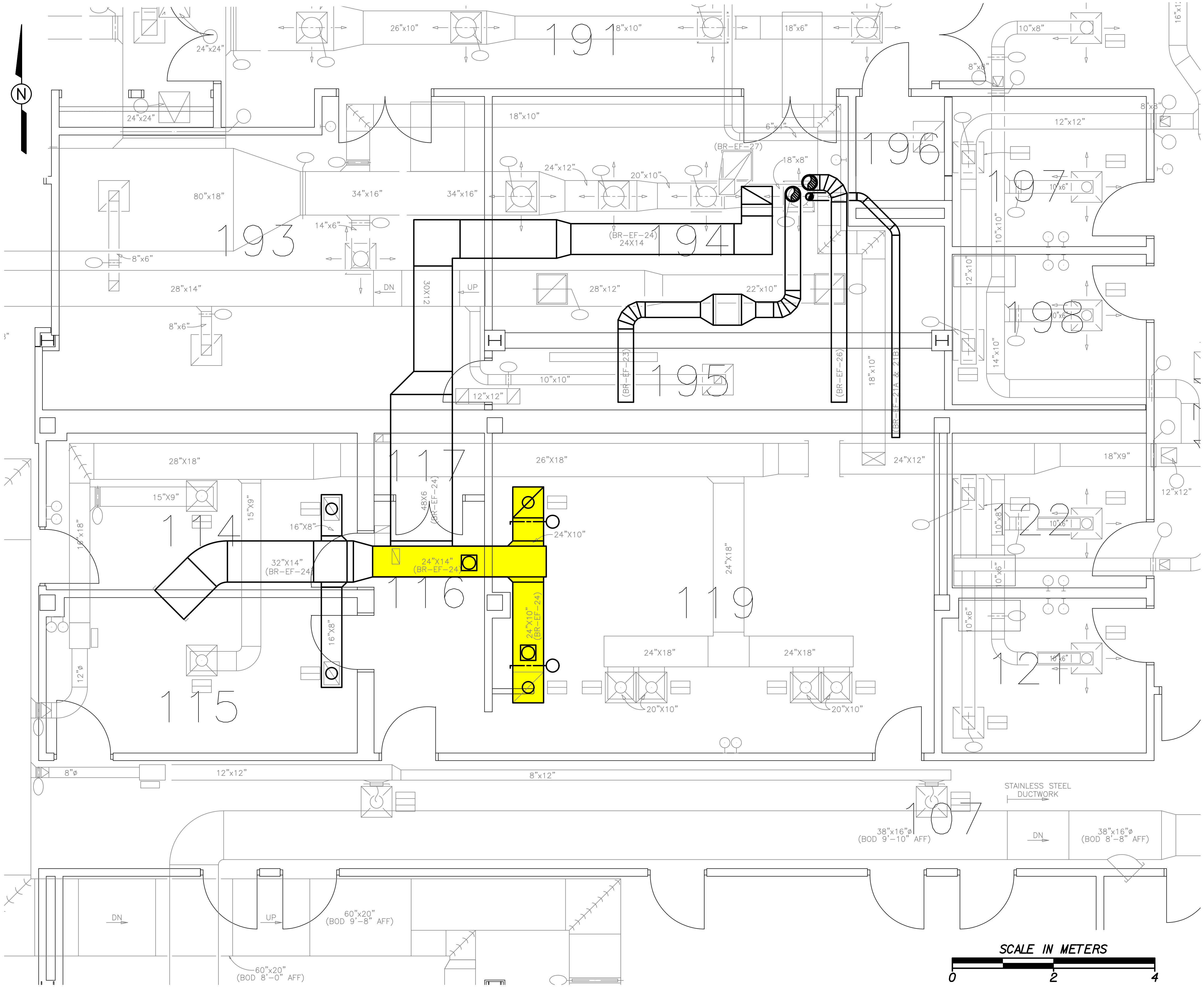


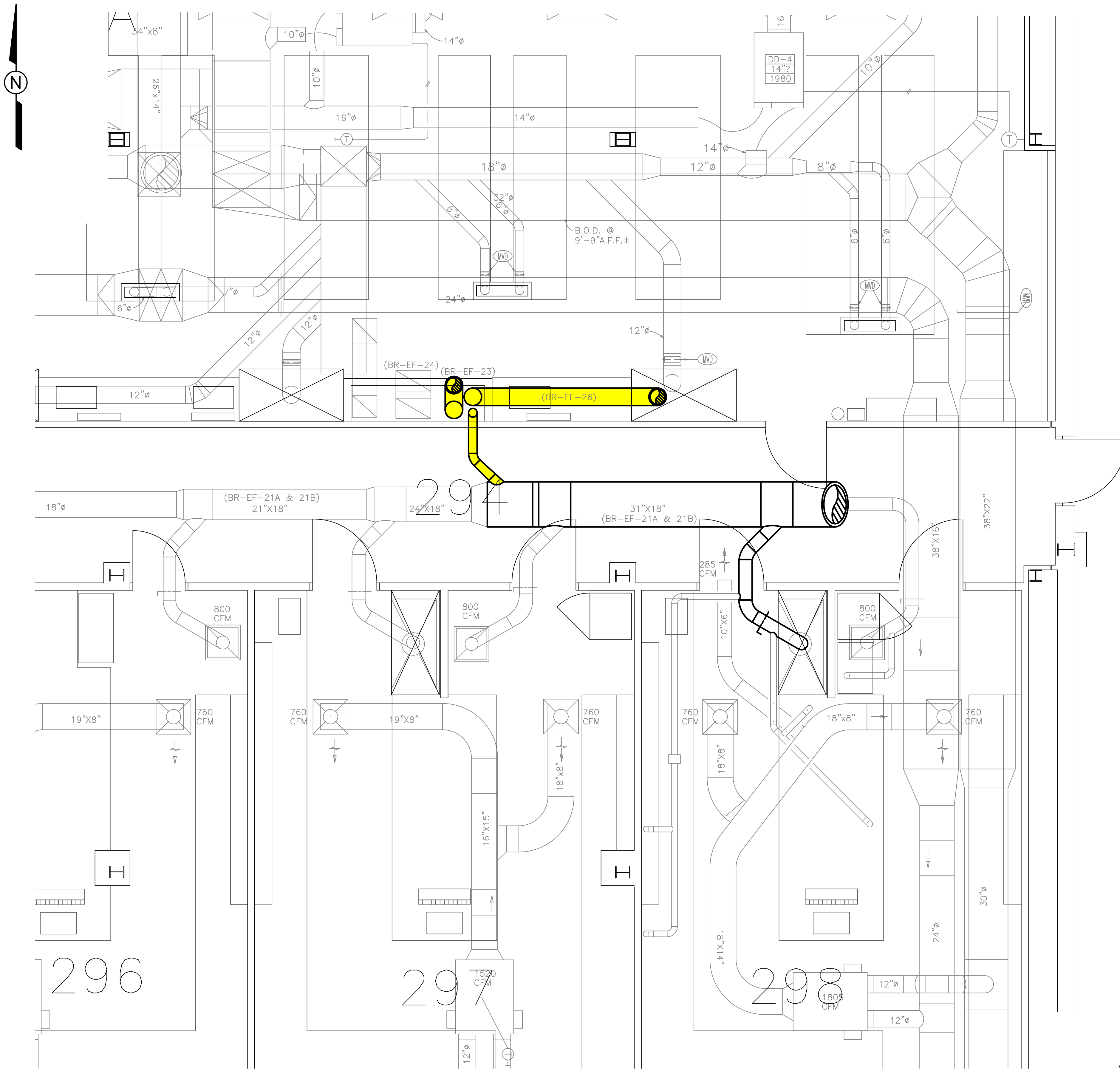
FIGURE 1-3

LEGACY DUCTWORK REMOVED, B BUILDING B2

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)



LEGEND:

LEGACY DUCTWORK THAT WAS REMOVED

SCALE IN METERS

0 2 4

FIGURE 1-4
LEGACY DUCTWORK REMOVED, B BUILDING B3

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

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LEGEND:

- CLASS 1 SURVEY UNITS
- CLASS 2 SURVEY UNIT
- CLASS 3 SURVEY UNIT
- CLASS 2 OVERHEAD SURVEY UNITS

SCALE IN METERS

0 14 28

FIGURE 2-1

SURVEY UNIT CLASSIFICATIONS, B BUILDING B2

FINAL STATUS SURVEY REPORT
APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

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LEGEND:

CLASS 1 SURVEY UNIT

FIGURE 2-2
SURVEY UNIT CLASSIFICATIONS,
B BUILDING B3

FINAL STATUS SURVEY REPORT
APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 14 28

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

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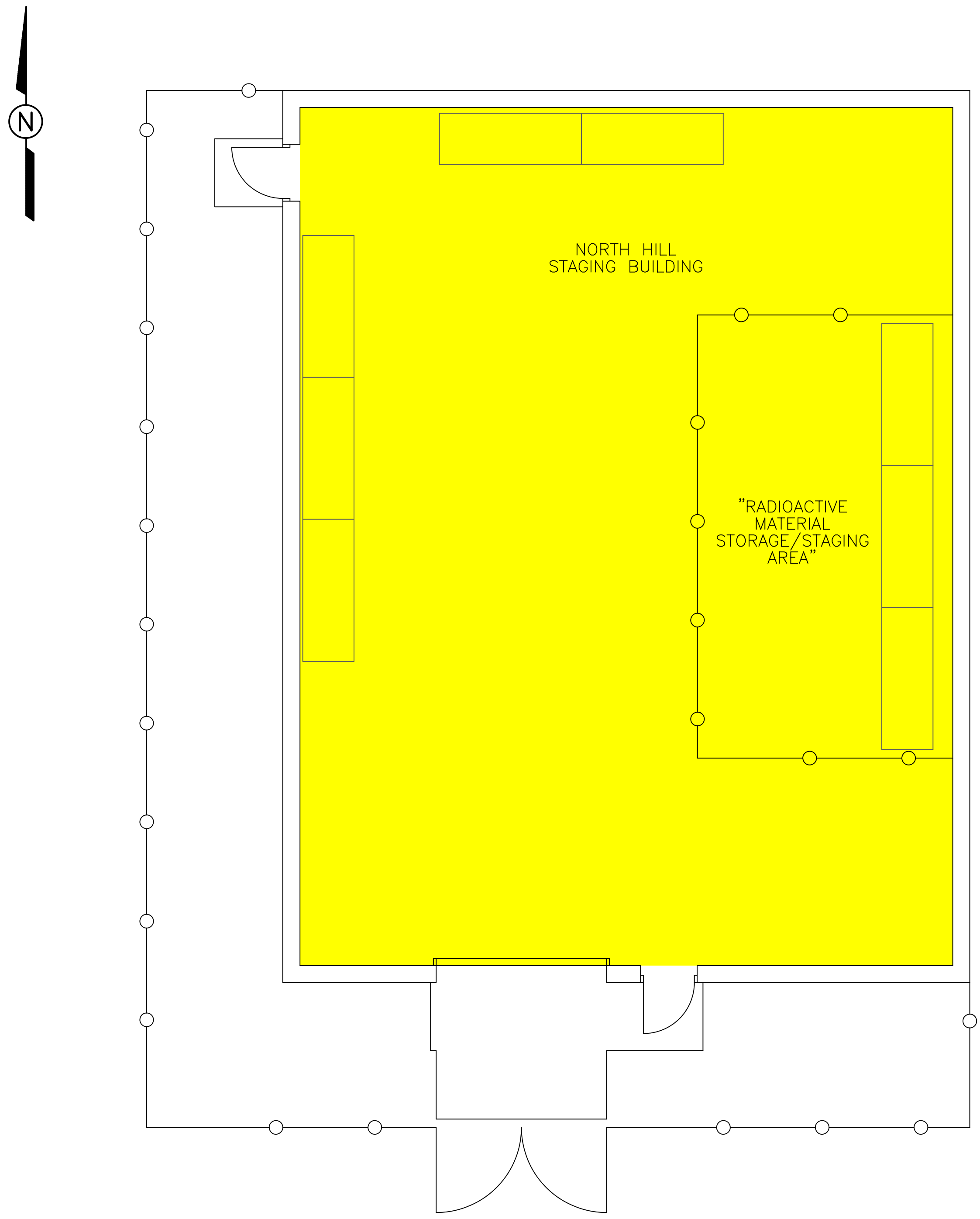

LEGEND:

CLASS 2 SURVEY UNIT

FIGURE 2-3
SURVEY UNIT CLASSIFICATIONS, NORTH HILL STAGING BUILDING (RAD WASTE STORAGE)

FINAL STATUS SURVEY REPORT
APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

SCALE IN METERS
0 3 6

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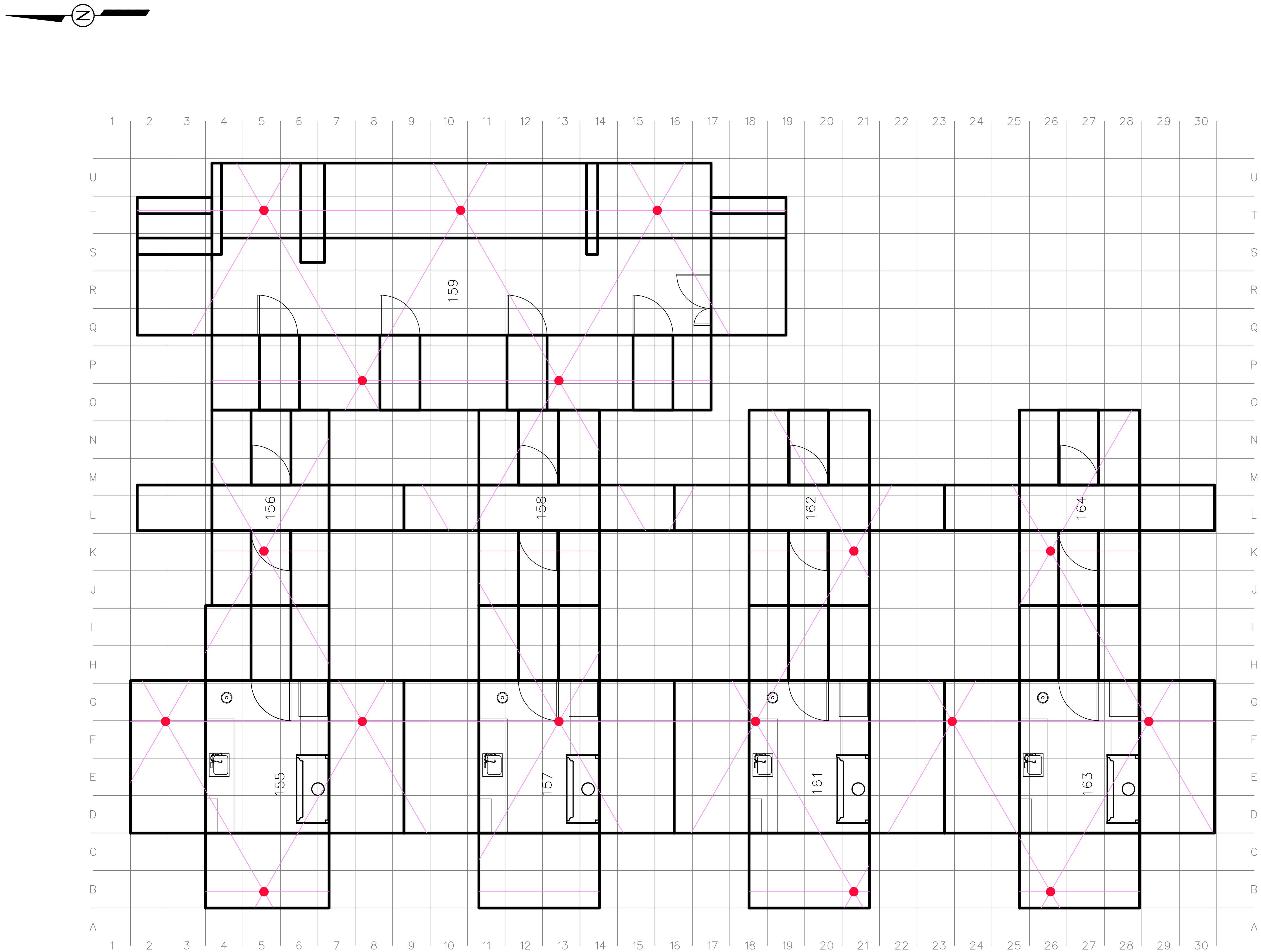

LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 232 SQ. M.
   FLOOR SURFACE AREA: 102 SQ. M.
   TOTAL SURFACE AREA: 334 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 5.25 METERS.

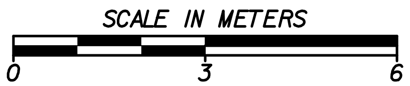

FIGURE 3-1
CLASS 1 SAMPLING LOCATIONS
IN B2-155 THROUGH B2-164
SU1-B2GMP

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

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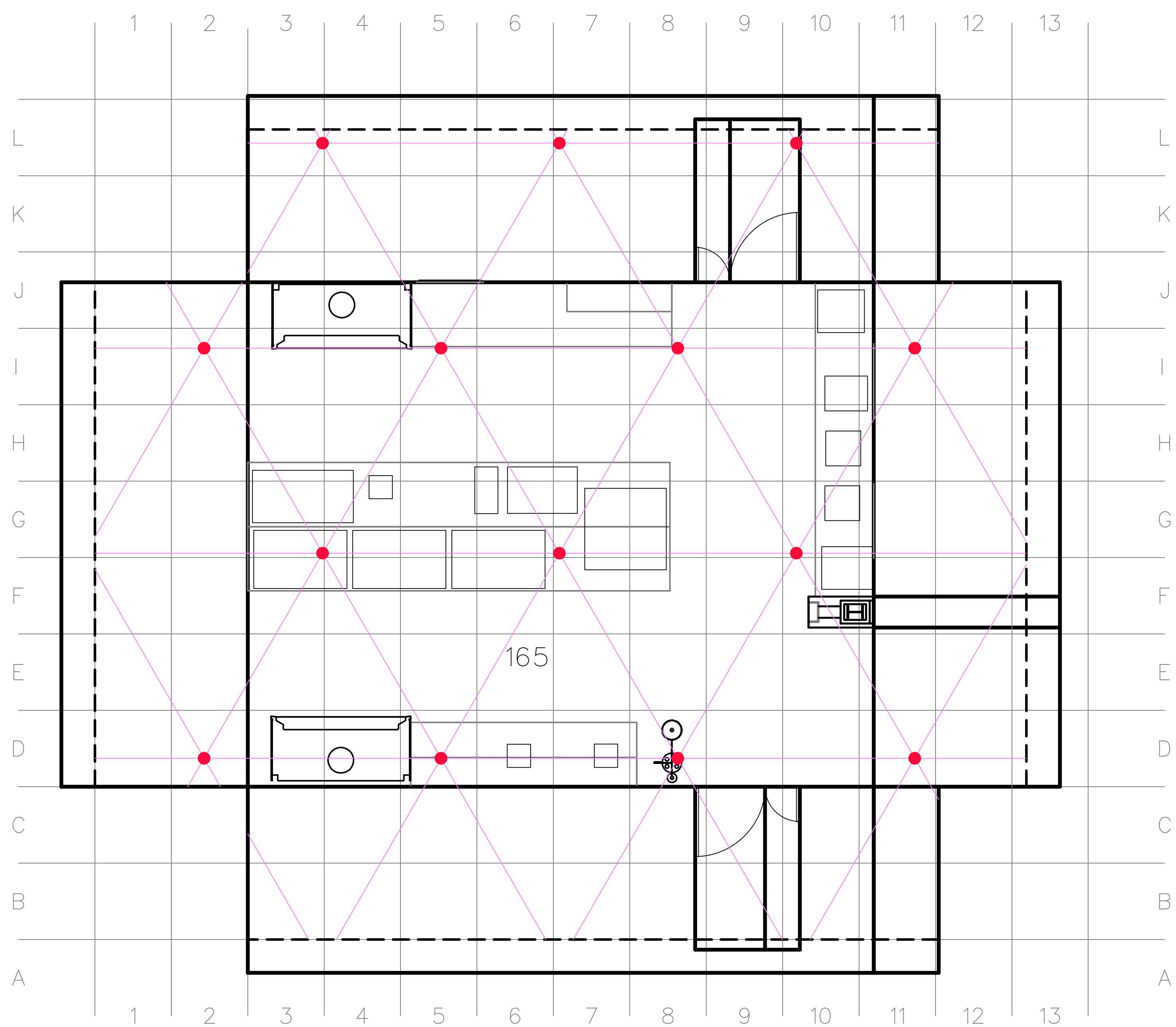

LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 62 SQ. M.
   FLOOR SURFACE AREA: 54 SQ. M.
   TOTAL SURFACE AREA: 116 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 3.10 METERS.

SCALE IN METERS
0 2 4

FIGURE 3-2
CLASS 1 SAMPLING LOCATIONS IN B2-165 SU1-B2165

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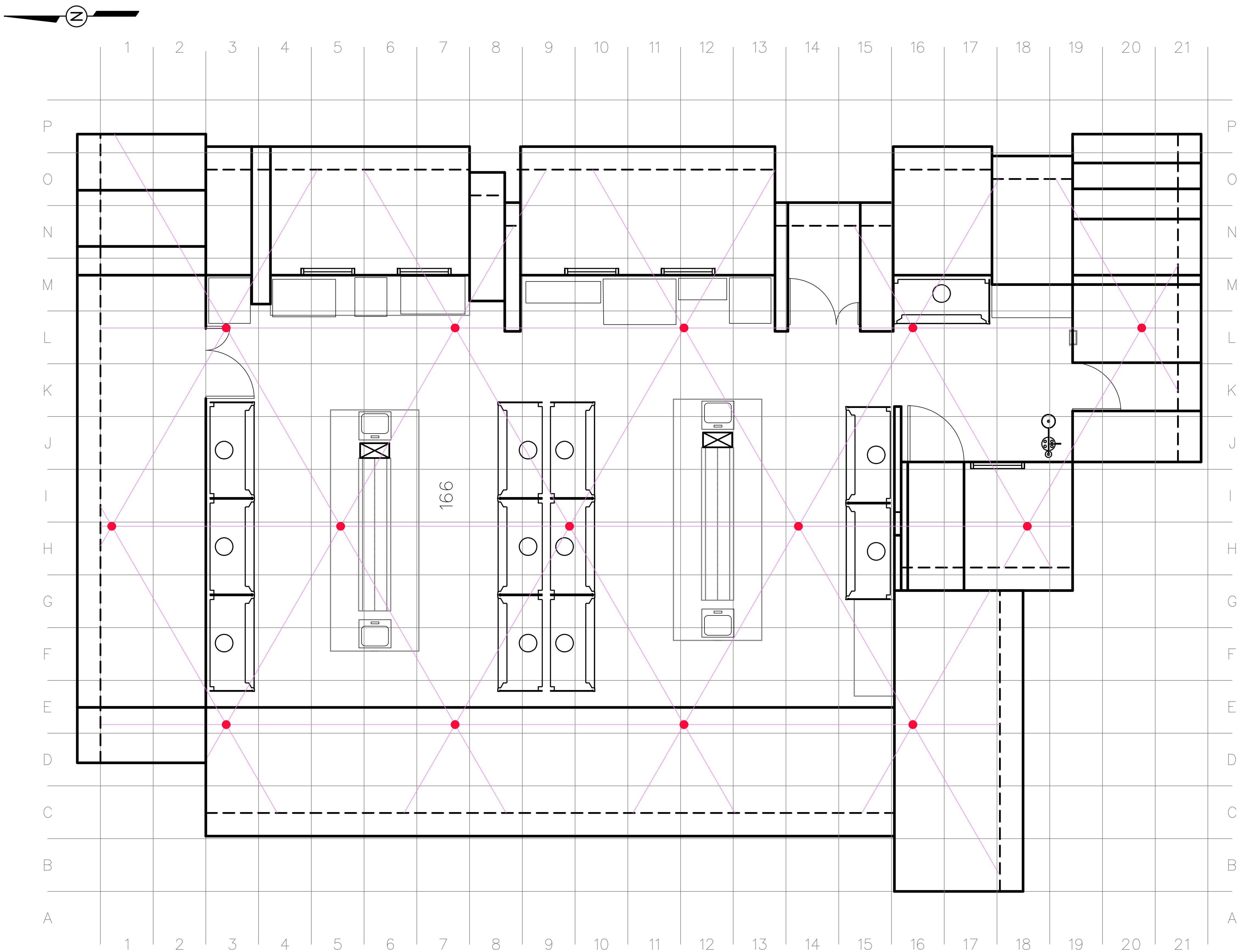

LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 114 SQ. M.
   FLOOR SURFACE AREA: 115 SQ. M.
   TOTAL SURFACE AREA: 229 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.34 METERS.

FIGURE 3-3
CLASS 1 SAMPLING LOCATIONS
IN B2-166
SU1-B2166

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 2 4

Shaw Environmental & Infrastructure, Inc.
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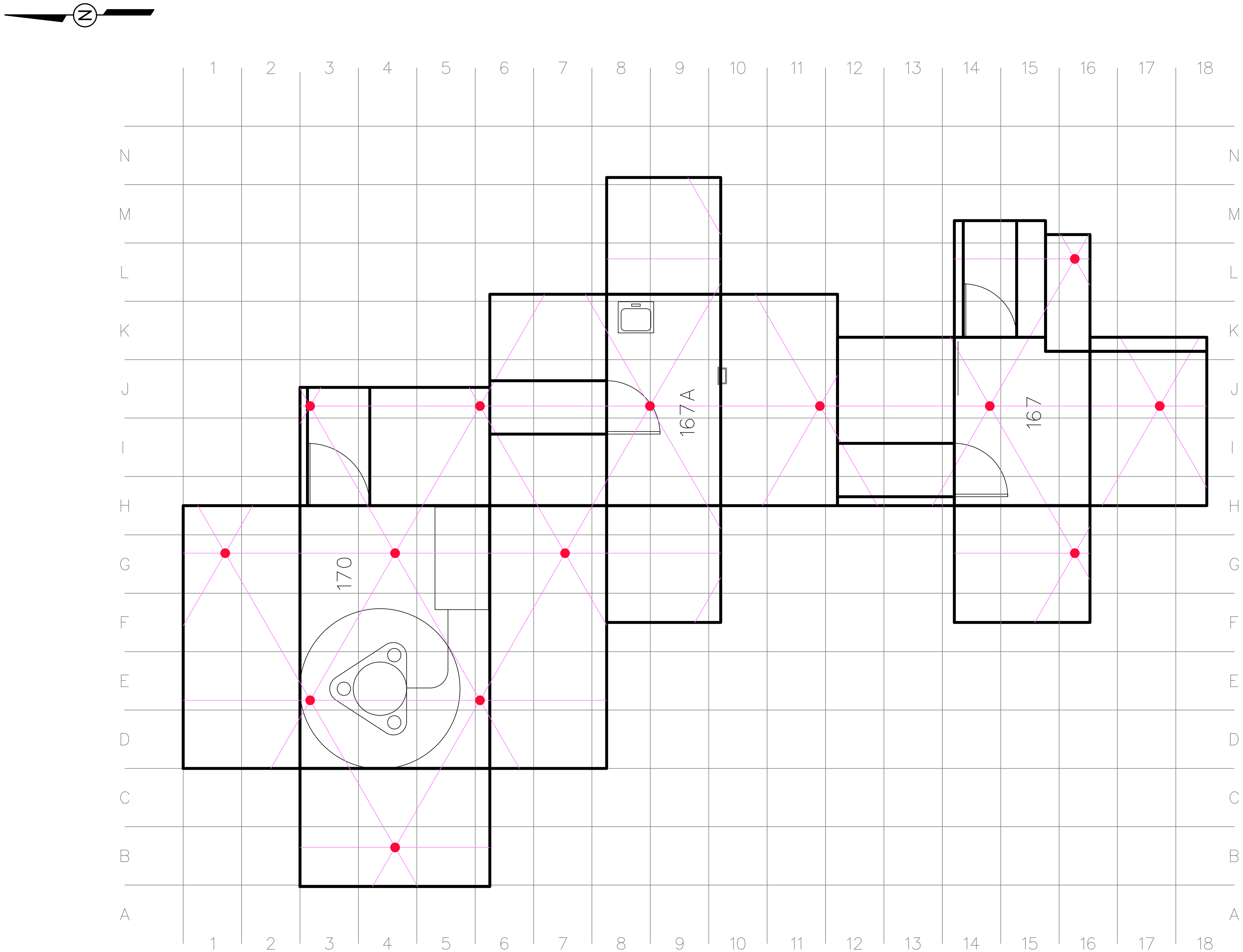

LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 75 SQ. M.
   FLOOR SURFACE AREA: 28 SQ. M.
   TOTAL SURFACE AREA: 103 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 2.91 METERS.

SCALE IN METERS

0 2 4

FIGURE 3-4
CLASS 1 SAMPLING LOCATIONS
IN B2-167, B2-167A, B2-170
SU1-B2AE

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
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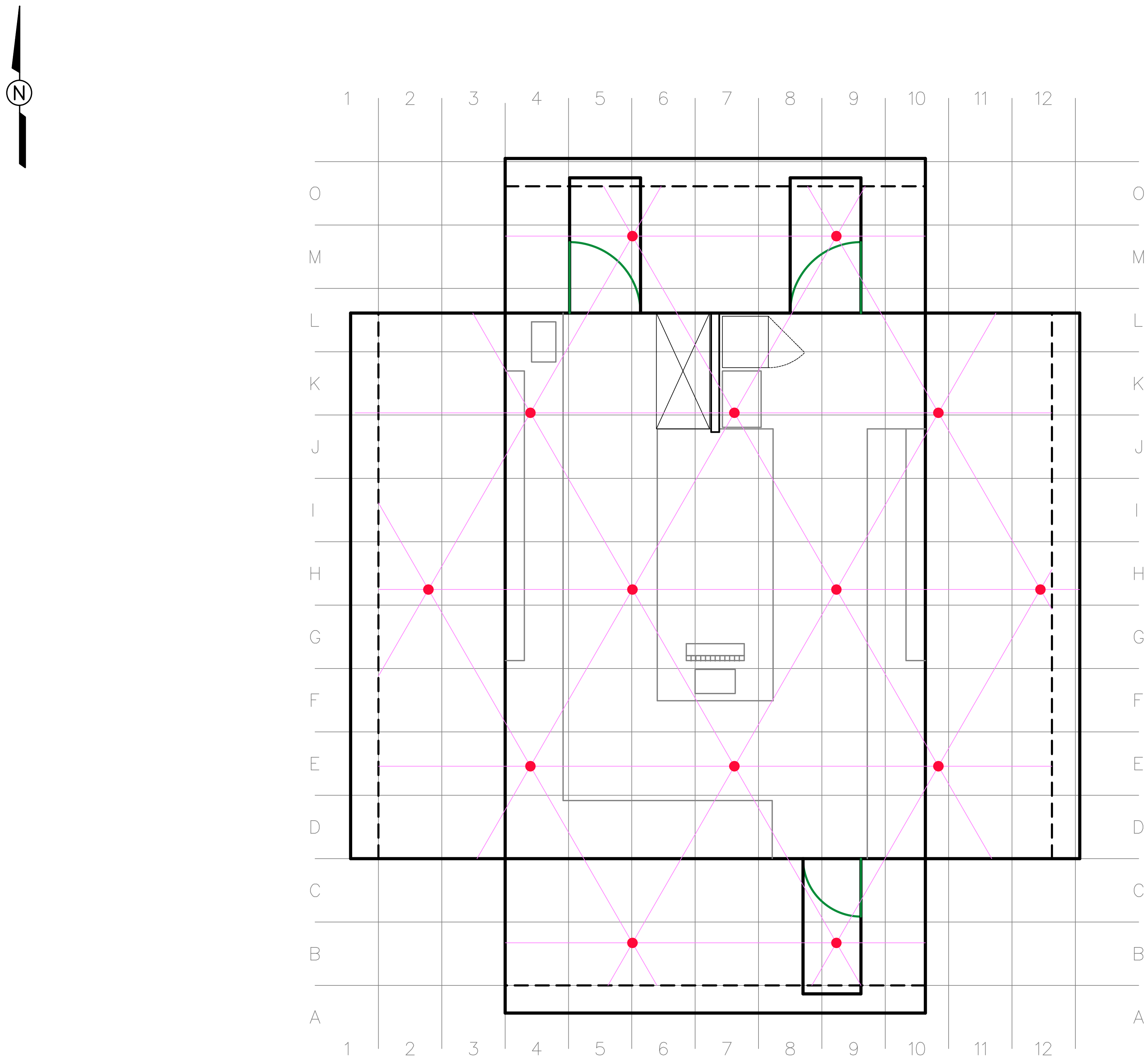

LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 68.5 SQ. M.
   FLOOR SURFACE AREA: 56.87 SQ. M.
   TOTAL SURFACE AREA: 125.37 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 3.22 METERS.

FIGURE 3-5
CLASS 1 SAMPLING LOCATIONS
IN B3-298
SU1-B3298

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 2 4

Shaw Environmental & Infrastructure, Inc.
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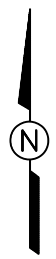
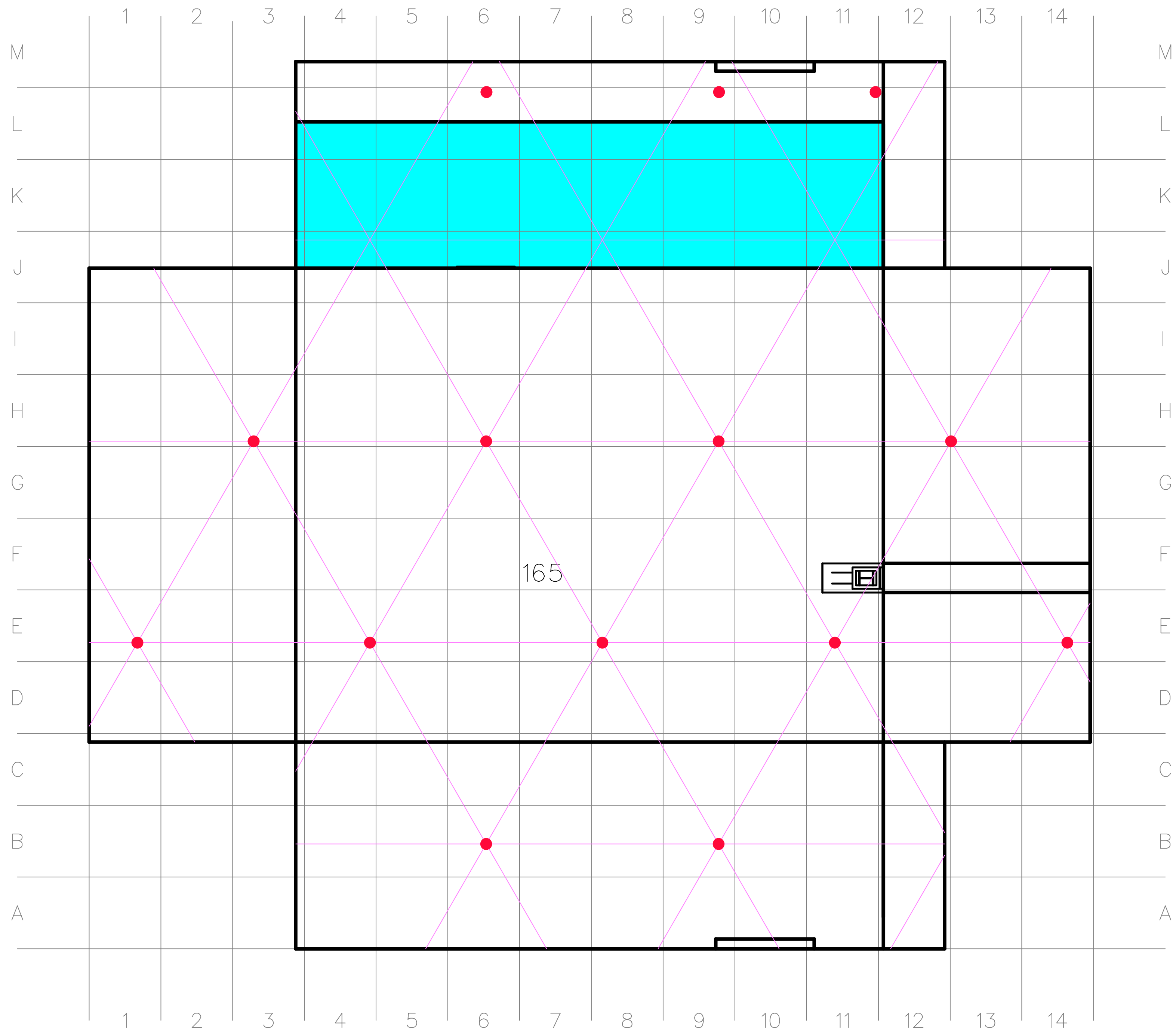




LEGEND:

- SYSTEMATIC SAMPLE LOCATION
- INDICATES OPEN WALL SPACE ABOVE CEILING TILE

NOTES:

1. WALL SURFACE AREA: 73 SQ. M. (ABOVE 2 M)

   CEILING SURFACE AREA: 54 SQ. M.

   TOTAL SURFACE AREA: 127 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 3.24 METERS.
3. CALCULATED AREA EXCLUDES OPEN WALL SPACE.

SCALE IN METERS

0 2 4

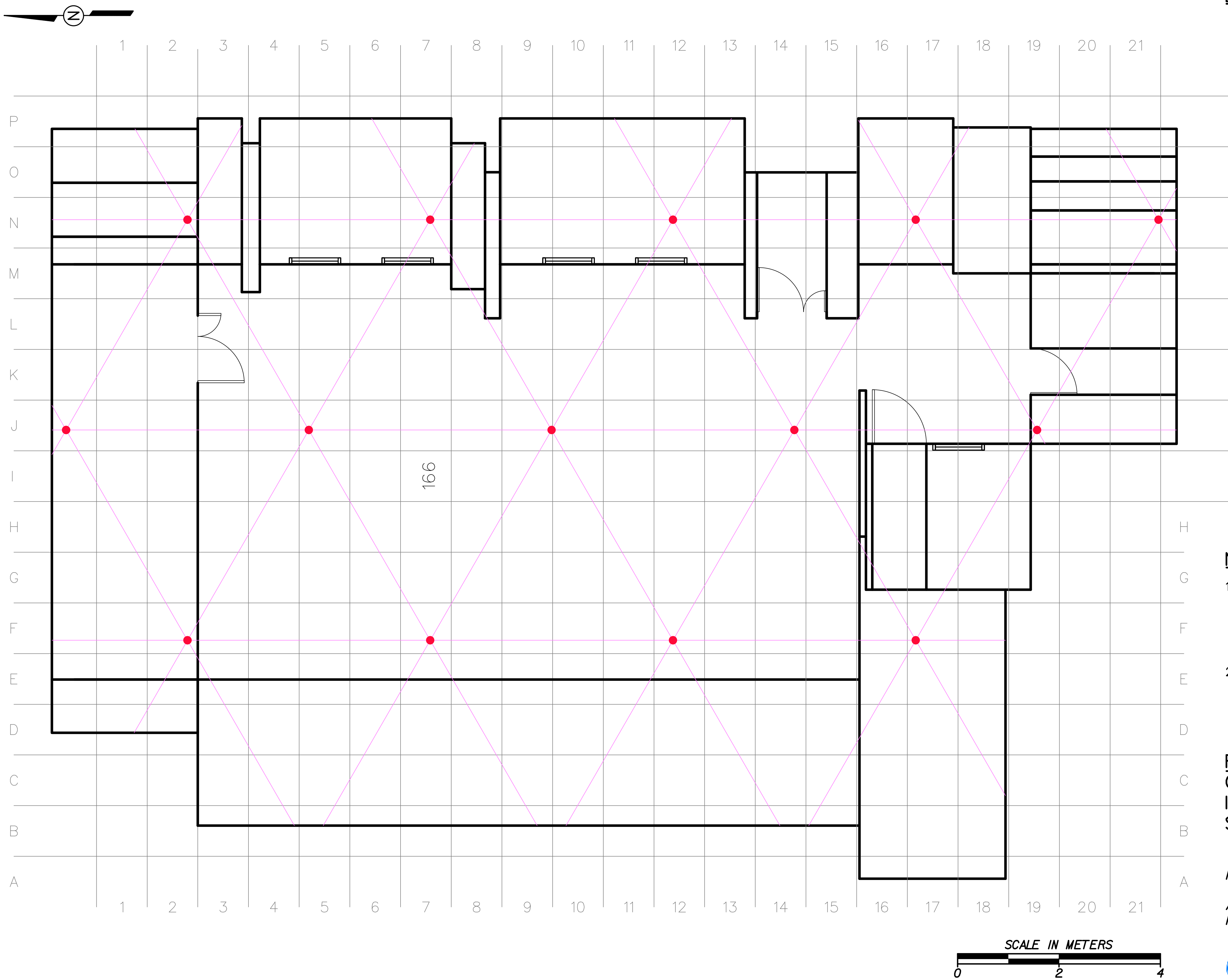
FIGURE 3-6

CLASS 2 SAMPLING LOCATIONS
IN B2-165 OVERHEAD
SU2-B21650

FINAL STATUS SURVEY

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: (ABOVE 2 METERS) 164 SQ. M.

   CEILING SURFACE AREA: 115 SQ. M.

   TOTAL SURFACE AREA: 279 SQ. M.

2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.79 METERS.

FIGURE 3-7
CLASS 2 SAMPLING LOCATIONS IN B2-166 OVERHEAD
SU2-B21660

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

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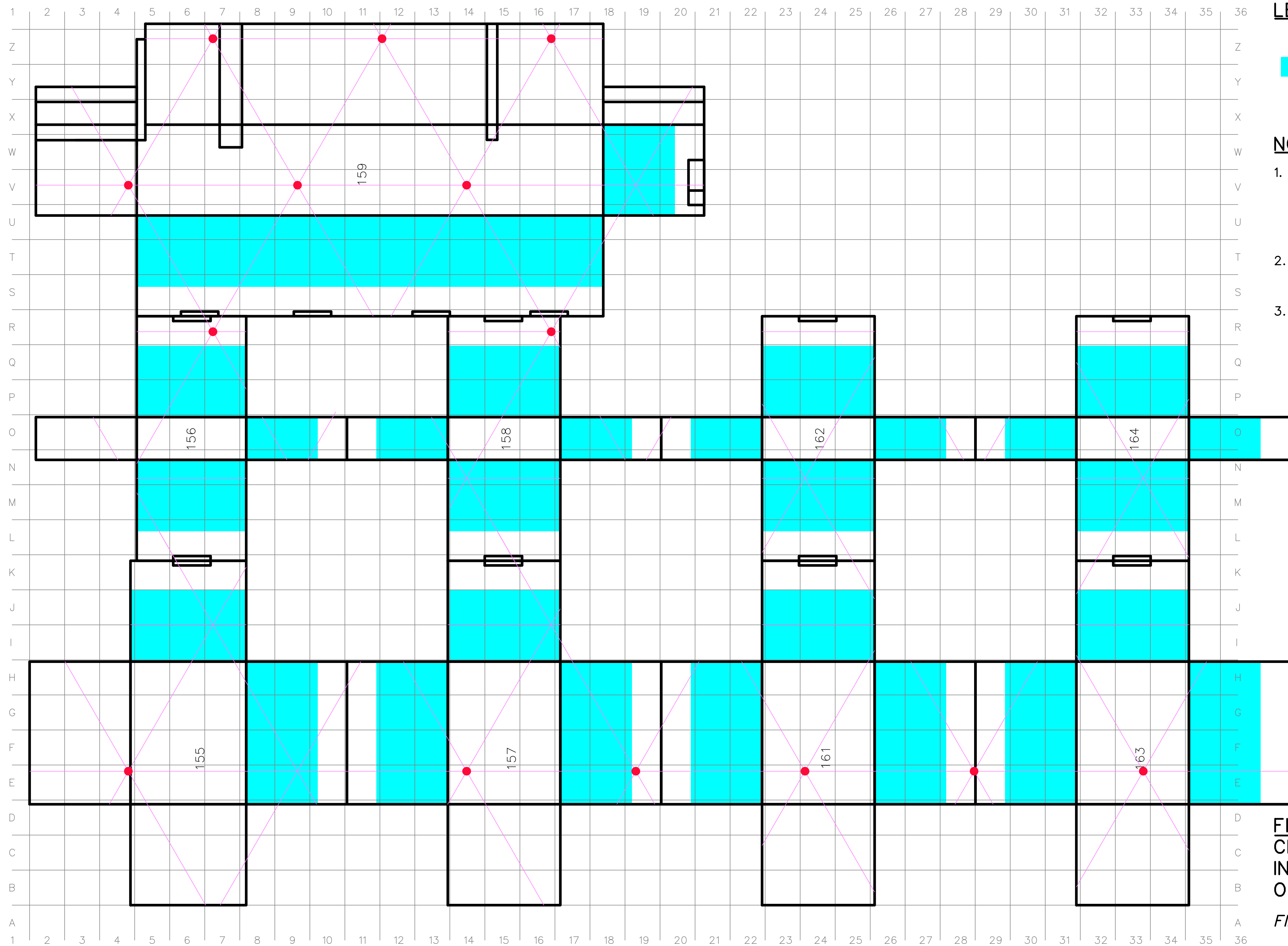

LEGEND:

● SYSTEMATIC SAMPLE LOCATION

INDICATES OPEN WALL SPACE ABOVE CEILING TILE

NOTES:

1. WALL SURFACE AREA: (ABOVE 2 M.) 181 SQ. M.

   CEILING SURFACE AREA: 102 SQ. M.

   TOTAL SURFACE AREA: 283 SQ. M.

2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.83 METERS.

3. CALCULATED AREA EXCLUDES OPEN WALL SPACE.

SCALE IN METERS
0 3 6

FIGURE 3-8
CLASS 2 SAMPLING LOCATIONS
IN B2-155 THROUGH B2-164
OVERHEAD SU2-B2GMPO

FINAL STATUS SURVEY

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

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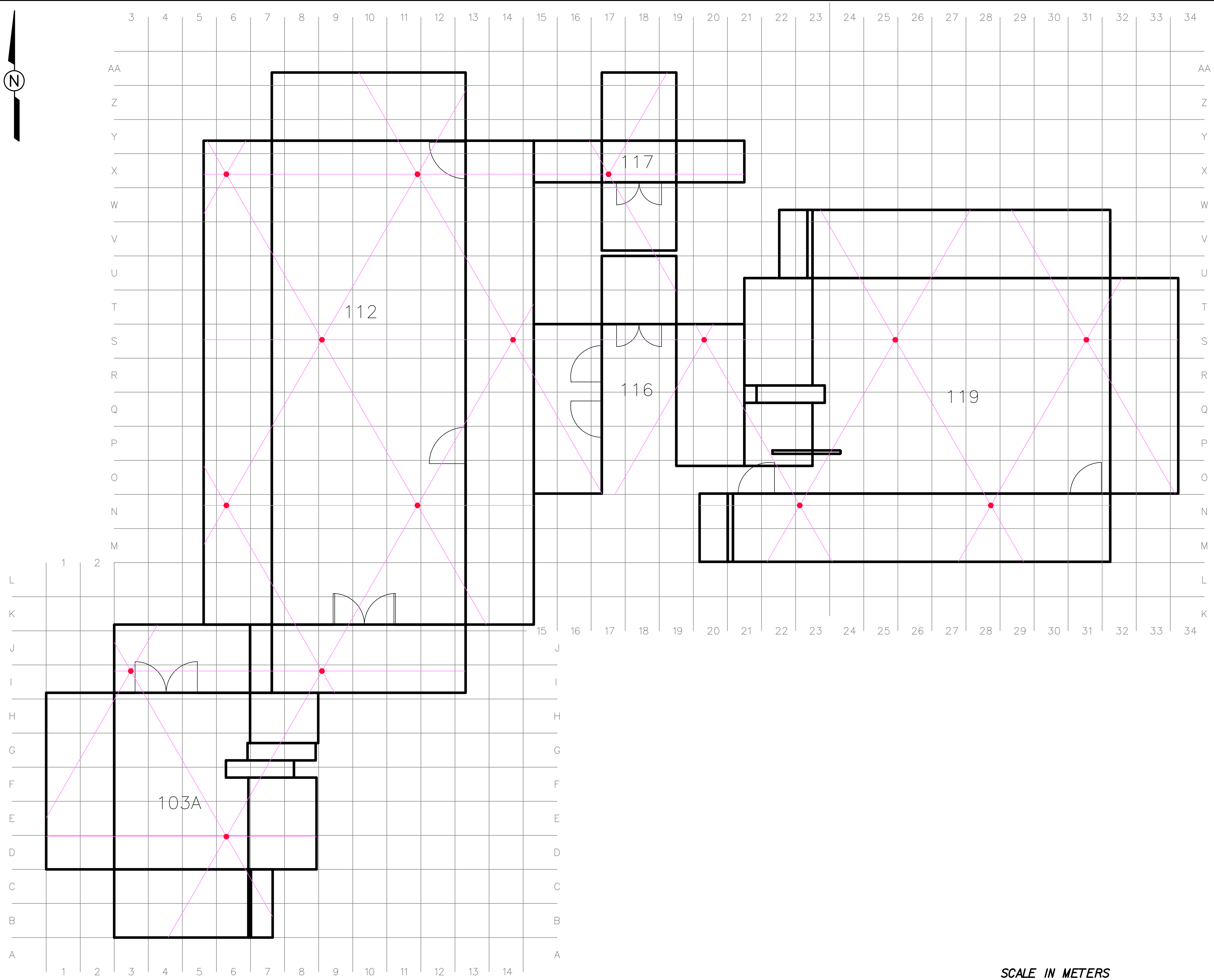

LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 211 SQ. M.
   FLOOR SURFACE AREA: 170 SQ. M.
   TOTAL SURFACE AREA: 381 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 5.61 METERS.

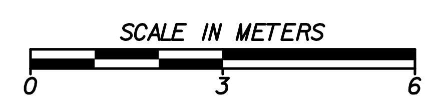

FIGURE 3-9
CLASS 2 SAMPLING LOCATIONS IN B2-103A, B2-112, B2-116, B2-117, AND B2-119
SU2-B2

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
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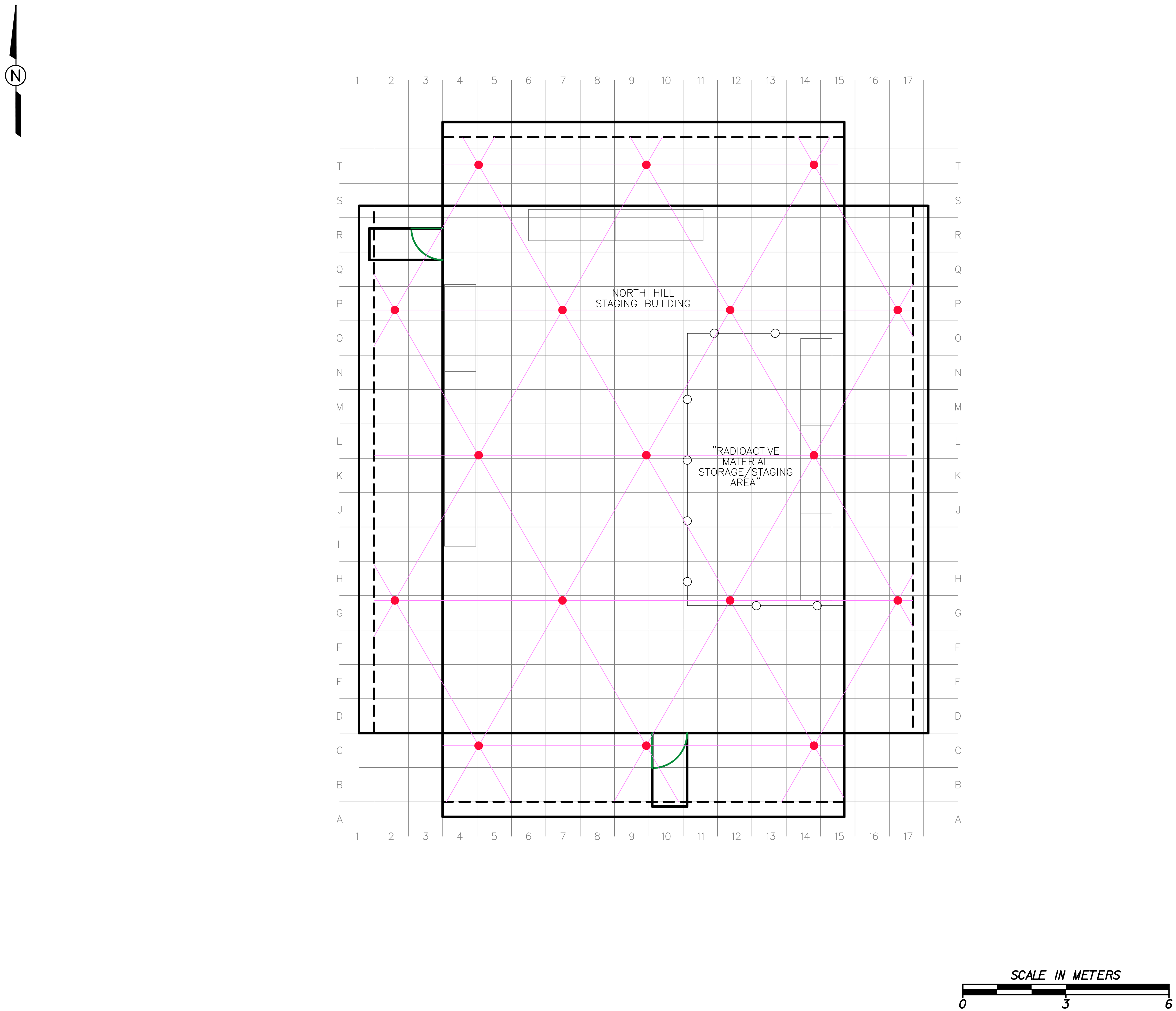

LEGEND:

SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 108.15 SQ. M.
   FLOOR SURFACE AREA: 179.41 SQ. M.
   TOTAL SURFACE AREA: 287.56 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.88 METERS.

FIGURE 3-10
CLASS 2 SAMPLING LOCATIONS
IN NORTH HILL STAGING BUILDING
SU2-HILL

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

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LEGEND:

● RANDOM SAMPLE LOCATION

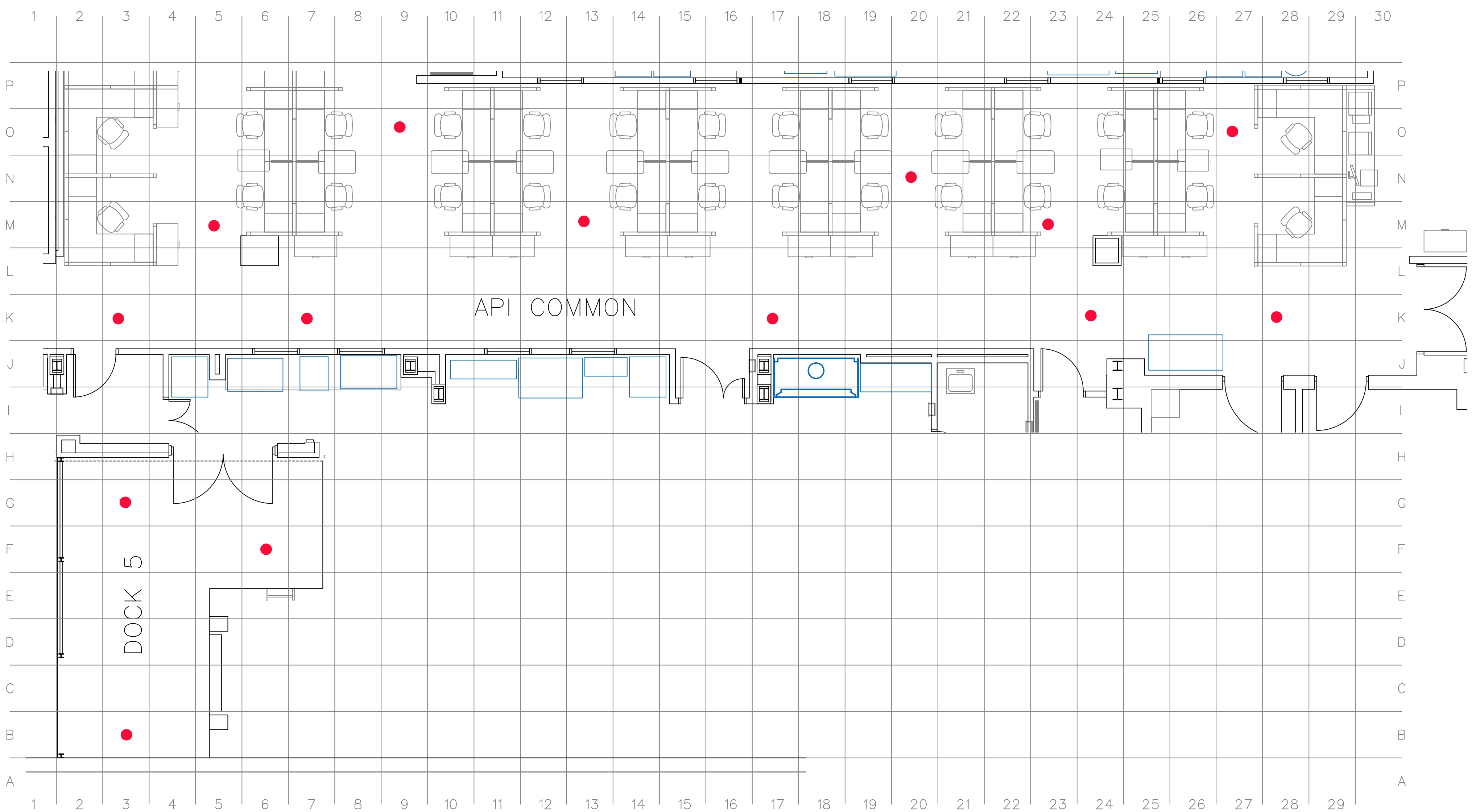

FIGURE 3-11
CLASS 3 SAMPLING LOCATIONS
IN B2 DOCK AND API COMMONS
SU3-B2

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 3 6

Shaw Environmental & Infrastructure, Inc.
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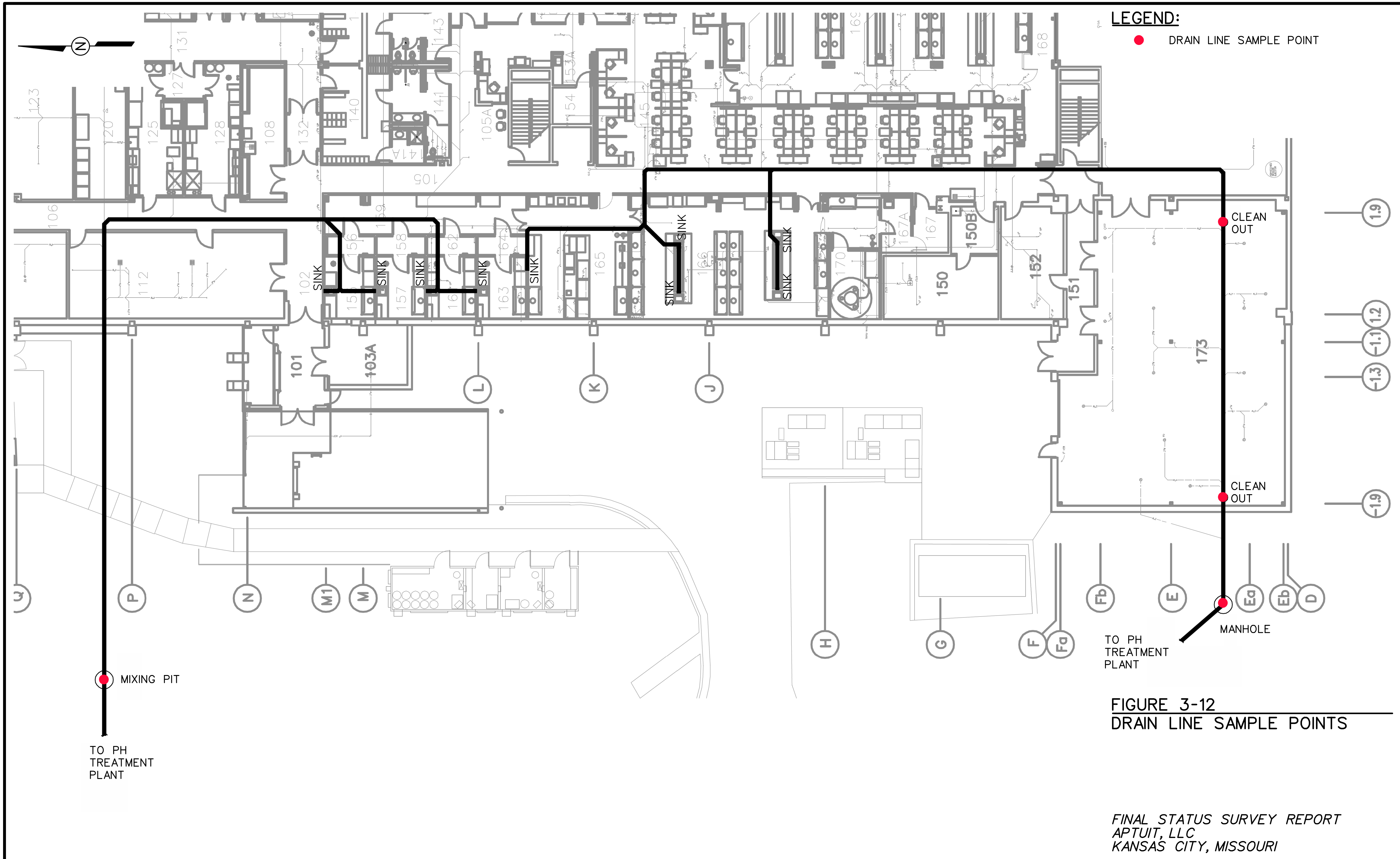

FIGURE 3-12
DRAIN LINE SAMPLE POINTS

FINAL STATUS SURVEY REPORT
APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

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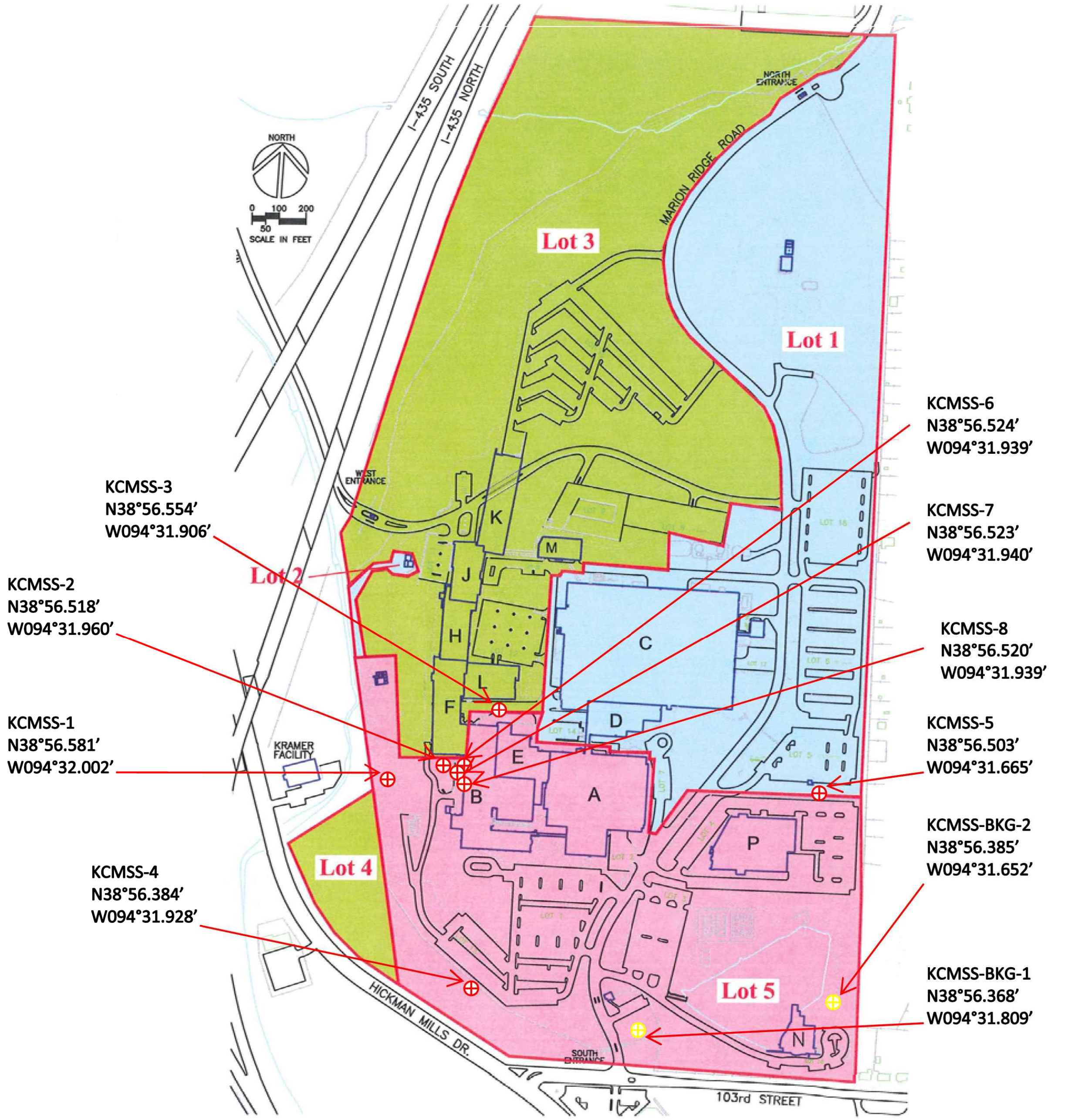

FIGURE 3-13
SURFACE SOIL SAMPLE LOCATIONS

FINAL STATUS SURVEY REPORT
APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

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APPENDIX A

APTUIT RADIOACTIVE MATERIALS LICENSE

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

DEC 19 2013

Mr. Clint Gregg
Radiation Safety Officer
Aptuit, LLC
10245 Hickman Mills Drive
Kansas City, MO 64134-0708

Dear Mr. Gregg:

Enclosed is Amendment No. 37 to your U.S. Nuclear Regulatory Commission (NRC) Material License No. 24-15595-01 in accordance with your request. Changes made to your license are printed in **bold** font. Please review the enclosed document carefully and be sure that you understand all conditions. If there are any errors or questions, please notify the NRC Region III office at (630) 829-9887 so that we may provide appropriate corrections and answers.

Enclosed please also find your decommissioning financial assurance, in the form of a standby letter of credit, dated October 5, 2005, and a standby trust agreement dated October 24, 2013, which we have cancelled, in accordance with your possession limit reduction to levels below those requiring decommissioning financial assurance. We have returned these cancelled instruments for your records. We have also enclosed Amendment Nos. 1 and 2 to your standby letter of credit, dated May 9, 2008, and June 22, 2010, respectively, as they are no longer required.

You will be periodically inspected by NRC. Failure to conduct your program in accordance with NRC regulations, license conditions, and representations made in your license application and supplemental correspondence with NRC will result in enforcement action against you. This could include issuance of a notice of violation, or imposition of a civil penalty, or an order suspending, modifying or revoking your license as specified in the General Statement of Policy and Procedure for NRC Enforcement Actions. Since serious consequences to employees and the public can result from failure to comply with NRC requirements, prompt and vigorous enforcement action will be taken when dealing with licensees who do not achieve the necessary meticulous attention to detail and the high standard of compliance which NRC expects of its licensees.

The NRC's Safety Culture Policy Statement became effective in June 2011. While a policy statement and not a regulation, it sets forth the agency's expectations for individuals and organizations to establish and maintain a positive safety culture. You can access the policy statement and supporting material that may benefit your organization on NRC's safety culture website at http://www.nrc.gov/about-nrc/regulatory/enforcement/safety-culture.html. We strongly encourage you to review this material and adapt it to your particular needs in order to develop and maintain a positive safety culture as you engage in NRC-regulated activities.

In accordance with Title 10 of the *Code of Federal Regulations* Section 2.390, a copy of this letter and its enclosures 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's website at http://www.nrc.gov/reading-rm/adams.html.

Sincerely,

Patricia J. Pelke, Chief
Materials Licensing Branch
Division of Nuclear Materials Safety

License No. 24-15595-01
Docket No. 030-09415

Enclosures:
1. Amendment No. 37
2. Standby letter of credit, dated October 5, 2005
3. Standby trust agreement, dated October 24, 2013
4. Amendment No. 1 to standby letter of credit, dated May 9, 2008
5. Amendment No. 2 to standby letter of credit, dated June 22, 2010

U.S. NUCLEAR REGULATORY COMMISSION

Amendment No. 37

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, 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	In accordance with letter dated **October 3, 2013**,
1. Aptuit, LLC	3. License number 24-15595-01 is amended in its entirety to read as follows:
2. 10245 Hickman Mills Drive Kansas City, MO 64134-0708	4. Expiration date September 30, 2014
	5. Docket No. 030-09415 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. Hydrogen-3	A. Any	A. **50 millicuries**
B. Carbon-14	B. Any	B. **60 millicuries**
C. Barium-133	C. Sealed Source (Model No. IND 1401)	C. 20 millicuries
D. Cesium-137	D. Sealed Source	D. 90 microcuries

9. Authorized use:

A. through B. Uses as described in February 28, 2013, Decommissioning Plan (ADAMS Accession No. ML13053A398) and associated supporting documents noted in the August 27, 2013, Aptuit, LLC Decommissioning Plan SER (ADAMS Accession No. ML13247A779).

E. To be used in a Perkin Elmer Tricarb 2900TR liquid scintillation counter.

F. To be used in a Beckman Model 100C, 3801, or 6500 or equivalent liquid scintillation counter.

CONDITIONS

10. Licensed material shall be used only at the licensee's facilities located at 10245 Hickman Mills Drive, Kansas City, Missouri.

11. The Radiation Safety Officer **(RSO)** for this license is Clint Gregg.

12. Licensed material listed in Item 6 above is only authorized for use by, or under the supervision of, Clint Gregg.

13. The licensee shall not use licensed material in or on human beings except as provided otherwise by specific condition of this license.

MATERIALS LICENSE SUPPLEMENTARY SHEET	License Number 24-15595-01
	Docket or Reference Number 030-09415
	Amendment No. 37

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

15. A. Sealed sources shall be tested for leakage and/or contamination at intervals not to exceed the intervals specified in the certificate of registration issued by the U.S. Nuclear Regulatory Commission under 10 CFR 32.210 or under equivalent regulations of an Agreement State.

B. In the absence of a certificate from a transferor indicating that a leak test has been made within the intervals specified in the certificate of registration issued by the U.S. Nuclear Regulatory Commission under 10 CFR 32.210 or under equivalent regulations of an Agreement State, prior to the transfer, a sealed source received from another person shall not be put into use until tested and the test results received.

C. Sealed sources need not be tested if they contain only hydrogen-3; or they contain only a radioactive gas; or the half-life of the isotope is 30 days or less; or they contain not more than 100 microcuries of beta- and/or gamma-emitting material or not more than 10 microcuries of alpha-emitting material.

D. Sealed sources need not be tested if they are in storage and are not being used; however, when they are removed from storage for use or transferred to another person and have not been tested within the required leak test interval, they shall be tested before use or transfer. No sealed source shall be stored for a period of more than 10 years without being tested for leakage and/or contamination.

E. The leak test shall be capable of detecting the presence of 0.005 microcurie (185 becquerels) of radioactive material on the test sample. If the test reveals the presence of 0.005 microcurie (185 becquerels) or more of removable contamination, a report shall be filed with the U.S. Nuclear Regulatory Commission in accordance with 10 CFR 30.50(c)(2), and the source shall be removed immediately from service and decontaminated, repaired, or disposed of in accordance with Commission regulations.

F. Tests for leakage and/or contamination, including leak test sample collection and analysis, shall be performed by the licensee or by other persons specifically licensed by the U.S. Nuclear Regulatory Commission or an Agreement State to perform such services.

G. Records of leak test results shall be kept in units of microcuries and shall be maintained for three years.

16. 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.

MATERIALS LICENSE **SUPPLEMENTARY SHEET**	License Number 24-15595-01
	Docket or Reference Number 030-09415
	Amendment No. 37

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.

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

18. 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. This license condition applies only to those procedures that are required to be submitted in accordance with the regulations. The U.S. 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. Applications dated October 25, 2007 (limited to the change in the RSO and Attachment 5, "Facility Diagrams."), and April 1, 2008; and

B. Letters dated April 7, 2008, February 2, 2009, June 8, 2009, July 2, 2009, March 29, 2010, May 21, 2010, June 2, 2010, October 8, 2010, January 21, 2011, October 20, 2011, November 2, 2012, February 20, 2013 (two letters referenced in ADAMS Accession Nos. ML13052A443 and ML13053A402), February 28, 2013 (including Decommissioning Plan referenced in ADAMS Accession No. ML13053A398), May 16, 2013, July 19, 2013 (including ADAMS Accession No. ML13204A418 and Safety Evaluation Report, ADAMS Accession No. ML13247A779), **October 3, 2013**, **December 4, 2013**, and **December 6, 2013**.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Date DEC 19 2013

By Cassandra F. Frazier
Materials Licensing Branch
Region III

APPENDIX B

SURVEY UNIT SUMMARY REPORTS

Aptuit

Final Status Survey Summary Report

Survey Unit: SU1-B2-165

API Laboratory

Prepared By:__________________________ **Date:** 3/11/14

Reviewed By:__________________________ **Date:** 3/18/14

Site Supervisor

Reviewed By: Rick Greene **Date:** 3/18/14

Project CHP

Approved By: Clinton Meggs **Date:** 3/18/14

Radiation Safety Officer

FINAL STATUS SURVEY SUMMARY REPORT

Survey Unit:

SU1 – B2-165
API Laboratory

Survey Unit Description:

This Class 1 survey unit is a laboratory which served as the radioanalytical QC lab. All materials and equipment in the B2 API labs were considered to be potentially contaminated.

Radionuclides of Concern:

Tritium (H-3) and C-14

Survey Unit Design Information:

The Survey Unit Design Parameters are presented below. Survey Unit details are presented in Table 1. The survey unit measurement locations are depicted on the map in Attachment 1. Fourteen direct measurement locations were needed to meet the design requirements of the statistical test. Scan coverage is required to be 100% of the impacted area. The survey design calls for wipe samples to be collected at each direct measurement location because of the lack of a reliable means to measure H-3 directly. Wipe samples are to be analyzed for H-3 and C-14 by liquid scintillation counter (LSC). The instruments to be used for the survey along with the minimum detectable concentration (MDC) values are listed in Attachment 2.

1. Scenario A is used. The null hypothesis for Scenario A is - “The residual radioactivity in the survey unit exceeds the release criterion.”
2. The statistical test used in survey design was the Sign test. An average background will be subtracted from each measurement.
3. The derived concentration guideline level over a wide area ($DCGL_w$) for total activity was 10 percent of the NRC screening value for C-14, or 3.7E+05 dpm/100 cm^2.
4. The $DCGL_w$ for removable activity (H-3 plus C-14) was set at 10 percent of the $DCGL_w$ for fixed activity, or 3.7E+04 dpm/100 cm^2.
5. Characterization had not been completed at the time the final status survey (FSS) was planned therefore the average and standard deviation of the contamination in the survey unit was based on reasonable estimates. The characterization survey (CS) was designed to meet the data quality objectives (DQOs) of the FSS.
    a. Lower bound of the gray region (LBGR) was set at 50% of the $DCGL_w$ or, 1.85E5 dpm/100 cm^2.

b. The standard deviation, σ, was assumed to be 30%[1]. 1.85E5 X 0.3 = 5.55E4 dpm/100 cm^2.

c. The relative shift (Δ/σ): $\Delta/\sigma = (DCGL_w - LBGR)/\sigma$

Δ/σ = (3.7E5 – 1.85E5)/5.55E4 = 3.3

d. A relative shift of 3 was used in survey planning since the calculated value was >3 (ref MARSSIM Chapter 5)[2].

6. The Type I (α) and Type II (β) decision errors were each set at 0.05. For $\alpha=\beta=0.05$ and a relative shift of 3, the number of samples (n) required for each survey unit (from Table 5.5 of MARSSIM) for the Sign test is 14 (including a 20% contingency). Therefore at least 14 measurements were made in this survey unit to meet the requirements of the statistical tests.

---

[1] Abelquist, Decommissioning Health Physics, (Bristol UK, Institute of Physics Publishing), 272.

[2] *Multi-Agency Radiation Survey and Site Investigation Manual*, Rev. 1, August 2000, 5-32. Characterization surveys were performed in combination with the FSS. The relative shift from characterization data was Δ/σ = (3.7E5 – 3,296)/7,868 = 46.61 thus confirming FSS planning assumptions (see Table 2-4).

Table 1. Survey Unit Details

Survey Unit: SU1-B2165

Final Status Survey Design Detail	Value	Comments
Survey Unit:	SU1-B2165	
Areas in Survey Unit:	B2-165	
Survey Class:	1	
SU Floor Area (m^2):	54	
SU Total Area (m^2):	116	Class 1 and 2 includes walls up to 2 m and floor. Class 3 includes only floors.
DCGL for C-14 ($dpm/100cm^2$):	370,000	Total Activity DCGL
DCGL for H-3/C-14 ($dpm/100cm^2$):	37,000	Removable H-3 + C-14
Number of Measurements Required:	14	
Survey Pattern:	Random start systematic on triangular grid	
Scan Coverage Required (%):	100%	
Triangular Grid Spacing L:	3.10	
Height of Triangle H:	2.68	

Final Status Survey Results:

A total of 14 direct measurements and smears were made in SU1 – B2-165 as part of the FSS. The results are shown in Table 2-1. Statistical data including the mean, median, and standard deviation are shown in Table 2-2. All of the direct measurements were less than the $DCGL_w$. All of the wipe sample results were less than the $DCGL_w$ and the sum of fractions for the combined measurements was less than 1. The FSS QC results are summarized in Table 2-3.

Characterization Survey Results:

The CS was designed to meet the DQOs of the FSS and was performed concurrently with the FSS. A summary of CS results is presented in Table 2-4. The CS results confirm: 1) the survey unit was properly classified 2) the assumptions used in FSS survey planning were valid.

Scan surveys were performed as part of the CS and the FSS. Several scan locations were identified as areas of elevated activity. The scan results are shown in Table 2-5.

Table 2-1. Measurement Results (Directs for C-14 & Wipes for H-3 and C-14)

Survey Unit: SU1-B2165

Sample ID	Instrument ID	C-14 Direct				C-14 & H-3 Wipes (LSC S/N DG12061925)						Sum of Fractions
		Gross CPM	Background CPM	Net DPM (dpm/100 cm^2)	Comments [1]	H-3 CPM	H-3 DPM	C-14 CPM	C-14 DPM	H-3 + C-14 DPM	Comments [1]	
2	237279	296	216	668		0	0	5	7	7		1.99E-03
3	237279	235	325	-748		7	13	13	16	29		-1.24E-03
4	237279	269	325	-464		0	0	0	0	0		-1.25E-03
5	237279	257	325	-564	R	0	0	14	18	18	R	-1.04E-03
6	237279	647	216	3600		8	10	25	29	39		1.08E-02
7	237279	347	325	188		8	17	7	7	24		1.16E-03
8	237279	273	325	-430		3	0	18	22	22		-5.68E-04
9	237279	219	325	-881		6	15	3	4	19		-1.87E-03
10	237279	334	216	985		0	1	0	0	1		2.69E-03
11	237279	268	325	-472		1	1	6	8	9		-1.03E-03
12	237279	636	325	2602		3	6	5	5	11		7.33E-03
13	237279	282	216	551		5	11	6	7	18		1.97E-03
14	237279	367	208	1327		5	11	3	3	14		3.96E-03
15	237279	349	216	1110		0	0	0	0	0		3.00E-03
16	237279	300	216	701		4	7	9	10	17		2.35E-03

[1] Indicate Replicates (R) in the "Comments" column

Result > 0.1 DCGL

Result > 0.5 DCGL

Result > DCGL

Table 2-2. Final Status Results Summary

Survey Unit: SU1-B2165

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	624			15		
Median	609			16		
Standard Deviation	1285			11		
Total Activity Range (Direct)	-881	to	3600	N/A		
Removable Activity Range (Wipes)	0	to	29	0	to	39
Mean SOF	2.09E-03					
Number of FSS Systematic/Random Measurements	14			14		

Table 2-3. FSS QC Results Summary

Survey Unit: SU1-B2165

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	11	1	63.79	23
C-14	10	30	1	95.72	23

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}\ d$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
269	257	0.05

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	0	0	N/A	RPD not relavent when result is less than MDC
C-14	0	18	2.00	RPD not relavent when result is less than MDC

Bias

$$relative\ \ bias = \frac{measured\ \ result\ - expected\ \ result}{expected\ \ result}$$

H-3 spike value = 4174 dpm
C-14 spike value= 4354 dpm

H-3 spike	H-3 result	Relative bias (±0.2)
4174	3616	-0.13368

C-14 spike	C-14 result	Relative bias (±0.2)
4354	4347	-0.00161

Table 2-4. Characterization Survey Results Summary

Survey Unit: SU1-B2165

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	3296			42		
Median	801			21		
Standard Deviation	7868			48		
Total Activity Range (Direct)	-1015	to	49862	N/A		
Removable Activity Range (Wipes)	0	to	158	0	to	220
Number of Characterization Survey Measurements	53			53		

Table 2-5. Scan Survey Results

Survey Unit: SU1-B2165

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
116	116	100%

Location Number	Grid	Range (cpm)		
Scans performed with 43-68				
2	D2	300	to	400
3	D5	200	to	300
4	D8	300	to	400
6	D11	300	to	800
7	G10	250	to	400
8	G7	200	to	350
9	G3	175	to	350
10	I2	200	to	400
11	I5	250	to	450
12	I8	250	to	500
13	I11	220	to	400
14	L10	280	to	500
15	L7	180	to	350
16	L3	220	to	300
17	H4	200	to	800
18	D3	250	to	850
19	D4	200	to	700
20	I9	300	to	400
21	K11	250	to	500
Char-001	B2	180	to	380
Char-002	B3	200	to	320
Char-003	B4	160	to	220
Char-004	B5	180	to	600
Char-005	B6	220	to	600
Char-006	B7	200	to	480
Char-007	B8	180	to	360
Char-008	B9	200	to	2400
Char-009	B10	180	to	300
Char-010	B11	180	to	400
Char-011	C3	200	to	520
Char-012	C4	160	to	320
Char-013	C5	220	to	360
Char-014	C6	180	to	300
Char-015	C7	180	to	320
Char-016	C8	160	to	280
Char-017	C9	200	to	800
Char-018	C10	180	to	360
Char-019	C11	160	to	420

Table 2-5. Scan Survey Results

Survey Unit: **SU1-B2165**

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
116	116	100%

Location Number	Grid	Range (cpm)		
Char-020	D1	150	to	380
Char-021	D2	250	to	360
Char-022	D11	200	to	360
Char-023	D12	200	to	600
Char-024	D13	180	to	320
Char-025	E1	150	to	800
Char-026	E2	200	to	350
Char-027	E11	290	to	340
Char-028	E12	200	to	1000
Char-029	E13	180	to	320
Char-030	L3	180	to	300
Char-031	L4	200	to	340
Char-032	L5	150	to	350
Char-033	L6	225	to	350
Char-034	L7	160	to	400
Char-035	L8	125	to	350
Char-036	L9	200	to	600
Char-037	L10	200	to	425
Char-038	L11	250	to	350
Char-039	J11	275	to	350
Char-040	J12	250	to	800
Char-041	J13	350	to	475
Char-042	F1	200	to	460
Char-043	F2	200	to	375
Char-044	F11	200	to	380
Char-045	F12	160	to	1500
Char-046	F13	250	to	300
Char-047	G1	150	to	350
Char-048	G2	220	to	380
Char-049	G11	200	to	300
Char-050	G12	250	to	600
Char-051	G13	150	to	300
Char-052	H1	160	to	380
Char-053	H2	150	to	600
Char-054	H11	200	to	350
Char-055	H12	250	to	475
Char-056	H13	350	to	475
Char-057	I1	225	to	400
Char-058	I2	240	to	375

Table 2-5. Scan Survey Results

Survey Unit: **SU1-B2165**

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
116	116	100%

Location Number	Grid	Range (cpm)		
Char-059	I11	250	to	550
Char-060	I12	250	to	600
Char-061	I13	175	to	300
Char-062	J3	250	to	350
Char-063	J4	200	to	300
Char-064	J5	125	to	275
Char-065	J6	175	to	300
Char-066	J7	150	to	300
Char-067	J8	175	to	300
Char-068	J9	125	to	320
Char-069	J10	200	to	300
Char-070	J11	150	to	250
Char-071	K3	175	to	350
Char-072	K4	225	to	325
Char-073	K5	225	to	600
Char-074	K6	150	to	500
Char-075	K7	150	to	450
Char-076	K8	250	to	400
Char-077	K9	225	to	1200
Char-078	K10	250	to	600
Char-079	K11	250	to	1000
Char-080	J1	250	to	450
Char-081	J2	225	to	400
Scans performed with 43-37				
Char-082	O3-J3	400	to	3800
Char-083	O4-J4	400	to	2200
Char-084	O5-J5	400	to	1000
Char-085	O6-J6	400	to	1000
Char-086	O7-J7	400	to	1000
Char-087	O8-J8	400	to	1000
Char-088	O9-J9	400	to	1200
Char-089	O10-J10	400	to	1000

Exceeds 2x Background

Survey Unit Data Assessment:

The survey design required 14 direct measurements and wipe samples for the Sign Test. Fourteen measurements were performed. All measurements and wipe sample results were less than the $DCGL_w$ and the sum of fractions was less than 1; therefore the survey unit meets the release criterion and the Sign test was not performed.

Survey Unit Investigations and Results:

During the scans, several areas were identified as being above twice materials background for scanning. Decontamination in these areas, via chipping up small sections of the floor, resulted in some reduction of activity consistent with ALARA goals. Some of these areas remain above twice materials background for scanning. However, because the activity represented only a fraction of the DCGLw, and was fixed, it was determined that further decontamination activities were unnecessary.

ALARA Statement:

The residual activity within the survey unit is less than the $DCGL_w$ and has been reduced to levels that are ALARA; therefore the ALARA criterion has been met.

Changes in Initial Survey Unit Assumptions:

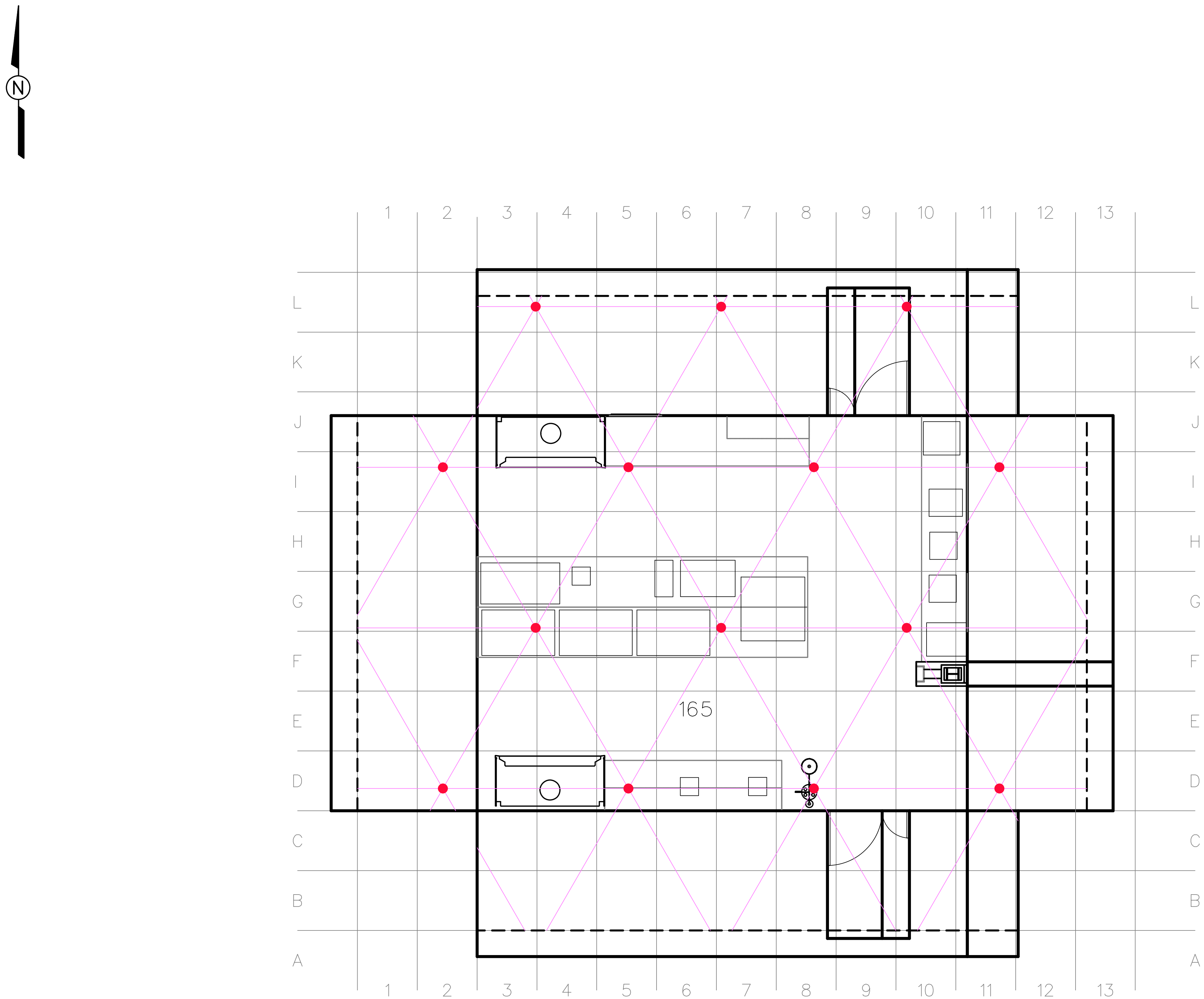
The survey unit was designed as a Class 1 building survey and the sample results are consistent with that classification. The variability of the survey results was less than the assumptions used in survey design, therefore characterization survey results confirm the FSS design.

Conclusion:

The FSS of this survey unit was properly designed as a Class 1 survey based on the decommissioning plan (DP). The required number of direct measurements was made and the scan coverage met the requirement of DP. All of the direct measurements were less than the $DCGL_w$. All identified elevated scans were appropriately investigated.

The measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

It is concluded that survey unit SU1 – B2-165 meets the release criteria of 10CFR20.1402.



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 62 SQ. M.
   FLOOR SURFACE AREA: 54 SQ. M.
   TOTAL SURFACE AREA: 116 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 3.10 METERS.

SCALE IN METERS
0 2 4

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS
IN B2-165
SU1-B2165

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

aptuit_api_fssr_temp004.dgn sammccawley 1/10/2014 3:27:33 PM PDF_with_Levels.plt sei_textsub_only.tbl

Attachment 2:
Instrumentation Used for Final Status Survey

	Removable Activity	Total Activity/Scans	
Instrument	Perkin Elmer TriCarb 2900TR	2360 S/N: 237279 43-68 S/N: PR190298	2360 S/N: 227437 43-37 S/N: PR216990
Source Type	H-3/C-14	C-14	C-14
Source Strength in dpm	H-3: 271800 C-14: 129000	48343	48343
Efficiency	H-3: 63.79 C-14: 95.72	0.10	0.07
MDC in dpm/100cm^2	H-3: 23 C-14: 23	615	291
Background in cpm	H-3: 11 C-14: 30	230	617

Aptuit

Final Status Survey Summary Report

Survey Unit: SU2-B2-165O

API Laboratory

(walls above 2m and ceiling)

Prepared By:____________________________ **Date:** 3/11/14

Reviewed By:____________________________ **Date:** 3/18/14

Site Supervisor

Reviewed By: Rick Greene **Date:** 3/18/14

Project CHP

Approved By: Clinton Meggs **Date:** 3/18/14

Radiation Safety Officer

FINAL STATUS SURVEY SUMMARY REPORT

Survey Unit:

SU2 – B2-165O
API Laboratory

Survey Unit Description:

This Class 2 survey unit consists of the walls above 2 meters and ceiling in a laboratory which served as the radioanalytical QC lab. All materials and equipment in the B2 API labs were considered to be potentially contaminated.

Radionuclides of Concern:

Tritium (H-3) and C-14

Survey Unit Design Information:

The Survey Unit Design Parameters are presented below. Survey Unit details are presented in Table 1. The survey unit measurement locations are depicted on the map in Attachment 1. Fourteen direct measurement locations were needed to meet the design requirements of the statistical test. Scan coverage is required to be 10 to 100% of the impacted area. The survey design calls for wipe samples to be collected at each direct measurement location because of the lack of a reliable means to measure H-3 directly. Wipe samples are to be analyzed for H-3 and C-14 by liquid scintillation counter (LSC). The instruments to be used for the survey along with the minimum detectable concentration (MDC) values are listed in Attachment 2.

1. Scenario A is used. The null hypothesis for Scenario A is - “The residual radioactivity in the survey unit exceeds the release criterion.”
2. The statistical test used in survey design was the Sign test. An average background will be subtracted from each measurement.
3. The derived concentration guideline level over a wide area ($DCGL_w$) for total activity was 10 percent of the NRC screening value for C-14, or 3.7E+05 dpm/100 cm^2.
4. The $DCGL_w$ for removable activity (H-3 plus C-14) was set at 10 percent of the $DCGL_w$ for fixed activity, or 3.7E+04 dpm/100 cm^2.
5. Characterization had not been completed at the time the final status survey (FSS) was planned therefore the average and standard deviation of the contamination in the survey unit was based on reasonable estimates. The characterization survey (CS) was designed to meet the data quality objectives (DQOs) of the FSS.
    a. Lower bound of the gray region (LBGR) was set at 50% of the $DCGL_w$ or, 1.85E5 dpm/100 cm^2.

b. The standard deviation, σ, was assumed to be 30%[1]. 1.85E5 X 0.3 = 5.55E4 dpm/100 cm^2.

c. The relative shift (Δ/σ): $\Delta/\sigma = (DCGL_w - LBGR)/\sigma$

   Δ/σ = (3.7E5 – 1.85E5)/5.55E4 = 3.3

d. A relative shift of 3 was used in survey planning since the calculated value was >3 (ref MARSSIM Chapter 5).

6. The Type I (α) and Type II (β) decision errors were each set at 0.05. For $\alpha=\beta=0.05$ and a relative shift of 3, the number of samples (n) required for each survey unit (from Table 5.5 of MARSSIM) for the Sign test is 14 (including a 20% contingency). Therefore at least 14 measurements were made in this survey unit to meet the requirements of the statistical tests.

[1] Abelquist, Decommissioning Health Physics, (Bristol UK, Institute of Physics Publishing), 272.

Table 1. Survey Unit Details

Survey Unit: SU2-B2165O

Final Status Survey Design Detail	Value	Comments
Survey Unit:	SU2-B2165O	
Areas in Survey Unit:	B2-165 Overhead	
Survey Class:	2	
SU Floor Area (m^2):	54	
SU Total Area (m^2):	127	This Class 2 survey unit includes walls above 2 m and ceiling.
DCGL for C-14 (dpm/100cm^2):	370,000	Total Activity DCGL
DCGL for H-3/C-14 (dpm/100cm^2):	37,000	Removable H-3 + C-14
Number of Measurements Required:	14	
Survey Pattern:	Random start systematic on triangular grid	
Scan Coverage Required (%):	10% to 50%	
Triangular Grid Spacing L:	3.24	
Height of Triangle H:	2.80	

Final Status Survey Results:

A total of 14 direct measurements and smears were made in SU2 – B2-165O as part of the FSS. The results are shown in Table 2-1. Statistical data including the mean, median, and standard deviation are shown in Table 2-2. All of the direct measurements were less than the $DCGL_w$. All of the wipe sample results were less than the $DCGL_w$ and the sum of fractions for the combined measurements was less than 1. The FSS QC results are summarized in Table 2-3.

Characterization Survey Results:

The CS was designed to meet the DQOs of the FSS and was performed concurrently with the FSS. No additional static locations were identified as necessary based on the results of scans performed during the CS and FSS; therefore there is no Table 2-4, Characterization Survey Results Summary.

Scan surveys were performed as part of the CS and the FSS. One scan location was identified as areas of elevated activity. The scan results are shown in Table 2-5.

Table 2-1. Measurement Results (Directs for C-14 & Wipes for H-3 and C-14)

Survey Unit: SU2-B2165O

Sample ID	Instrument ID	C-14 Direct				C-14 & H-3 Wipes (LSC S/N DG12061925)						Sum of Fractions
		Gross CPM	Background CPM	Net DPM (dpm/100 cm^2)	Comments[1]	H-3 CPM	H-3 DPM	C-14 CPM	C-14 DPM	H-3 + C-14 DPM	Comments[1]	
2	237279	236	216	166		1	2	1	1	3		5.30E-04
3	237279	230	216	116		3	4	8	10	14		6.92E-04
4	237279	229	216	108		0	0	12	15	15		6.97E-04
5	237279	229	183	385		2	2	9	11	13		1.39E-03
6	237279	225	183	352		0	0	2	3	3		1.03E-03
7	237279	195	183	101		1	1	4	4	5		4.08E-04
8	237279	370	216	1286		0	0	15	18	18		3.96E-03
9	237279	386	216	1419	R	0	0	27	34	34	R	4.76E-03
10	237279	210	216	-51		2	9	0	0	9		1.06E-04
11	237279	235	183	435		4	11	0	0	11		1.47E-03
12	237279	263	183	669		4	14	0	0	14		2.19E-03
13	237279	261	216	375		12	19	28	33	52		2.42E-03
14	237279	337	216	1010		0	0	6	8	8		2.95E-03
15	237279	265	216	409		1	2	1	2	4		1.21E-03
16	237279	727	216	4268		33	12	185	224	236		1.79E-02

[1] Indicate Replicates (R) in the "Comments" column

Result > 0.1 DCGL

Result > 0.5 DCGL

Result > DCGL

Table 2-2. Final Status Results Summary

Survey Unit: SU2-B2165O

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	688			29		
Median	380			12		
Standard Deviation	1094			61		
Total Activity Range (Direct)	-51	to	4268	N/A		
Removable Activity Range (Wipes)	0	to	224	3	to	236
Mean SOF	2.64E-03					
Number of FSS Systematic/Random Measurements	14			14		

Table 2-3. FSS QC Results Summary

Survey Unit: SU2-B2165O

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	12	1	63.79	23
C-14	10	34	1	95.72	24

$$\frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)} d$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

$$RPD = \frac{|X_1 - X_2|}{\overline{X}}$$

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
370	386	0.04

where: RPD = Relative range between the two observed values (X1 and X2)

$\overline{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	0	0	N/A	RPD not relavent when result is less than MDC
C-14	18	34	0.62	RPD not relavent when result is less than MDC

Bias

$$relative\ \ bias = \frac{measured\ \ result\ - expected\ \ result}{expected\ \ result}$$

H-3 spike	H-3 result	Relative bias (+0.2)
4174	3554	-0.14854

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

C-14 spike	C-14 result	Relative bias (+0.2)
4354	4382	0.00643

Table 2-4. CS Results Summary

(no CS Results Summary was produced for this survey unit)

Table 2-5. Scan Survey Results

Survey Unit: SU2-B2165O

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
127	15	12%

Location Number	Grid	Range (cpm)		
Scans performed with 43-68				
2	B9	200	to	300
3	B6	150	to	300
4	E1	250	to	350
5	E4	250	to	300
6	E8	150	to	250
7	E11	180	to	250
8	E14	250	to	350
10	H13	150	to	250
11	H9	160	to	280
12	H6	180	to	320
13	H3	200	to	320
14	L/M 11	175	to	400
15	L/M 9	250	to	350
16	L/M 6	300	to	800

Exceeds 2x Background

Survey Unit Data Assessment:

The survey design required 14 direct measurements and wipe samples for the Sign Test. Fourteen measurements were performed. All measurements and wipe sample results were less than the $DCGL_w$ and the sum of fractions was less than 1; therefore the survey unit meets the release criterion and the Sign test was not performed.

Survey Unit Investigations and Results:

During the scans, one area was identified as being above twice materials background for scanning. This area remains above twice materials background for scanning. Because the activity represented only a fraction of the DCGLw, and was fixed, it was determined that further decontamination activities were unnecessary.

ALARA Statement:

The residual activity within the survey unit is less than the $DCGL_w$ and has been reduced to levels that are ALARA; therefore the ALARA criterion has been met.

Changes in Initial Survey Unit Assumptions:

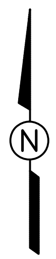
The survey unit was designed as a Class 2 building survey and the sample results are consistent with that classification. The variability of the survey results was less than the assumptions used in survey design, therefore characterization survey results confirm the FSS design.

Conclusion:

The FSS of this survey unit was properly designed as a Class 2 survey based on the decommissioning plan (DP). The required number of direct measurements was made and the scan coverage met the requirement of DP. All of the direct measurements were less than the $DCGL_w$. All identified elevated scans were appropriately investigated.

The measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

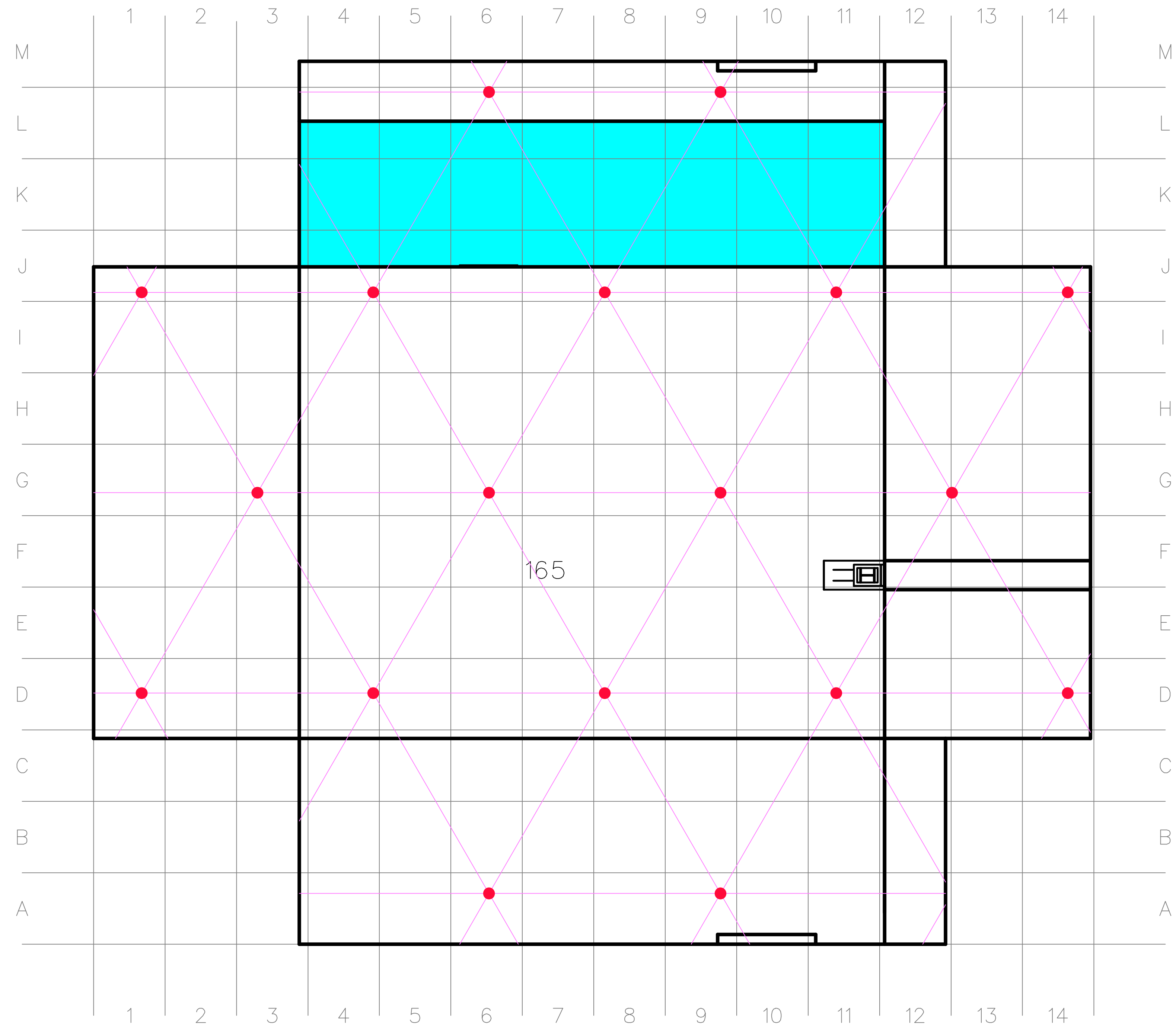
It is concluded that survey unit SU2 – B2-165O meets the release criteria of 10CFR20.1402.



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

INDICATES OPEN WALL SPACE ABOVE CEILING TILE



NOTES:

1. WALL SURFACE AREA: 73 SQ. M.
   (ABOVE 2 M)

   CEILING SURFACE AREA: 54 SQ. M.

   TOTAL SURFACE AREA: 127 SQ. M.

2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 3.24 METERS.

3. CALCULATED AREA EXCLUDES OPEN WALL SPACE.

FIGURE X-X
CLASS 2 SAMPLING LOCATIONS
IN B2-165 OVERHEAD
SU2-B21650

FINAL STATUS SURVEY

APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 2 4

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Attachment 2:
Instrumentation Used for Final Status Survey

	Removable Activity	Total Activity/Scans	
Instrument	Perkin Elmer TriCarb 2900TR	2360 S/N: 237279 43-68 S/N: PR190298	2360 S/N: 227437 43-37 S/N: PR216990
Source Type	H-3/C-14	C-14	C-14
Source Strength in dpm	H-3: 271800 C-14: 129000	48343	48343
Efficiency	H-3: 63.79 C-14: 95.72	0.10	0.07
MDC in dpm/100cm^2	H-3: 23 C-14: 24	615	291
Background in cpm	H-3: 12 C-14: 34	230	617

Aptuit

Final Status Survey Summary Report

Survey Unit: SU1-B2-166

API Laboratory

Prepared By:______________________ **Date:** 3/11/14

Reviewed By:______________________ **Date:** 3/18/14

Site Supervisor

Reviewed By: Rick Greene **Date:** 3/18/14

Project CHP

Approved By: Clinton Meggs **Date:** 3/18/14

Radiation Safety Officer

FINAL STATUS SURVEY SUMMARY REPORT

Survey Unit:

SU1 – B2-166
API Laboratory

Survey Unit Description:

This Class 1 survey unit is a laboratory which performed radiosynthesis of labeled organic compounds. All materials and equipment in the B2 API labs were considered to be potentially contaminated.

Radionuclides of Concern:

Tritium (H-3) and C-14

Survey Unit Design Information:

The Survey Unit Design Parameters are presented below. Survey Unit details are presented in Table 1. The survey unit measurement locations are depicted on the map in Attachment 1. Fourteen direct measurement locations were needed to meet the design requirements of the statistical test. Scan coverage is required to be 100% of the impacted area. The survey design calls for wipe samples to be collected at each direct measurement location because of the lack of a reliable means to measure H-3 directly. Wipe samples are to be analyzed for H-3 and C-14 by liquid scintillation counter (LSC). The instruments to be used for the survey along with the minimum detectable concentration (MDC) values are listed in Attachment 2.

1. Scenario A is used. The null hypothesis for Scenario A is - "The residual radioactivity in the survey unit exceeds the release criterion."
2. The statistical test used in survey design was the Sign test. An average background will be subtracted from each measurement.
3. The derived concentration guideline level over a wide area ($DCGL_w$) for total activity was 10 percent of the NRC screening value for C-14, or 3.7E+05 dpm/100 cm^2.
4. The $DCGL_w$ for removable activity (H-3 plus C-14) was set at 10 percent of the $DCGL_w$ for fixed activity, or 3.7E+04 dpm/100 cm^2.
5. Characterization had not been completed at the time the final status survey (FSS) was planned therefore the average and standard deviation of the contamination in the survey unit was based on reasonable estimates. The characterization survey (CS) was designed to meet the data quality objectives (DQOs) of the FSS.
    a. Lower bound of the gray region (LBGR) was set at 50% of the $DCGL_w$ or, 1.85E5 dpm/100 cm^2.

b. The standard deviation, σ, was assumed to be 30%[1]. 1.85E5 X 0.3 = 5.55E4 dpm/100 cm^2.

c. The relative shift (Δ/σ): $\Delta/\sigma = (DCGL_w - LBGR)/\sigma$

Δ/σ = (3.7E5 – 1.85E5)/5.55E4 = 3.3

d. A relative shift of 3 was used in survey planning since the calculated value was >3 (ref MARSSIM Chapter 5)[2].

6. The Type I (α) and Type II (β) decision errors were each set at 0.05. For $\alpha=\beta=0.05$ and a relative shift of 3, the number of samples (n) required for each survey unit (from Table 5.5 of MARSSIM) for the Sign test is 14 (including a 20% contingency). Therefore at least 14 measurements were made in this survey unit to meet the requirements of the statistical tests.

[1] Abelquist, Decommissioning Health Physics, (Bristol UK, Institute of Physics Publishing), 272.
[2] *Multi-Agency Radiation Survey and Site Investigation Manual*, Rev. 1, August 2000, 5-32. Characterization surveys were performed in combination with the FSS. The relative shift from characterization data was Δ/σ = (3.7E5 – 13,498)/16,669 = 21.39 thus confirming FSS planning assumptions (see Table 2-4).

Table 1. Survey Unit Details

Survey Unit: SU1-B2166

Final Status Survey Design Detail	Value	Comments
Survey Unit:	SU1-B2166	
Areas in Survey Unit:	B2-166	
Survey Class:	1	
SU Floor Area (m^2):	115	
SU Total Area (m^2):	229	Class 1 and 2 includes walls up to 2 m and floor. Class 3 includes only floors.
DCGL for C-14 (dpm/100cm^2):	370,000	Total Activity DCGL
DCGL for H-3/C-14 (dpm/100cm^2):	37,000	Removable H-3 + C-14
Number of Measurements Required:	14	
Survey Pattern:	Random start systematic on triangular grid	
Scan Coverage Required (%):	100%	
Triangular Grid Spacing L:	4.34	
Height of Triangle H:	3.76	

Final Status Survey Results:

A total of 14 direct measurements and smears were made in SU1 – B2-166 as part of the FSS. The results are shown in Table 2-1. Statistical data including the mean, median, and standard deviation are shown in Table 2-2. All of the direct measurements were less than the $DCGL_w$. All of the wipe sample results were less than the $DCGL_w$ and the sum of fractions for the combined measurements was less than 1. The FSS QC results are summarized in Table 2-3.

Characterization Survey Results:

The CS was designed to meet the DQOs of the FSS and was performed concurrently with the FSS. A summary of CS results is presented in Table 2-4. The CS results confirm: 1) the survey unit was properly classified 2) the assumptions used in FSS survey planning were valid.

Scan surveys were performed as part of the CS and the FSS. Several scan locations were identified as areas of elevated activity. The scan results are shown in Table 2-5.

Table 2-1. Measurement Results (Directs for C-14 & Wipes for H-3 and C-14)

Survey Unit: SU1-B2166

Sample ID	Instrument ID	C-14 Direct				C-14 & H-3 Wipes (LSC S/N DG12061925)						Sum of Fractions
		Gross CPM	Background CPM	Net DPM (dpm/100 cm^2)	Comments[1]	H-3 CPM	H-3 DPM	C-14 CPM	C-14 DPM	H-3 + C-14 DPM	Comments[1]	
2	237279	392	216	1470		15	37	1	0	37		4.97E-03
3	237279	1062	216	7067		4	8	8	9	17		1.96E-02
4	237279	819	216	5037		3	5	8	10	15		1.40E-02
5	237279	1035	216	6841		12	29	2	1	30		1.93E-02
6	237279	2260	216	17075		18	29	39	46	75		4.82E-02
7	237279	264	325	-505		9	20	9	10	30		-5.54E-04
8	237279	430	325	881		16	37	8	8	45		3.60E-03
9	237279	421	325	806	R	0	0	27	33	33	R	3.07E-03
10	237279	348	325	196		1	3	2	2	5		6.66E-04
11	237279	1222	325	7498		7	13	11	13	26		2.10E-02
12	237279	325	325	4		4	7	9	11	18		4.98E-04
13	237279	915	325	4933		6	10	12	13	23		1.40E-02
14	237279	365	325	338		3	8	1	1	9		1.16E-03
15	237279	1008	216	6616		10	18	17	19	37		1.89E-02
16	237279	296	266	254		0	0	8	10	10		9.57E-04

[1] Indicate Replicates (R) in the "Comments" column

Result > 0.1 DCGL

Result > 0.5 DCGL

Result > DCGL

Table 2-2. Final Status Results Summary

Survey Unit: SU1-B2166

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	4122			27		
Median	3202			25		
Standard Deviation	4832			18		
Total Activity Range (Direct)	-505	to	17075	N/A		
Removable Activity Range (Wipes)	0	to	46	5	to	75
Mean SOF	1.19E-02					
Number of FSS Systematic/Random Measurements	14			14		

Table 2-3. FSS QC Results Summary

Survey Unit: SU1-B2166

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	11	1	63.79	23
C-14	10	30	1	95.72	23

$$\frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}^{d}$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

$$RPD = \frac{|X_1 - X_2|}{\overline{X}}$$

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
430	421	0.02

where: RPD = Relative range between the two observed values (X1 and X2)

$\overline{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	37	0	2.00	RPD not relavent when result is less than MDC
C-14	8	33	1.22	RPD not relavent when result is less than MDC

Bias

$$relative\ \ bias = \frac{measured\ \ result\ - expected\ \ result}{expected\ \ result}$$

H-3 spike	H-3 result	Relative bias (±0.2)
4174	3634	-0.12937

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

C-14 spike	C-14 result	Relative bias (±0.2)
4354	4388	0.00781

Table 2-4. Characterization Survey Results Summary

Survey Unit: SU1-B2166

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	13498			57		
Median	7042			35		
Standard Deviation	16669			80		
Total Activity Range (Direct)	-456	to	99799	N/A		
Removable Activity Range (Wipes)	0	to	569	0	to	569
Number of Characterization Survey Measurements	77			77		

Table 2-5. Scan Survey Results

Survey Unit: **SU1-B2166**

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
229	229	100%

Location Number	Grid	Range (cpm)		
Scans performed with 43-68				
FSS - 002	E16	300	to	350
FSS - 003	E12	600	to	800
FSS - 004	E7	200	to	800
FSS - 005	E3	800	to	1000
FSS - 006	H1	600	to	2600
FSS - 007	H5	250	to	450
FSS - 008	L3	250	to	550
FSS - 010	L7	250	to	600
FSS - 011	H9	350	to	1200
FSS - 012	L12	250	to	500
FSS - 013	H14	200	to	1000
FSS - 014	L16	300	to	500
FSS - 015	H18	200	to	450
FSS - 016	L20	300	to	1000
Walls - 001	O3	800	to	1400
Walls - 002	O4	600	to	2200
Walls - 003	O5	400	to	2000
Walls - 004	O6	300	to	2300
Walls - 005	O7	300	to	2500
Walls - 006	O8	300	to	2400
Walls - 007	O9	1000	to	3800
Walls - 008	O10	200	to	2500
Walls - 009	O11	200	to	2800
Walls - 010	O12	200	to	1200
Walls - 011	O13	800	to	2000
Walls - 012	N14	400	to	4000
Walls - 013	N15	400	to	3800
Walls - 014	O16	200	to	500
Walls - 015	O17	200	to	500
Walls - 016	O18	300	to	600
Walls - 017	O19	200	to	400
Walls - 018	N3	800	to	2000
Walls - 019	N4	800	to	3600
Walls - 020	N5	300	to	3000
Walls - 021	N6	300	to	3500
Walls - 022	N7	800	to	3000
Walls - 023	N8	1000	to	3200
Walls - 024	N9	400	to	2500

Table 2-5. Scan Survey Results

Survey Unit: **SU1-B2166**

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
229	229	100%

Location Number	Grid	Range (cpm)		
Walls - 025	N10	200	to	2000
Walls - 026	N11	300	to	2000
Walls - 027	N12	300	to	1200
Walls - 028	N13	400	to	2000
Walls - 029	M14	400	to	2000
Walls - 030	M15	600	to	1000
Walls - 031	N16	200	to	500
Walls - 032	N17	300	to	500
Walls - 033	N18	300	to	600
Walls - 034	N19	400	to	600
Walls - 035	M1	800	to	1200
Walls - 036	M2	800	to	1200
Walls - 037	M3	800	to	1500
Walls - 038	M4	800	to	2000
Walls - 039	M5	1500	to	2000
Walls - 040	M6	1000	to	3000
Walls - 041	M7	1000	to	2600
Walls - 042	M8	1000	to	4000
Walls - 043	M9	400	to	500
Walls - 044	M10	200	to	500
Walls - 045	M11	300	to	500
Walls - 046	M12	200	to	1000
Walls - 047	M13	800	to	1200
Walls - 048	M14	400	to	800
Walls - 049	M15	600	to	1000
Walls - 050	M16	300	to	500
Walls - 051	M17	400	to	500
Walls - 052	M18	300	to	400
Walls - 053	M19	400	to	500
Walls - 054	L1	1000	to	1800
Walls - 055	L2	600	to	1800
Walls - 056	L19	200	to	600
Walls - 057	L20	400	to	800
Walls - 058	L21	200	to	550
Walls - 059	K1	600	to	2200
Walls - 060	K2	800	to	2000
Walls - 061	K19	200	to	500
Walls - 062	K20	200	to	500
Walls - 063	K21	200	to	500

Table 2-5. Scan Survey Results

Survey Unit: **SU1-B2166**

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
229	229	100%

Location Number	Grid	Range (cpm)		
Walls - 064	J1	800	to	1400
Walls - 065	J2	800	to	2000
Walls - 066	J19	200	to	500
Walls - 067	J20	200	to	500
Walls - 068	J21	200	to	300
Walls - 069	I1	800	to	2000
Walls - 070	I2	600	to	1200
Walls - 071	I16	200	to	500
Walls - 072	I17	200	to	1000
Walls - 073	I18	200	to	1200
Walls - 074	I19	200	to	500
Walls - 075	H1	800	to	2000
Walls - 076	H2	800	to	1400
Walls - 077	H16	200	to	500
Walls - 078	H17	200	to	1000
Walls - 079	H18	200	to	400
Walls - 080	H19	200	to	500
Walls - 081	G1	600	to	1200
Walls - 082	G2	1000	to	2000
Walls - 083	G16	600	to	1000
Walls - 084	G17	600	to	1000
Walls - 085	F1	400	to	1200
Walls - 086	F2	1200	to	2600
Walls - 087	F16	400	to	600
Walls - 088	F17	300	to	500
Walls - 089	E1	500	to	1000
Walls - 090	E2	800	to	2000
Walls - 091	E3	200	to	1200
Walls - 092	E4	1000	to	2800
Walls - 093	E5	200	to	2000
Walls - 094	E6	200	to	300
Walls - 095	E7	200	to	300
Walls - 096	E8	200	to	300
Walls - 097	E9	200	to	300
Walls - 098	E10	400	to	1200
Walls - 099	E11	200	to	600
Walls - 100	E12	200	to	600
Walls - 101	E13	800	to	2400
Walls - 102	E14	200	to	800

Table 2-5. Scan Survey Results

Survey Unit: **SU1-B2166**

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
229	229	100%

Location Number	Grid	Range (cpm)		
Walls - 103	E15	400	to	600
Walls - 104	E16	200	to	500
Walls - 105	E17	300	to	600
Walls - 106	D3	200	to	1600
Walls - 107	D4	200	to	1600
Walls - 108	D5	200	to	2800
Walls - 109	D6	200	to	2000
Walls - 110	D7	200	to	3800
Walls - 111	D8	200	to	300
Walls - 112	D9	200	to	2000
Walls - 113	D10	200	to	1000
Walls - 114	D11	200	to	800
Walls - 115	D12	200	to	600
Walls - 116	D13	200	to	1200
Walls - 117	D14	200	to	600
Walls - 118	D15	400	to	600
Walls - 119	D16	200	to	400
Walls - 120	D17	200	to	400
Walls - 121	C3	200	to	800
Walls - 122	C4	200	to	800
Walls - 123	C5	200	to	1000
Walls - 124	C6	200	to	2000
Walls - 125	C7	200	to	3800
Walls - 126	C8	200	to	300
Walls - 127	C9	200	to	1600
Walls - 128	C10	200	to	400
Walls - 129	C11	200	to	600
Walls - 130	C12	200	to	500
Walls - 131	C13	200	to	300
Walls - 132	C14	200	to	600
Walls - 133	C15	200	to	600
Walls - 134	C16	200	to	400
Walls - 135	C17	400	to	1000
Walls - 136	B16	200	to	400
Walls - 137	B17	200	to	1400
Walls - 138	A16	200	to	600
Walls - 139	A17	200	to	600
Walls - 140	M20	200	to	550
Walls - 141	M21	200	to	550

Table 2-5. Scan Survey Results

Survey Unit: SU1-B2166

Survey Area (m^2)	**Area Scanned (m^2)**	**Percent Scanned (%)**
229	229	100%

Location Number	**Grid**	**Range (cpm)**		
Scans performed with 43-37				
Floor - 001	E3 - M3	400	to	800
Floor - 002	E4 - M4	400	to	800
Floor - 003	E5 - M5	400	to	900
Floor - 004	E6 - M6	400	to	1000
Floor - 005	E7 - M7	400	to	1000
Floor - 006	E8 - M8	600	to	1400
Floor - 007	E9 - M9	600	to	1000
Floor - 008	E10 - M10	400	to	1000
Floor - 009	E11 - M11	400	to	1000
Floor - 010	E12 - M12	400	to	800
Floor - 011	E13 - M13	400	to	1000
Floor - 012	E14 - M14	400	to	1000
Floor - 013	E15 - M15	400	to	1000
Floor - 014	J16 - M16	400	to	1000
Floor - 015	J17 - M17	400	to	1000
Floor - 016	J18 - M18	400	to	1000
Floor - 017	J19 - M19	400	to	1000
Floor - 018	G3	N/A	to	5000
Floor - 019	I4	N/A	to	2000
Floor - 020	I8	N/A	to	6000
Floor - 021	H8	N/A	to	6000
Floor - 022	L8/9	N/A	to	2500
Floor - 023	H10	2000	to	5000
Floor - 024	H9	N/A	to	1600
Floor - 025	K10	N/A	to	1400
Floor - 026	H11	N/A	to	1400
Floor - 027	E13	N/A	to	1400
Floor - 028	L18	N/A	to	2000
Floor - 029	K9	N/A	to	2000
Floor - 030	K11-12	2000	to	5000

Exceeds 2x Background

Survey Unit Data Assessment:

The survey design required 14 direct measurements and wipe samples for the Sign Test. Fourteen measurements were performed. All measurements and wipe sample results were less than the $DCGL_w$ and the sum of fractions was less than 1; therefore the survey unit meets the release criterion and the Sign test was not performed.

Survey Unit Investigations and Results:

During the scans, several areas were identified as being elevated, above twice materials background for scanning. Decontamination in these areas, via chipping up small sections of the floor, resulted in some reduction of activity consistent with ALARA goals. These areas remain above twice materials background for scanning. However, because the activity represented only a fraction of the DCGLw, and was fixed, it was determined that further decontamination activities were unnecessary.

ALARA Statement:

The residual activity within the survey unit is less than the $DCGL_w$ and has been reduced to levels that are ALARA; therefore the ALARA criterion has been met.

Changes in Initial Survey Unit Assumptions:

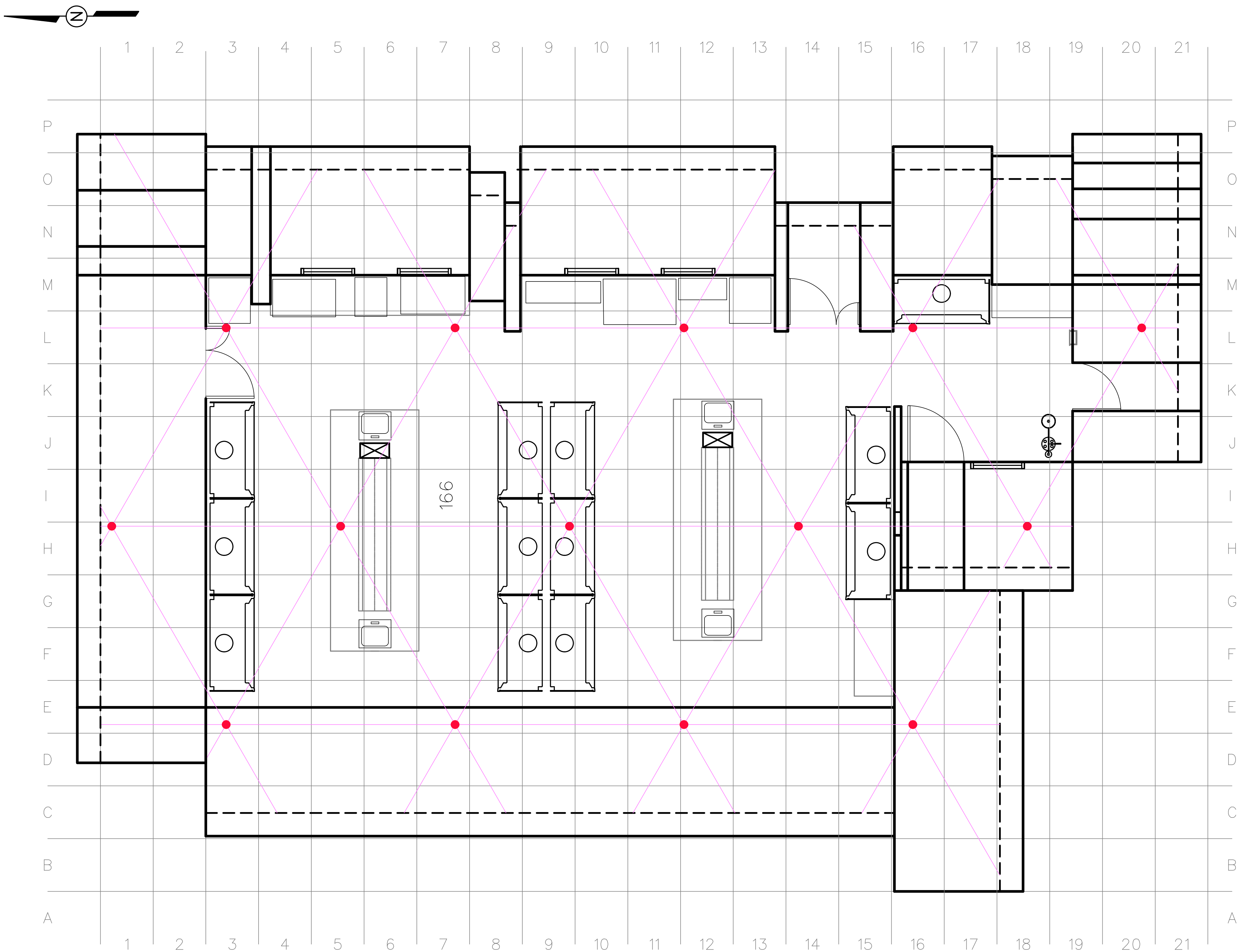
The survey unit was designed as a Class 1 building survey and the sample results are consistent with that classification. The variability of the survey results was less than the assumptions used in survey design, therefore characterization survey results confirm the FSS design.

Conclusion:

The FSS of this survey unit was properly designed as a Class 1 survey based on the decommissioning plan (DP). The required number of direct measurements was made and the scan coverage met the requirement of DP. All of the direct measurements were less than the $DCGL_w$. All identified elevated scans were appropriately investigated.

The measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

It is concluded that survey unit SU1 – B2-166 meets the release criteria of 10CFR20.1402.



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 114 SQ. M.
   FLOOR SURFACE AREA: 115 SQ. M.
   TOTAL SURFACE AREA: 229 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.34 METERS.

FIGURE X-X

CLASS 1 SAMPLING LOCATIONS
IN B2-166
SU1-B2166

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 2 4

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Attachment 2:
Instrumentation Used for Final Status Survey

	Removable Activity	Total Activity/Scans	
Instrument	Perkin Elmer TriCarb 2900TR	2360 S/N: 237279 43-68 S/N: PR190298	2360 S/N: 227437 43-37 S/N: PR216990
Source Type	H-3/C-14	C-14	C-14
Source Strength in dpm	H-3: 271800 C-14: 129000	48343	48343
Efficiency	H-3: 63.79 C-14: 95.72	0.10	0.07
MDC in dpm/100cm^2	H-3: 23 C-14: 23	615	291
Background in cpm	H-3: 11 C-14: 30	230	617

Aptuit

Final Status Survey Summary Report

Survey Unit: SU2-B2-166O

API Laboratory

(walls above 2m and ceiling)

Prepared By:_______________ **Date:** 3/11/14

Reviewed By:_______________ **Date:** 3/18/14

Site Supervisor

Reviewed By: Rick Greene **Date:** 3/18/14

Project CHP

Approved By: Clinton Meggs **Date:** 3/18/14

Radiation Safety Officer

FINAL STATUS SURVEY SUMMARY REPORT

Survey Unit:

SU2 – B2-166O
API Laboratory

Survey Unit Description:

This Class 2 survey unit consists of the walls above 2 meters and ceiling in a laboratory which performed radiosynthesis of labeled organic compounds. All materials and equipment in the B2 API labs were considered to be potentially contaminated.

Radionuclides of Concern:

Tritium (H-3) and C-14

Survey Unit Design Information:

The Survey Unit Design Parameters are presented below. Survey Unit details are presented in Table 1. The survey unit measurement locations are depicted on the map in Attachment 1. Fourteen direct measurement locations were needed to meet the design requirements of the statistical test. Scan coverage is required to be 10 to 100% of the impacted area. The survey design calls for wipe samples to be collected at each direct measurement location because of the lack of a reliable means to measure H-3 directly. Wipe samples are to be analyzed for H-3 and C-14 by liquid scintillation counter (LSC). The instruments to be used for the survey along with the minimum detectable concentration (MDC) values are listed in Attachment 2.

1. Scenario A is used. The null hypothesis for Scenario A is - "The residual radioactivity in the survey unit exceeds the release criterion."
2. The statistical test used in survey design was the Sign test. An average background will be subtracted from each measurement.
3. The derived concentration guideline level over a wide area ($DCGL_w$) for total activity was 10 percent of the NRC screening value for C-14, or 3.7E+05 dpm/100 cm^2.
4. The $DCGL_w$ for removable activity (H-3 plus C-14) was set at 10 percent of the $DCGL_w$ for fixed activity, or 3.7E+04 dpm/100 cm^2.
5. Characterization had not been completed at the time the final status survey (FSS) was planned therefore the average and standard deviation of the contamination in the survey unit was based on reasonable estimates. The characterization survey (CS) was designed to meet the data quality objectives (DQOs) of the FSS.
    a. Lower bound of the gray region (LBGR) was set at 50% of the $DCGL_w$ or, 1.85E5 dpm/100 cm^2.

b. The standard deviation, σ, was assumed to be 30%[1]. 1.85E5 X 0.3 = 5.55E4 dpm/100 cm^2.

c. The relative shift (Δ/σ): Δ/σ = ($DCGL_w$ – LBGR)/σ

Δ/σ = (3.7E5 – 1.85E5)/5.55E4 = 3.3

d. A relative shift of 3 was used in survey planning since the calculated value was >3 (ref MARSSIM Chapter 5)[2].

6. The Type I (α) and Type II (β) decision errors were each set at 0.05. For α=β=0.05 and a relative shift of 3, the number of samples (n) required for each survey unit (from Table 5.5 of MARSSIM) for the Sign test is 14 (including a 20% contingency). Therefore at least 14 measurements were made in this survey unit to meet the requirements of the statistical tests.

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[1] Abelquist, Decommissioning Health Physics, (Bristol UK, Institute of Physics Publishing), 272.

[2] *Multi-Agency Radiation Survey and Site Investigation Manual*, Rev. 1, August 2000, 5-32. Characterization surveys were performed in combination with the FSS. The relative shift from characterization data was Δ/σ = (3.7E5 – 6,259)/5,727 = 5,237 thus confirming FSS planning assumptions (see Table 2-4).

Table 1. Survey Unit Details

Survey Unit: SU2-B2166O

Final Status Survey Design Detail	Value	Comments
Survey Unit:	SU2-B2166O	
Areas in Survey Unit:	B2-166 Overhead	
Survey Class:	2	
SU Floor Area (m^2):	115	
SU Total Area (m^2):	278	This Class 2 survey unit includes walls above 2 m and ceiling.
DCGL for C-14 (dpm/100cm^2):	370,000	Total Activity DCGL
DCGL for H-3/C-14 (dpm/100cm^2):	37,000	Removable H-3 + C-14
Number of Measurements Required:	14	
Survey Pattern:	Random start systematic on triangular grid	
Scan Coverage Required (%):	10% to 50%	
Triangular Grid Spacing L:	4.79	
Height of Triangle H:	4.15	

Final Status Survey Results:

A total of 14 direct measurements and smears were made in SU2 – B2-166O as part of the FSS. The results are shown in Table 2-1. Statistical data including the mean, median, and standard deviation are shown in Table 2-2. All of the direct measurements were less than the $DCGL_w$. All of the wipe sample results were less than the $DCGL_w$ and the sum of fractions for the combined measurements was less than 1. The FSS QC results are summarized in Table 2-3.

Characterization Survey Results:

The CS was designed to meet the DQOs of the FSS and was performed concurrently with the FSS. A summary of CS results is presented in Table 2-4. The CS results confirm: 1) the survey unit was properly classified 2) the assumptions used in FSS survey planning were valid.

Scan surveys were performed as part of the CS and the FSS. Several scan locations were identified as areas of elevated activity. The scan results are shown in Table 2-5.

Table 2-1. Measurement Results (Directs for C-14 & Wipes for H-3 and C-14)

Survey Unit: SU2-B2166O

Sample ID	Instrument ID	C-14 Direct				C-14 & H-3 Wipes (LSC S/N DG12061925)						Sum of Fractions
		Gross CPM	Background CPM	Net DPM (dpm/100 cm^2)	Comments[1]	H-3 CPM	H-3 DPM	C-14 CPM	C-14 DPM	H-3 + C-14 DPM	Comments[1]	
2	237279	313	216	810		5	7	11	13	20		2.73E-03
3	237279	337	183	1287		0	0	15	18	18		3.97E-03
4	237279	502	183	2666		12	6	64	78	84		9.48E-03
5	237279	316	216	835		2	0	31	37	37		3.26E-03
6	237279	1572	216	11327		13	20	32	38	58		3.22E-02
7	237279	249	183	552		3	0	19	23	23		2.11E-03
8	237279	410	183	1897		7	0	45	54	54		6.59E-03
9	237279	215	183	268		6	15	3	3	18		1.21E-03
10	237279	256	216	333		5	0	37	45	45		2.12E-03
11	237279	246	216	250		9	15	19	22	37		1.68E-03
12	237279	1381	216	9732		10	8	43	52	60		2.79E-02
13	237279	1332	216	9322	R	10	0	72	87	87	R	2.75E-02
14	237279	2283	216	17267		7	0	47	57	57		4.82E-02
15	237279	1123	216	7576		11	14	31	36	50		2.18E-02
16	237279	624	216	3408		22	36	48	57	93		1.17E-02

[1] Indicate Replicates (R) in the "Comments" column

Result > 0.1 DCGL

Result > 0.5 DCGL

Result > DCGL

Table 2-2. Final Status Results Summary

Survey Unit: SU2-B2166O

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	4158			47		
Median	1592			48		
Standard Deviation	5280			23		
Total Activity Range (Direct)	250	to	17267	N/A		
Removable Activity Range (Wipes)	3	to	78	18	to	93
Mean SOF	1.25E-02					
Number of FSS Systematic/Random Measurements	14			14		

Table 2-3. FSS QC Results Summary

Survey Unit: SU2-B2166O

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	18	1	63.79	28
C-14	10	30	1	95.72	23

$$\frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$ [d]

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

$$RPD = \frac{|X_1 - X_2|}{\overline{X}}$$

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
1381	1332	0.04

where: RPD = Relative range between the two observed values (X1 and X2)

$\overline{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)
H-3	8	0	2.00
C-14	52	87	0.50

RPD not relavent when result is less than MDC

Bias

$$relative\ \ bias = \frac{measured\ \ result\ - expected\ \ result}{expected\ \ result}$$

H-3 spike	H-3 result	Relative bias (±0.2)
4174	3548	-0.14998

C-14 spike	C-14 result	Relative bias (±0.2)
4354	4460	0.02435

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Table 2-4. Characterization Survey Results Summary

Survey Unit: SU2-B2166O

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	6259			87		
Median	6039			32		
Standard Deviation	5727			209		
Total Activity Range (Direct)	-590	to	22480	N/A		
Removable Activity Range (Wipes)	0	to	1102	0	to	1347
Number of Characterization Survey Measurements	43			43		

Table 2-5. Scan Survey Results

Survey Unit: SU2-B2166O

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
278	60	22%

Location Number	Grid	Range (cpm)		
Scans performed with 43-68				
2	F17	250	to	350
3	F12	300	to	400
4	F7	400	to	1000
5	F2	250	to	350
6	J0	1000	to	1600
7	J5	200	to	300
8	J9	300	to	500
9	J14	200	to	350
10	J19	200	to	350
11	N17	200	to	400
12	N12	1000	to	2000
14	N21	2000	to	2500
15	N7	300	to	1400
16	N2	300	to	600
17	E14	200	to	600
18	C13	250	to	350
19	D12	300	to	800
20	C11	600	to	1000
21	D10	800	to	2500
22	D8	1000	to	2000
23	E8	1000	to	2000
24	D7	400	to	1800
25	C4	400	to	1200
26	F0	500	to	1000
27	G1	500	to	850
28	H0	800	to	1600
29	I0	800	to	1600
30	K0	600	to	1400
31	P3	300	to	1000
32	P4	800	to	2000
33	N5	250	to	800
34	O6	1200	to	2200
35	P7	800	to	2000
36	O8	2000	to	3000
38	P9	2000	to	3000
39	O10	800	to	3500
40	N11	1200	to	1800
41	O12	600	to	3000

Table 2-5. Scan Survey Results

Survey Unit: **SU2-B2166O**

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
278	60	22%

Location Number	Grid	Range (cpm)		
42	O13	900	to	1400
43	N0	500	to	1000
44	N14	800	to	1200
45	O15	400	to	800
46	P16	200	to	300
47	P17	200	to	500
48	O18	200	to	500
49	K22	300	to	400
50	G18	300	to	500
51	G16	300	to	400
52	F18	200	to	600
53	E18	200	to	400
54	D17	200	to	600
55	C18	200	to	600
56	B17	200	to	600
57	B15	200	to	300
58	B13	200	to	300
59	B10	200	to	300
60	E6	200	to	300

Exceeds 2x Background

Survey Unit Data Assessment:

The survey design required 14 direct measurements and wipe samples for the Sign Test. Fourteen measurements were performed. All measurements and wipe sample results were less than the $DCGL_w$ and the sum of fractions was less than 1; therefore the survey unit meets the release criterion and the Sign test was not performed.

Survey Unit Investigations and Results:

During the scans, several areas were identified as being above twice materials background for scanning. These areas remain above twice materials background for scanning. However, because the activity represented only a fraction of the DCGLw, and was fixed, it was determined that further decontamination activities were unnecessary.

ALARA Statement:

The residual activity within the survey unit is less than the $DCGL_w$ and has been reduced to levels that are ALARA; therefore the ALARA criterion has been met.

Changes in Initial Survey Unit Assumptions:

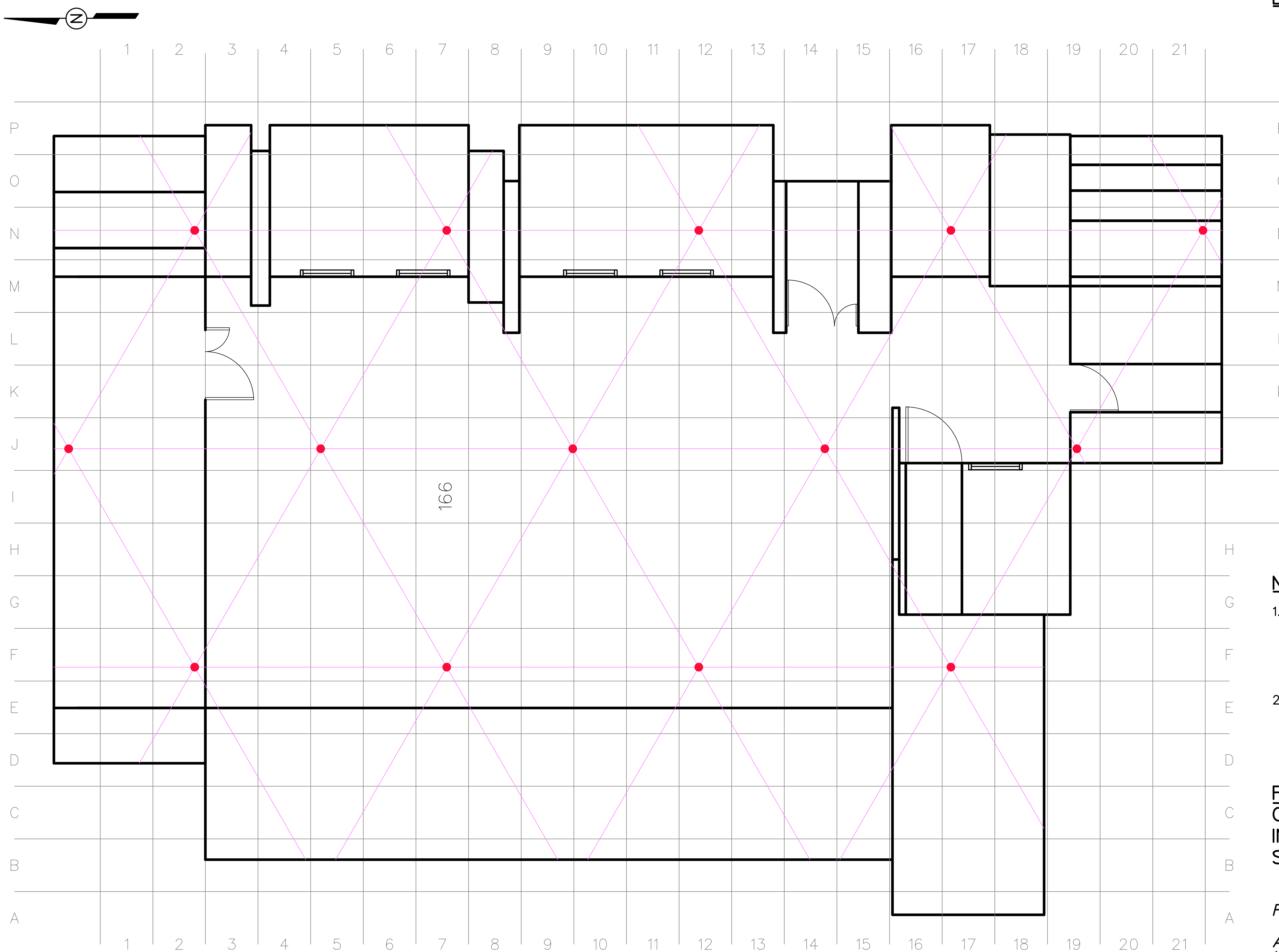
The survey unit was designed as a Class 2 building survey and the sample results are consistent with that classification. The variability of the survey results was less than the assumptions used in survey design, therefore characterization survey results confirm the FSS design.

Conclusion:

The FSS of this survey unit was properly designed as a Class 2 survey based on the decommissioning plan (DP). The required number of direct measurements was made and the scan coverage met the requirement of DP. All of the direct measurements were less than the $DCGL_w$. All identified elevated scans were appropriately investigated.

The measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

It is concluded that survey unit SU2 – B2-166O meets the release criteria of 10CFR20.1402.



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 164 SQ. M.
   (ABOVE 2 METERS)

   CEILING SURFACE AREA: 115 SQ. M.

   TOTAL SURFACE AREA: 279 SQ. M.

2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.79 METERS.

SCALE IN METERS
0 2 4

FIGURE X-X
CLASS 2 SAMPLING LOCATIONS IN B2-166 OVERHEAD SU2-B21660

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Attachment 2:
Instrumentation Used for Final Status Survey

	Removable Activity	Total Activity/Scans	
Instrument	Perkin Elmer TriCarb 2900TR	2360 S/N: 237279 43-68 S/N: PR190298	2360 S/N: 227437 43-37 S/N: PR216990
Source Type	H-3/C-14	C-14	C-14
Source Strength in dpm	H-3: 271800 C-14: 129000	48343	48343
Efficiency	H-3: 63.79 C-14: 95.72	0.10	0.07
MDC in dpm/100cm^2	H-3: 28 C-14: 23	615	291
Background in cpm	H-3: 18 C-14: 30	230	617

Aptuit

Final Status Survey Summary Report

Survey Unit: SU1-B2-AE

Access/Egress and NMR Room

Prepared By:____________________________ **Date:** 3/11/14

Reviewed By:____________________________ **Date:** 3/18/14

Site Supervisor

Reviewed By: Rick Greene **Date:** 3/18/14

Project CHP

Approved By: Clinton Meggs **Date:** 3/18/14

Radiation Safety Officer

FINAL STATUS SURVEY SUMMARY REPORT

Survey Unit:

SU1 – B2-AE
Access/Egress and NMR Room

Survey Unit Description:

This Class 1 survey unit consists of the access/egress area to the API Laboratories and the Nuclear Magnetic Resonance (NMR) room. All materials and equipment in the B2 API labs were considered to be potentially contaminated.

Radionuclides of Concern:

Tritium (H-3) and C-14

Survey Unit Design Information:

The Survey Unit Design Parameters are presented below. Survey Unit details are presented in Table 1. The survey unit measurement locations are depicted on the map in Attachment 1. Fourteen direct measurement locations were needed to meet the design requirements of the statistical test. Scan coverage is required to be 100% of the impacted area. The survey design calls for wipe samples to be collected at each direct measurement location because of the lack of a reliable means to measure H-3 directly. Wipe samples are to be analyzed for H-3 and C-14 by liquid scintillation counter (LSC). The instruments to be used for the survey along with the minimum detectable concentration (MDC) values are listed in Attachment 2.

1. Scenario A is used. The null hypothesis for Scenario A is - "The residual radioactivity in the survey unit exceeds the release criterion."
2. The statistical test used in survey design was the Sign test. An average background will be subtracted from each measurement.
3. The derived concentration guideline level over a wide area ($DCGL_w$) for total activity was 10 percent of the NRC screening value for C-14, or 3.7E+05 dpm/100 cm^2.
4. The $DCGL_w$ for removable activity (H-3 plus C-14) was set at 10 percent of the $DCGL_w$ for fixed activity, or 3.7E+04 dpm/100 cm^2.
5. Characterization had not been completed at the time the final status survey (FSS) was planned therefore the average and standard deviation of the contamination in the survey unit was based on reasonable estimates. The characterization survey (CS) was designed to meet the data quality objectives (DQOs) of the FSS.
    a. Lower bound of the gray region (LBGR) was set at 50% of the $DCGL_w$ or, 1.85E5 dpm/100 cm^2.

b. The standard deviation, σ, was assumed to be 30%[1]. 1.85E5 X 0.3 = 5.55E4 dpm/100 cm[2].

c. The relative shift (Δ/σ): $\Delta/\sigma = (DCGL_w - LBGR)/\sigma$

$\Delta/\sigma =$ (3.7E5 – 1.85E5)/5.55E4 = 3.3

d. A relative shift of 3 was used in survey planning since the calculated value was >3 (ref MARSSIM Chapter 5)[2].

6. The Type I (α) and Type II (β) decision errors were each set at 0.05. For α=β=0.05 and a relative shift of 3, the number of samples (n) required for each survey unit (from Table 5.5 of MARSSIM) for the Sign test is 14 (including a 20% contingency). Therefore at least 14 measurements were made in this survey unit to meet the requirements of the statistical tests.

[1] Abelquist, Decommissioning Health Physics, (Bristol UK, Institute of Physics Publishing), 272.
[2] *Multi-Agency Radiation Survey and Site Investigation Manual*, Rev. 1, August 2000, 5-32. Characterization surveys were performed in combination with the FSS. The relative shift from characterization data was Δ/σ = (3.7E5 – 1,846)/3,034 = 121.36 thus confirming FSS planning assumptions (see Table 2-4).

Table 1. Survey Unit Details

Survey Unit: SU1-B2AE

Final Status Survey Design Detail	Value	Comments
Survey Unit:	SU1-B2AE	
Areas in Survey Unit:	B2-167/167A/170	
Survey Class:	1	
SU Floor Area (m^2):	28	
SU Total Area (m^2):	103	Class 1 and 2 includes walls up to 2 m and floor. Class 3 includes only floors.
DCGL for C-14 (dpm/100cm^2):	370,000	Total Activity DCGL
DCGL for H-3/C-14 (dpm/100cm^2):	37,000	Removable H-3 + C-14
Number of Measurements Required:	14	
Survey Pattern:	Random start systematic on triangular grid	
Scan Coverage Required (%):	100%	
Triangular Grid Spacing L:	2.91	
Height of Triangle H:	2.52	

Final Status Survey Results:

A total of 14 direct measurements and smears were made in SU1 – B2-AE as part of the FSS. The results are shown in Table 2-1. Statistical data including the mean, median, and standard deviation are shown in Table 2-2. All of the direct measurements were less than the $DCGL_w$. All of the wipe sample results were less than the $DCGL_w$ and the sum of fractions for the combined measurements was less than 1. The FSS QC results are summarized in Table 2-3.

Characterization Survey Results:

The CS was designed to meet the DQOs of the FSS and was performed concurrently with the FSS. A summary of CS results is presented in Table 2-4. The CS results confirm: 1) the survey unit was properly classified 2) the assumptions used in FSS survey planning were valid.

Scan surveys were performed as part of the CS and the FSS. Several scan locations were identified as areas of elevated activity. The scan results are shown in Table 2-5.

Table 2-1. Measurement Results (Directs for C-14 & Wipes for H-3 and C-14)

Survey Unit: SU1-B2AE

Sample ID	Instrument ID	C-14 Direct				C-14 & H-3 Wipes (LSC S/N DG12061925)						Sum of Fractions
		Gross CPM	Background CPM	Net DPM (dpm/100 cm²)	Comments[1]	H-3 CPM	H-3 DPM	C-14 CPM	C-14 DPM	H-3 + C-14 DPM	Comments[1]	
2	237279	451	287	1373		0	0	8	10	10		3.98E-03
3	237279	258	325	-556		0	0	2	2	2		-1.45E-03
4	237279	260	325	-539		0	3	0	0	3		-1.38E-03
5	237279	519	216	2530		0	0	6	8	8		7.06E-03
6	237279	288	325	-305		0	0	9	11	11		-5.27E-04
7	237279	438	216	1854		0	0	6	8	8		5.23E-03
8	237279	345	208	1143		8	14	12	14	28		3.85E-03
9	237279	404	216	1570		1	2	1	1	3		4.32E-03
10	237279	510	230	2339		9	15	16	19	34		7.24E-03
11	237279	218	216	16		1	1	2	2	3		1.24E-04
12	237279	368	287	680		2	6	0	0	6		2.00E-03
13	237279	328	287	346		5	14	0	0	14		1.31E-03
14	237279	329	287	354		0	0	0	0	0		9.57E-04
15	237279	548	230	2657		1	1	2	2	3		7.26E-03
16	237279	487	230	2147	R	3	3	14	16	19	R	6.32E-03

[1] Indicate Replicates (R) in the "Comments" column

Result > 0.1 DCGL

Result > 0.5 DCGL

Result > DCGL

Table 2-2. Final Status Results Summary

Survey Unit: SU1-B2AE

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	962			10		
Median	911			7		
Standard Deviation	1126			10		
Total Activity Range (Direct)	-556	to	2657	N/A		
Removable Activity Range (Wipes)	0	to	19	0	to	34
Mean SOF	2.86E-03					
Number of FSS Systematic/Random Measurements	14			14		

Table 2-3. FSS QC Results Summary

Survey Unit: SU1-B2AE

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	13	1	63.98	24
C-14	10	29	1	95.56	23

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

$$RPD = \frac{|X_1 - X_2|}{\bar{X}}$$

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
548	487	0.12

where:

RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	1	3	1.00	RPD not relavent when result is less than MDC
C-14	2	16	1.56	RPD not relavent when result is less than MDC

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

H-3 spike	H-3 result	Relative bias (±0.2)
4174	3513	-0.15836

C-14 spike	C-14 result	Relative bias (±0.2)
4354	4432	0.01791

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Table 2-4. Characterization Survey Results Summary

Survey Unit: SU1-B2AE

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	1846			15		
Median	794			12		
Standard Deviation	3034			15		
Total Activity Range (Direct)	-256	to	12688	N/A		
Removable Activity Range (Wipes)	0	to	58	0	to	79
Number of Characterization Survey Measurements	34			34		

Table 2-5. Scan Survey Results

Survey Unit: SU1-B2AE

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
103	103	100%

Location Number	Grid	Range (cpm)		
Scans performed with 43-68				
1	C3-B6	400	to	600
2	E1-D2	400	to	600
3	G1-F2	300	to	600
4	H1-H2	200	to	600
5	H6-H8	400	to	600
6	G6-G8	400	to	650
7	G7	1000	to	1600
8	F6-F8	400	to	600
9	E6-E8	400	to	800
10	D6-D8	400	to	600
11	J3-H4	200	to	600
12	J4-H4	400	to	1200
13	I4	N/A	to	3000
14	J5-H6	300	to	600
15	K6-J8	200	to	320
16	J6-I8	150	to	350
17	I6-H8	150	to	300
18	N8-L10	200	to	340
19	H8-F10	150	to	350
20	L10-K12	200	to	320
21	J10-J12	250	to	400
22	I10-H12	150	to	400
23	K12-H14	200	to	300
24	M14-K15	180	to	450
25	M15-K16	260	to	460
26	H14-F14	300	to	460
27	K16-H18	300	to	450
Scans performed with 43-37				
28	H3-D6	400	to	650
29	L8-J10	900	to	1500
30	I8-H10	900	to	1000
31	K14-J16	600	to	1000
32	I14-H16	600	to	1200

Exceeds 2x Background

Survey Unit Data Assessment:

The survey design required 14 direct measurements and wipe samples for the Sign Test. Fourteen measurements were performed. All measurements and wipe sample results were less than the $DCGL_w$ and the sum of fractions was less than 1; therefore the survey unit meets the release criterion and the Sign test was not performed.

Survey Unit Investigations and Results:

During the scans, several areas were identified as being above twice materials background for scanning. These elevated areas represented only a fraction of the DCGLw and the contamination was fixed. Additionally, no readings were observed above the previously established ALARA goals so it was determined that further decontamination activities were unnecessary.

ALARA Statement:

The residual activity within the survey unit is less than the $DCGL_w$ and has been reduced to levels that are ALARA; therefore the ALARA criterion has been met.

Changes in Initial Survey Unit Assumptions:

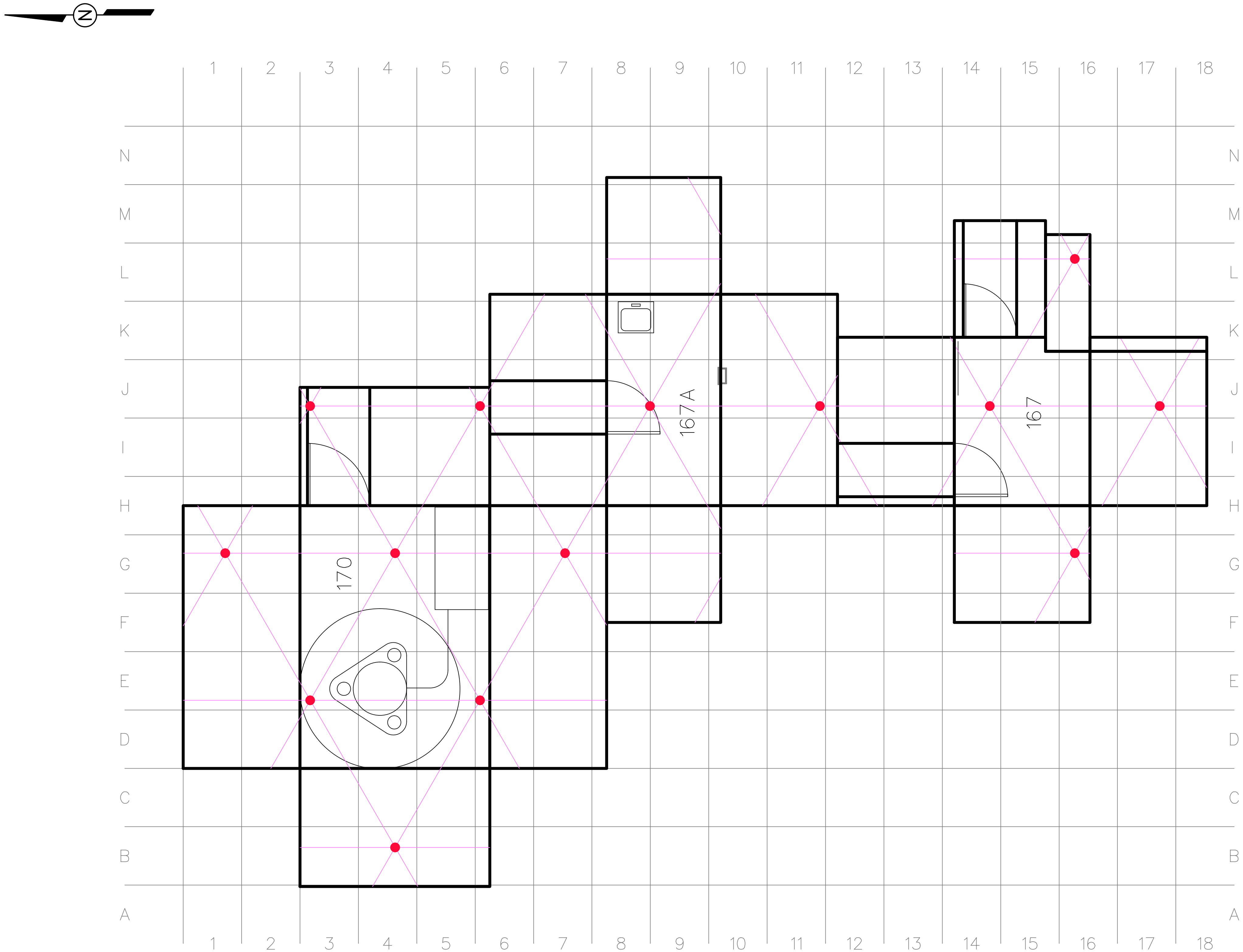
The survey unit was designed as a Class 1 building survey and the sample results are consistent with that classification. The variability of the survey results was less than the assumptions used in survey design, therefore characterization survey results confirm the FSS design.

Conclusion:

The FSS of this survey unit was properly designed as a Class 1 survey based on the decommissioning plan (DP). The required number of direct measurements was made and the scan coverage met the requirement of DP. All of the direct measurements were less than the $DCGL_w$. All identified elevated scans were appropriately investigated.

The measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

It is concluded that survey unit SU1 – B2-AE meets the release criteria of 10CFR20.1402.



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 75 SQ. M.
   FLOOR SURFACE AREA: 28 SQ. M.
   TOTAL SURFACE AREA: 103 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 2.91 METERS.

SCALE IN METERS

0 2 4

FIGURE X-X

CLASS 1 SAMPLING LOCATIONS
IN B2-167, B2-167A, B2-170
SU1-B2AE

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Attachment 2:
Instrumentation Used for Final Status Survey

	Removable Activity	Total Activity/Scans	
Instrument	Perkin Elmer TriCarb 2900TR	2360 S/N: 237279 43-68 S/N: PR190298	2360 S/N: 227437 43-37 S/N: PR216990
Source Type	H-3/C-14	C-14	C-14
Source Strength in dpm	H-3: 271800 C-14: 129000	48343	48343
Efficiency	H-3: 63.98 C-14: 95.56	0.10	0.07
MDC in dpm/100cm^2	H-3: 24 C-14: 23	615	291
Background in cpm	H-3: 13 C-14: 29	230	617

Aptuit

Final Status Survey Summary Report

Survey Unit: SU1-B2-GMP

API Laboratories

Prepared By:__________________________ **Date:** 3/11/14

Reviewed By:__________________________ **Date:** 3/18/14

Site Supervisor

Reviewed By: Rick Greene **Date:** 3/18/14

Project CHP

Approved By: Clinton Meggs **Date:** 3/18/14

Radiation Safety Officer

FINAL STATUS SURVEY SUMMARY REPORT

Survey Unit:

SU1 – B2-GMP
API Laboratories

Survey Unit Description:

This Class 1 survey unit is a suite of laboratories consisting of B2-155 through 164. This includes four GMP labs for the synthesis of radiolabeled compounds, their respective airlocks, and a common area that housed freezers for material storage. All materials and equipment in the B2 API labs were considered to be potentially contaminated.

Radionuclides of Concern:

Tritium (H-3) and C-14

Survey Unit Design Information:

The Survey Unit Design Parameters are presented below. Survey Unit details are presented in Table 1. The survey unit measurement locations are depicted on the map in Attachment 1. Fourteen direct measurement locations were needed to meet the design requirements of the statistical test. Scan coverage is required to be 100% of the impacted area. The survey design calls for wipe samples to be collected at each direct measurement location because of the lack of a reliable means to measure H-3 directly. Wipe samples are to be analyzed for H-3 and C-14 by liquid scintillation counter (LSC). The instruments to be used for the survey along with the minimum detectable concentration (MDC) values are listed in Attachment 2.

1. Scenario A is used. The null hypothesis for Scenario A is - “The residual radioactivity in the survey unit exceeds the release criterion.”
2. The statistical test used in survey design was the Sign test. An average background will be subtracted from each measurement.
3. The derived concentration guideline level over a wide area ($DCGL_w$) for total activity was 10 percent of the NRC screening value for C-14, or 3.7E+05 dpm/100 cm^2.
4. The $DCGL_w$ for removable activity (H-3 plus C-14) was set at 10 percent of the $DCGL_w$ for fixed activity, or 3.7E+04 dpm/100 cm^2.
5. Characterization had not been completed at the time the final status survey (FSS) was planned therefore the average and standard deviation of the contamination in the survey unit was based on reasonable estimates. The characterization survey (CS) was designed to meet the data quality objectives (DQOs) of the FSS.

a. Lower bound of the gray region (LBGR) was set at 50% of the $DCGL_w$ or, 1.85E5 dpm/100 cm^2.

b. The standard deviation, σ, was assumed to be 30%[1]. 1.85E5 X 0.3 = 5.55E4 dpm/100 cm^2.

c. The relative shift (Δ/σ): $\Delta/\sigma = (DCGL_w - LBGR)/\sigma$

$\Delta/\sigma = (3.7E5 - 1.85E5)/5.55E4 = 3.3$

d. A relative shift of 3 was used in survey planning since the calculated value was >3 (ref MARSSIM Chapter 5)[2].

6. The Type I (α) and Type II (β) decision errors were each set at 0.05. For $\alpha=\beta=0.05$ and a relative shift of 3, the number of samples (n) required for each survey unit (from Table 5.5 of MARSSIM) for the Sign test is 14 (including a 20% contingency). Therefore at least 14 measurements were made in this survey unit to meet the requirements of the statistical tests.

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[1] Abelquist, Decommissioning Health Physics, (Bristol UK, Institute of Physics Publishing), 272.
[2] *Multi-Agency Radiation Survey and Site Investigation Manual*, Rev. 1, August 2000, 5-32. Characterization surveys were performed in combination with the FSS. The relative shift from characterization data was $\Delta/\sigma = (3.7E5 - 2{,}844)/5{,}055 = 72.64$ thus confirming FSS planning assumptions (see Table 2-4).

Table 1. Survey Unit Details

Survey Unit: SU1-B2GMP

Final Status Survey Design Detail	Value	Comments
Survey Unit:	SU1-B2GMP	
Areas in Survey Unit:	B2-155 thru B2-164	
Survey Class:	1	
SU Floor Area (m^2):	102	
SU Total Area (m^2):	334	Class 1 and 2 includes walls up to 2 m and floor. Class 3 includes only floors.
DCGL for C-14 (dpm/100cm^2):	370,000	Total Activity DCGL
DCGL for H-3/C-14 (dpm/100cm^2):	37,000	Removable H-3 + C-14
Number of Measurements Required:	14	
Survey Pattern:	Random start systematic on triangular grid	
Scan Coverage Required (%):	100%	
Triangular Grid Spacing L:	5.25	
Height of Triangle H:	4.55	

Final Status Survey Results:

A total of 17 direct measurements and smears were made in SU1 – B2-GMP as part of the FSS. The results are shown in Table 2-1. Statistical data including the mean, median, and standard deviation are shown in Table 2-2. All of the direct measurements were less than the $DCGL_w$. All of the wipe sample results were less than the $DCGL_w$ and the sum of fractions for the combined measurements was less than 1. The FSS QC results are summarized in Table 2-3.

Characterization Survey Results:

The CS was designed to meet the DQOs of the FSS and was performed concurrently with the FSS. A summary of CS results is presented in Table 2-4. The CS results confirm: 1) the survey unit was properly classified 2) the assumptions used in FSS survey planning were valid.

Scan surveys were performed as part of the CS and the FSS. Several scan locations were identified as areas of elevated activity. The scan results are shown in Table 2-5.

Table 2-1. Measurement Results (Directs for C-14 & Wipes for H-3 and C-14)

Survey Unit: SU1-B2GMP

Sample ID	Instrument ID	C-14 Direct				C-14 & H-3 Wipes (LSC S/N DG12061925)						Sum of Fractions
		Gross CPM	Background CPM	Net DPM (dpm/100 cm^2)	Comments[1]	H-3 CPM	H-3 DPM	C-14 CPM	C-14 DPM	H-3 + C-14 DPM	Comments[1]	
2	237279	354	216	1152		9	17	15	17	34		4.03E-03
3	237279	363	216	1227		13	1	58	70	71		5.24E-03
4	237279	251	216	292		12	17	34	40	57		2.33E-03
5	237279	297	216	676		2	0	13	16	16		2.26E-03
6	237279	304	216	734		4	5	11	13	18		2.47E-03
7	237279	202	208	-52		7	11	15	18	29		6.44E-04
8	237279	236	216	166		5	3	27	32	35		1.40E-03
9	237279	462	216	2054		0	0	8	10	10		5.82E-03
10	237279	249	216	275		3	0	26	31	31		1.58E-03
11	237279	268	325	-472		0	0	2	3	3		-1.19E-03
12	237279	283	216	559		5	8	10	12	20		2.05E-03
13	237279	295	325	-246		0	0	0	0	0		-6.66E-04
14	237279	1854	216	13683		4	8	3	3	11		3.73E-02
15	237279	439	216	1862		4	1	26	32	33		5.92E-03
16	237279	571	216	2965		15	14	64	76	90		1.04E-02
17	237279	331	216	960		5	5	17	20	25		3.27E-03
18	237279	502	216	2388		0	0	0	0	0		6.46E-03
19	237279	482	216	2221	R	0	0	14	17	17	R	6.46E-03

[1] Indicate Replicates (R) in the "Comments" column

Result > 0.1 DCGL

Result > 0.5 DCGL

Result > DCGL

Table 2-2. Final Status Results Summary

Survey Unit: SU1-B2GMP

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	1660			28		
Median	734			25		
Standard Deviation	3241			25		
Total Activity Range (Direct)	-472	to	13683	N/A		
Removable Activity Range (Wipes)	0	to	76	0	to	90
Mean SOF	5.25E-03					
Number of FSS Systematic/Random Measurements	17			17		

Table 2-3. FSS QC Results Summary

Survey Unit: SU1-B2GMP

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	11	1	63.93	23
C-14	10	32	1	96.54	23

$$d = \frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

$$RPD = \frac{|X_1 - X_2|}{\overline{X}}$$

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
502	482	0.04

where:

RPD = Relative range between the two observed values (X1 and X2)

$\overline{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	0	0	N/A	RPD not relavent when result is less than MDC
C-14	0	17	2.00	RPD not relavent when result is less than MDC

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

H-3 spike	H-3 result	Relative bias ($\pm$0.2)
4174	3579	-0.14255

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

C-14 spike	C-14 result	Relative bias ($\pm$0.2)
4354	4345	-0.00207

Table 2-4. Characterization Survey Results Summary

Survey Unit: SU1-B2GMP

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	2844			75		
Median	768			26		
Standard Deviation	5055			208		
Total Activity Range (Direct)	-840	to	21862	N/A		
Removable Activity Range (Wipes)	0	to	1360	0	to	1517
Number of Characterization Survey Measurements	105			105		

Table 2-5. Scan Survey Results

Survey Unit: **SU1-B2GMP**

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
334	334	100%

Location Number	Grid	Range (cpm)		
Scans performed with 43-68				
2	T16	250	to	400
3	P13	250	to	450
4	T10	200	to	400
5	P8	200	to	400
6	T5	200	to	500
7	K5	150	to	300
8	G2	200	to	600
9	B5	200	to	600
10	G8	200	to	400
11	G13	200	to	400
12	K21	200	to	380
13	G18	200	to	300
14	B21	1600	to	2600
15	K26	300	to	500
16	G23	200	to	600
17	G29	300	to	500
18	B26	350	to	600
Char-001	T2-Q4	200	to	500
Char-002	U4-T14	200	to	500
Char-003	U14-T17	175	to	400
Char-004	T17-T19	200	to	500
Char-005	S17-Q18	200	to	400
Char-006	S19-Q19	200	to	350
Char-007	R18	N/A	to	1400
Char-008	Q4-O15	250	to	600
Char-009	P15	N/A	to	1200
Char-010	Q15-O17	250	to	600
Char-011	O4-M7	250	to	500
Char-012	N5	N/A	to	1200
Char-013	N6	N/A	to	2500
Char-014	O11-M14	220	to	550
Char-015	O18-M21	220	to	600
Char-016	O25-M28	300	to	500
Char-017	M2-L4	250	to	500
Char-018	M7-L9	250	to	500
Char-019	M9-L11	220	to	500
Char-020	M14-L16	220	to	500
Char-021	M15-L18	250	to	500

Table 2-5. Scan Survey Results

Survey Unit: SU1-B2GMP

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
334	334	100%

Location Number	Grid	Range (cpm)		
Char-022	M21-L23	250	to	500
Char-023	M23-L25	300	to	650
Char-024	M29-L30	300	to	600
Char-025	K4-J7	250	to	500
Char-026	I4-H7	200	to	600
Char-027	K11-J14	220	to	500
Char-028	I11-H14	220	to	600
Char-029	K18-J21	250	to	600
Char-030	I18-H21	400	to	2000
Char-031	K25-J28	300	to	600
Char-032	I25-H28	400	to	600
Char-033	G2-D3	200	to	600
Char-034	C4-B7	200	to	600
Char-035	G7-D9	200	to	400
Char-036	G9-D11	250	to	600
Char-037	C11-B14	250	to	500
Char-038	G14-D16	250	to	600
Char-039	G16-D18	300	to	1200
Char-040	C18-B21	800	to	2800
Char-041	G21-D23	400	to	1200
Char-042	G23-D25	250	to	600
Char-043	F24	N/A	to	1100
Char-044	C25-B28	250	to	600
Char-045	G29-D30	400	to	600
Char-046	F29	N/A	to	2500
Char-047	E29	N/A	to	1200
Char-060	M26	N/A	to	1700
Char-061	J5	N/A	to	1000
Char-062	J12	N/A	to	1400
Char-063	D2	N/A	to	2600
Char-064	S2-Q2	200	to	600
Scans performed with 43-37				
Char-048	Q15	N/A	to	1600
Char-049	S8	N/A	to	1600
Char-050	S4-Q17	300	to	600
Char-051	M4-L7	400	to	800
Char-052	M11-L14	400	to	800
Char-053	M18-L21	400	to	800
Char-054	M25-L28	400	to	800

Table 2-5. Scan Survey Results

Survey Unit: **SU1-B2GMP**

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
334	334	100%

Location Number	Grid	Range (cpm)		
Char-055	G4-D7	400	to	800
Char-056	G11-D14	400	to	800
Char-057	D11	N/A	to	2500
Char-058	G18-D21	400	to	800
Char-059	G25-D28	400	to	800

Exceeds 2x Background

Survey Unit Data Assessment:

The survey design required 14 direct measurements and wipe samples for the Sign Test. Seventeen measurements were performed. All measurements and wipe sample results were less than the $DCGL_w$ and the sum of fractions was less than 1; therefore the survey unit meets the release criterion and the Sign test was not performed.

Survey Unit Investigations and Results:

During the scans, several areas were identified as being above twice materials background for scanning. These elevated areas represented only a fraction of the DCGLw and the contamination was fixed. Additionally, no readings were observed above the previously established ALARA goals so it was determined that further decontamination activities were unnecessary.

ALARA Statement:

The residual activity within the survey unit is less than the $DCGL_w$ and has been reduced to levels that are ALARA; therefore the ALARA criterion has been met.

Changes in Initial Survey Unit Assumptions:

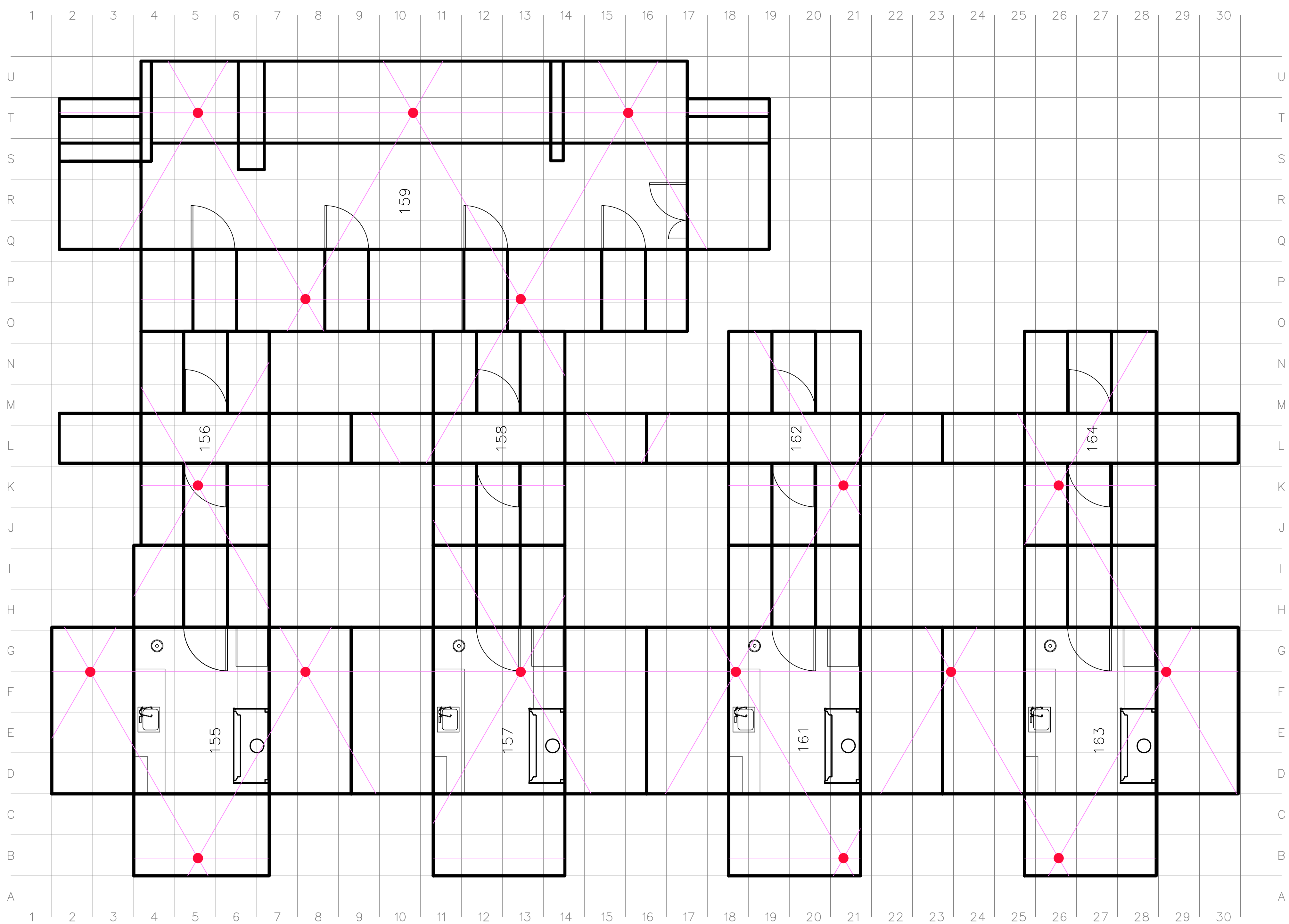
The survey unit was designed as a Class 1 building survey and the sample results are consistent with that classification. The variability of the survey results was less than the assumptions used in survey design, therefore characterization survey results confirm the FSS design.

Conclusion:

The FSS of this survey unit was properly designed as a Class 1 survey based on the decommissioning plan (DP). The required number of direct measurements was made and the scan coverage met the requirement of DP. All of the direct measurements were less than the $DCGL_w$. All identified elevated scans were appropriately investigated.

The measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

It is concluded that survey unit SU1 – B2-GMP meets the release criteria of 10CFR20.1402.



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 232 SQ. M.
   FLOOR SURFACE AREA: 102 SQ. M.
   TOTAL SURFACE AREA: 334 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 5.25 METERS.

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS
IN B2-155 THROUGH B2-164
SU1-B2GMP

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 3 6

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Attachment 2:
Instrumentation Used for Final Status Survey

	Removable Activity	Total Activity/Scans	
Instrument	Perkin Elmer TriCarb 2900TR	2360 S/N: 237279 43-68 S/N: PR190298	2360 S/N: 227437 43-37 S/N: PR216990
Source Type	H-3/C-14	C-14	C-14
Source Strength in dpm	H-3: 271800 C-14: 129000	48343	48343
Efficiency	H-3: 63.93 C-14: 96.54	0.10	0.07
MDC in dpm/100cm^2	H-3: 23 C-14: 23	615	291
Background in cpm	H-3: 11 C-14: 32	230	617

Aptuit

Final Status Survey Summary Report

Survey Unit: SU2-B2-GMPO

API Laboratories

(walls above 2m and ceiling)

Prepared By:____________________________ **Date:** 3/11/14

Reviewed By:____________________________ **Date:** 3/18/14

Site Supervisor

Reviewed By: Rick Greene **Date:** 3/18/14

Project CHP

Approved By: Clinton Meggs **Date:** 3/18/14

Radiation Safety Officer

FINAL STATUS SURVEY SUMMARY REPORT

Survey Unit:

SU2 – B2-GMPO
API Laboratories

Survey Unit Description:

This Class 2 survey unit consists of the walls above 2 meters and ceiling in a suite of laboratories consisting of B2-155 through 164. This includes four GMP labs for the synthesis of radiolabeled compounds, their respective airlocks, and a common area that housed freezers for material storage. All materials and equipment in the B2 API labs were considered to be potentially contaminated.

Radionuclides of Concern:

Tritium (H-3) and C-14

Survey Unit Design Information:

The Survey Unit Design Parameters are presented below. Survey Unit details are presented in Table 1. The survey unit measurement locations are depicted on the map in Attachment 1. Fourteen direct measurement locations were needed to meet the design requirements of the statistical test. Scan coverage is required to be 10 to 100% of the impacted area. The survey design calls for wipe samples to be collected at each direct measurement location because of the lack of a reliable means to measure H-3 directly. Wipe samples are to be analyzed for H-3 and C-14 by liquid scintillation counter (LSC). The instruments to be used for the survey along with the minimum detectable concentration (MDC) values are listed in Attachment 2.

1. Scenario A is used. The null hypothesis for Scenario A is - "The residual radioactivity in the survey unit exceeds the release criterion."
2. The statistical test used in survey design was the Sign test. An average background will be subtracted from each measurement.
3. The derived concentration guideline level over a wide area ($DCGL_w$) for total activity was 10 percent of the NRC screening value for C-14, or 3.7E+05 dpm/100 cm^2.
4. The $DCGL_w$ for removable activity (H-3 plus C-14) was set at 10 percent of the $DCGL_w$ for fixed activity, or 3.7E+04 dpm/100 cm^2.
5. Characterization had not been completed at the time the final status survey (FSS) was planned therefore the average and standard deviation of the contamination in the survey unit was based on reasonable estimates. The characterization survey (CS) was designed to meet the data quality objectives (DQOs) of the FSS.

a. Lower bound of the gray region (LBGR) was set at 50% of the $DCGL_w$ or, 1.85E5 dpm/100 cm^2.

b. The standard deviation, σ, was assumed to be 30%[1]. 1.85E5 X 0.3 = 5.55E4 dpm/100 cm^2.

c. The relative shift (Δ/σ): $\Delta/\sigma = (DCGL_w - LBGR)/\sigma$

$\Delta/\sigma = (3.7E5 - 1.85E5)/5.55E4 = 3.3$

d. A relative shift of 3 was used in survey planning since the calculated value was >3 (ref MARSSIM Chapter 5)[2].

6. The Type I (α) and Type II (β) decision errors were each set at 0.05. For $\alpha=\beta=0.05$ and a relative shift of 3, the number of samples (n) required for each survey unit (from Table 5.5 of MARSSIM) for the Sign test is 14 (including a 20% contingency). Therefore at least 14 measurements were made in this survey unit to meet the requirements of the statistical tests.

---

[1] Abelquist, Decommissioning Health Physics, (Bristol UK, Institute of Physics Publishing), 272.
[2] *Multi-Agency Radiation Survey and Site Investigation Manual*, Rev. 1, August 2000, 5-32. Characterization surveys were performed in combination with the FSS. The relative shift from characterization data was $\Delta/\sigma = (3.7E5 - 1{,}450)/2{,}841 = 129.73$ thus confirming FSS planning assumptions.

Table 1. Survey Unit Details

Survey Unit: SU2-B2GMPO

Final Status Survey Design Detail	Value	Comments
Survey Unit:	SU2-B2GMPO	
Areas in Survey Unit:	B2-155 thru B2-164 Overhead	
Survey Class:	2	
SU Floor Area (m^2):	102	
SU Total Area (m^2):	283	This Class 2 survey unit includes walls above 2 m and ceiling.
DCGL for C-14 (dpm/100cm^2):	370,000	Total Activity DCGL
DCGL for H-3/C-14 (dpm/100cm^2):	37,000	Removable H-3 + C-14
Number of Measurements Required:	14	
Survey Pattern:	Random start systematic on triangular grid	
Scan Coverage Required (%):	10% to 50%	
Triangular Grid Spacing L:	4.83	
Height of Triangle H:	4.18	

Final Status Survey Results:

A total of 14 direct measurements and smears were made in SU2 – B2-GMPO as part of the FSS. The results are shown in Table 2-1. Statistical data including the mean, median, and standard deviation are shown in Table 2-2. All of the direct measurements were less than the $DCGL_w$. All of the wipe sample results were less than the $DCGL_w$ and the sum of fractions for the combined measurements was less than 1. The FSS QC results are summarized in Table 2-3.

Characterization Survey Results:

The CS was designed to meet the DQOs of the FSS and was performed concurrently with the FSS. A summary of CS results is presented in Table 2-4. The CS results confirm: 1) the survey unit was properly classified 2) the assumptions used in FSS survey planning were valid.

Scan surveys were performed as part of the CS and the FSS. Several scan locations were identified as areas of elevated activity. The scan results are shown in Table 2-5..

Table 2-1. Measurement Results (Directs for C-14 & Wipes for H-3 and C-14)

Survey Unit: SU2-B2GMPO

Sample ID	Instrument ID	C-14 Direct				C-14 & H-3 Wipes (LSC S/N DG12061925)						Sum of Fractions
		Gross CPM	Background CPM	Net DPM (dpm/100 cm^2)	Comments[1]	H-3 CPM	H-3 DPM	C-14 CPM	C-14 DPM	H-3 + C-14 DPM	Comments[1]	
2	237279	239	183	469		0	0	9	11	11		1.56E-03
3	237279	224	183	343		0	0	18	22	22		1.52E-03
4	237279	247	183	536		0	0	0	0	0		1.45E-03
5	237279	216	183	277		1	0	11	14	14		1.13E-03
6	237279	252	183	577		7	15	2	1	16		1.99E-03
10	237279	352	216	1135		0	0	21	26	26		3.77E-03
12	237279	288	216	601		7	4	35	43	47		2.89E-03
14	237279	328	216	935		4	3	19	22	25		3.20E-03
16	237279	320	216	868		10	12	36	44	56		3.86E-03
19	237279	244	216	233		0	0	22	27	27		1.36E-03
20	237279	346	216	1085		7	11	18	22	33		3.82E-03
21	237279	329	216	943	R	6	6	24	28	34	R	3.47E-03
22	237279	293	216	642		10	2	61	74	76		3.79E-03
26	237279	350	216	1119		14	17	48	56	73		5.00E-03
30	237279	349	216	1110		9	1	57	69	70		4.89E-03

[1] Indicate Replicates (R) in the "Comments" column

Result > 0.1 DCGL
Result > 0.5 DCGL
Result > DCGL

Table 2-2. Final Status Results Summary

Survey Unit: SU2-B2GMPO

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	709			35		
Median	622			27		
Standard Deviation	328			25		
Total Activity Range (Direct)	233	to	1135	N/A		
Removable Activity Range (Wipes)	0	to	74	0	to	76
Mean SOF	2.87E-03					
Number of FSS Systematic/Random Measurements	14			14		

Table 2-3. FSS QC Results Summary

Survey Unit: SU2-B2GMPO

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	14	1	63.93	25
C-14	10	31	1	96.54	23

$$\frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

$$RPD = \frac{|X_1 - X_2|}{\bar{X}}$$

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
346	329	0.05

where:

RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	11	6	0.59	RPD not relavent when result is less than MDC
C-14	22	28	0.24	RPD not relavent when result is less than MDC

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

H-3 spike	H-3 result	Relative bias (±0.2)
4174	3794	-0.09104

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

C-14 spike	C-14 result	Relative bias (±0.2)
4354	4331	-0.00528

Table 2-4. Characterization Survey Results Summary

Survey Unit: SU2-B2GMPO

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	1450			17		
Median	651			10		
Standard Deviation	2841			15		
Total Activity Range (Direct)	300	to	13057	N/A		
Removable Activity Range (Wipes)	0	to	57	0	to	57
Number of Characterization Survey Measurements	19			19		

Table 2-5. Scan Survey Results

Survey Unit: **SU2-B2GMPO**

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
283	35	12%

Location Number	Grid	Range (cpm)		
Scans performed with 43-68				
2	V14	200	to	300
3	V9	100	to	300
4	E14	200	to	300
5	E24	200	to	300
6	E33	200	to	300
7	C33	300	to	600
8	R33	300	to	400
9	L23	220	to	400
10	E28	200	to	600
11	B25	1000	to	2000
12	R16	250	to	400
13	O11	200	to	350
14	E19	250	to	400
15	B14	300	to	500
16	E4	200	to	350
17	B6	300	to	500
18	K6	200	to	400
19	R7	200	to	400
20	V4	200	to	500
22	Z7	250	to	400
23	S8	250	to	500
24	Y10	300	to	500
25	S11	200	to	500
26	Z12	200	to	400
27	S13	200	to	300
28	Y14	200	to	400
29	S15	200	to	500
30	Z16	200	to	480
31	V21	200	to	400
32	U21	250	to	400
33	R24	250	to	400
34	O20	250	to	420
35	O28	200	to	420

Exceeds 2x Background

Survey Unit Data Assessment:

The survey design required 14 direct measurements and wipe samples for the Sign Test. Fourteen measurements were performed. All measurements and wipe sample results were less than the $DCGL_w$ and the sum of fractions was less than 1; therefore the survey unit meets the release criterion and the Sign test was not performed.

Survey Unit Investigations and Results:

During the scans, several areas were identified as being above twice materials background for scanning. These elevated areas represented only a fraction of the DCGLw and the contamination was fixed. Additionally, no readings were observed above the previously established ALARA goals so it was determined that further decontamination activities were unnecessary.

ALARA Statement:

The residual activity within the survey unit is less than the $DCGL_w$ and has been reduced to levels that are ALARA; therefore the ALARA criterion has been met.

Changes in Initial Survey Unit Assumptions:

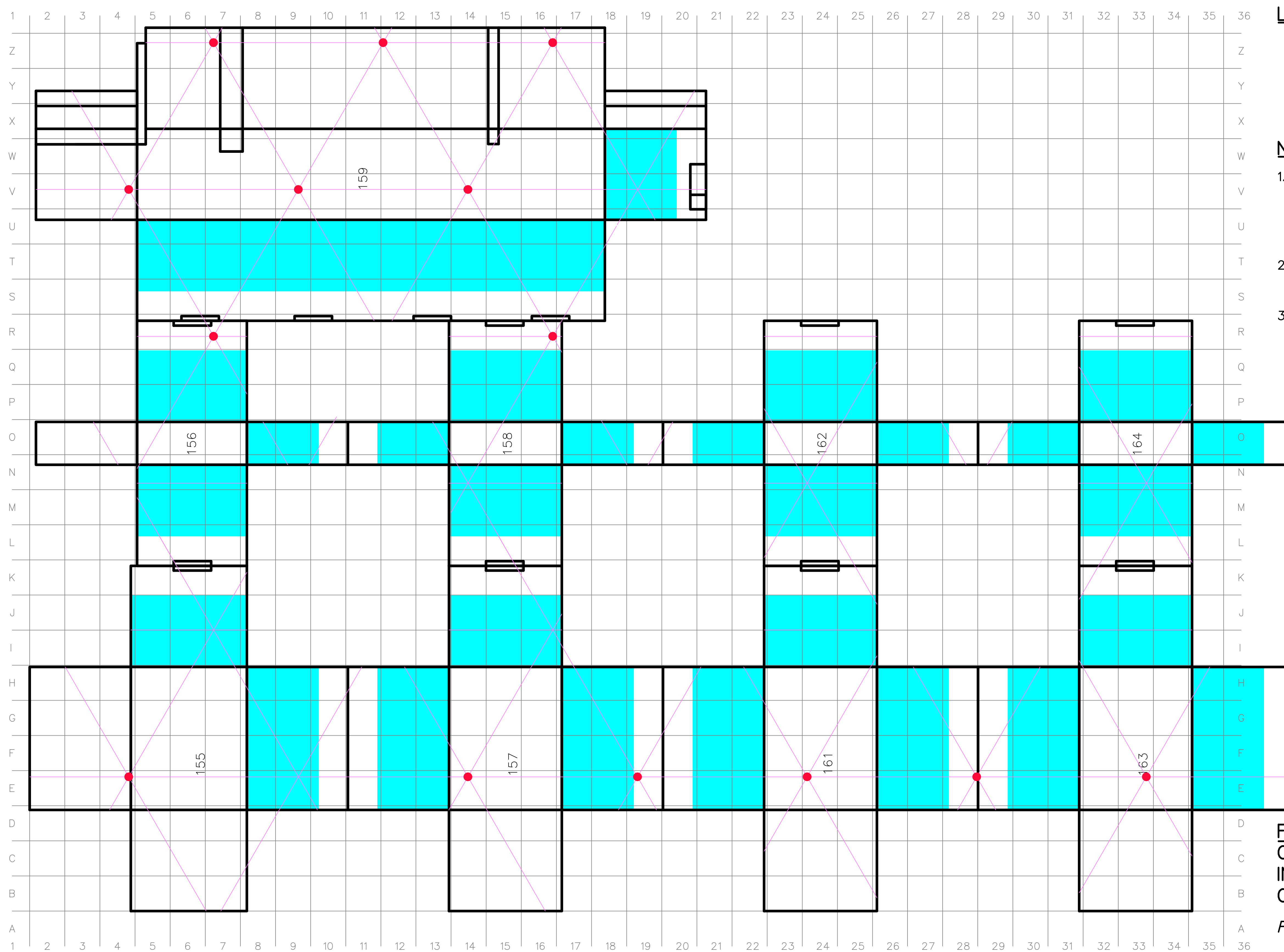
The survey unit was designed as a Class 2 building survey and the sample results are consistent with that classification. The variability of the survey results was less than the assumptions used in survey design, therefore characterization survey results confirm the FSS design.

Conclusion:

The FSS of this survey unit was properly designed as a Class 2 survey based on the decommissioning plan (DP). The required number of direct measurements was made and the scan coverage met the requirement of DP. All of the direct measurements were less than the $DCGL_w$. All identified elevated scans were appropriately investigated.

The measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

It is concluded that survey unit SU2 – B2-GMPO meets the release criteria of 10CFR20.1402.



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

INDICATES OPEN WALL SPACE ABOVE CEILING TILE

NOTES:

1. WALL SURFACE AREA: (ABOVE 2 M.) 181 SQ. M.

   CEILING SURFACE AREA: 102 SQ. M.

   TOTAL SURFACE AREA: 283 SQ. M.

2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.83 METERS.

3. CALCULATED AREA EXCLUDES OPEN WALL SPACE.

SCALE IN METERS

0 3 6

FIGURE X-X

CLASS 2 SAMPLING LOCATIONS IN B2-155 THROUGH B2-164 OVERHEAD SU2-B2GMPO

FINAL STATUS SURVEY

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

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Attachment 2:
Instrumentation Used for Final Status Survey

	Removable Activity	Total Activity/Scans	
Instrument	Perkin Elmer TriCarb 2900TR	2360 S/N: 237279 43-68 S/N: PR190298	2360 S/N: 227437 43-37 S/N: PR216990
Source Type	H-3/C-14	C-14	C-14
Source Strength in dpm	H-3: 271800 C-14: 129000	48343	48343
Efficiency	H-3: 63.93 C-14: 96.54	0.10	0.07
MDC in dpm/100cm^2	H-3: 25 C-14: 23	615	291
Background in cpm	H-3: 14 C-14: 31	230	617

Aptuit

Final Status Survey Summary Report

Survey Unit: SU1-B3-298

Analytical Laboratory

Prepared By:______________________________ **Date:** 3/11/14

Reviewed By:______________________________ **Date:** 3/18/14

Site Supervisor

Reviewed By: Rick Greene **Date:** 3/18/14

Project CHP

Approved By: Clinton Meggs **Date:** 3/18/14

Radiation Safety Officer

FINAL STATUS SURVEY SUMMARY REPORT

Survey Unit:

SU1 – B3-298
Analytical Laboratory

Survey Unit Description:

This Class 1 survey unit is an analytical laboratory containing an HPLC that was used for Carbon-14 (C-14) projects. Some known contamination exists on a section of lab bench and floor from a spill from the HPLC.

Radionuclides of Concern:

Tritium (H-3) and C-14

Survey Unit Design Information:

The Survey Unit Design Parameters are presented below. Survey Unit details are presented in Table 1. The survey unit measurement locations are depicted on the map in Attachment 1. Fourteen direct measurement locations were needed to meet the design requirements of the statistical test. Scan coverage is required to be 100% of the impacted area. The survey design calls for wipe samples to be collected at each direct measurement location because of the lack of a reliable means to measure H-3 directly. Wipe samples are to be analyzed for H-3 and C-14 by liquid scintillation counter (LSC). The instruments to be used for the survey along with the minimum detectable concentration (MDC) values are listed in Attachment 2.

1. Scenario A is used. The null hypothesis for Scenario A is - "The residual radioactivity in the survey unit exceeds the release criterion."
2. The statistical test used in survey design was the Sign test. An average background will be subtracted from each measurement.
3. The derived concentration guideline level over a wide area ($DCGL_w$) for total activity was 10 percent of the NRC screening value for C-14, or 3.7E+05 dpm/100 cm^2.
4. The $DCGL_w$ for removable activity (H-3 plus C-14) was set at 10 percent of the $DCGL_w$ for fixed activity, or 3.7E+04 dpm/100 cm^2.
5. Characterization had not been completed at the time the final status survey (FSS) was planned therefore the average and standard deviation of the contamination in the survey unit was based on reasonable estimates. The characterization survey (CS) was designed to meet the data quality objectives (DQOs) of the FSS.
    a. Lower bound of the gray region (LBGR) was set at 50% of the $DCGL_w$ or, 1.85E5 dpm/100 cm^2.

b. The standard deviation, σ, was assumed to be 30%[1]. 1.85E5 X 0.3 = 5.55E4 dpm/100 cm^2.

c. The relative shift (Δ/σ): $\Delta/\sigma = (DCGL_w – LBGR)/\sigma$

Δ/σ = (3.7E5 – 1.85E5)/5.55E4 = 3.3

d. A relative shift of 3 was used in survey planning since the calculated value was >3 (ref MARSSIM Chapter 5)[2].

6. The Type I (α) and Type II (β) decision errors were each set at 0.05. For α=β=0.05 and a relative shift of 3, the number of samples (n) required for each survey unit (from Table 5.5 of MARSSIM) for the Sign test is 14 (including a 20% contingency). Therefore at least 14 measurements were made in this survey unit to meet the requirements of the statistical tests.

[1] Abelquist, Decommissioning Health Physics, (Bristol UK, Institute of Physics Publishing), 272.
[2] *Multi-Agency Radiation Survey and Site Investigation Manual*, Rev. 1, August 2000, 5-32. Characterization surveys were performed in combination with the FSS. The relative shift from characterization data was Δ/σ = (3.7E5 – 156)/227 = 1629 thus confirming FSS planning assumptions (see Table 2-4).

Table 1. Survey Unit Details

Survey Unit: SU1-B3298

Final Status Survey Design Detail	Value	Comments
Survey Unit:	SU1-B3298	
Areas in Survey Unit:	B3-298	
Survey Class:	1	
SU Floor Area (m^2):	57	
SU Total Area (m^2):	125	Class 1 and 2 includes walls up to 2 m and floor. Class 3 includes only floors.
DCGL for C-14 ($dpm/100cm^2$):	370,000	Total Activity DCGL
DCGL for H-3/C-14 ($dpm/100cm^2$):	37,000	Removable H-3 + C-14
Number of Measurements Required:	14	
Survey Pattern:	Random start systematic on triangular grid	
Scan Coverage Required (%):	100%	
Triangular Grid Spacing L:	3.22	
Height of Triangle H:	2.78	

Final Status Survey Results:

A total of 14 direct measurements and smears were made in SU1 – B3-298 as part of the FSS. The results are shown in Table 2-1. Statistical data including the mean, median, and standard deviation are shown in Table 2-2. All of the direct measurements were less than the $DCGL_w$. All of the wipe sample results were less than the $DCGL_w$ and the sum of fractions for the combined measurements was less than 1. The FSS QC results are summarized in Table 2-3.

Characterization Survey Results:

The CS was designed to meet the DQOs of the FSS and was performed concurrently with the FSS. A summary of CS results is presented in Table 2-4. The CS results confirm: 1) the survey unit was properly classified 2) the assumptions used in FSS survey planning were valid.

Scan surveys were performed as part of the CS and the FSS. Scan measurements did not identify areas of elevated activity. The scan results are shown in Table 2-5.

Table 2-1. Measurement Results (Directs for C-14 & Wipes for H-3 and C-14)

Survey Unit: SU1-B3298

		C-14 Direct				*C-14 & H-3 Wipes (LSC S/N DG12061925)*						
Sample ID	***Instrument ID***	***Gross CPM***	***Background CPM***	***Net DPM (dpm/100 cm^2)***	***Comments [1]***	***H-3 CPM***	***H-3 DPM***	***C-14 CPM***	***C-14 DPM***	***H-3 + C-14 DPM***	***Comments [1]***	***Sum of Fractions***
2	183987	165	178	-94		0	0	0	0	0		-2.54E-04
3	183987	149	178	-209		1	0	8	9	9		-3.22E-04
4	183987	155	116	281		2	0	0	0	0		7.61E-04
5	183987	261	222	281		3	6	1	1	7		9.50E-04
6	183987	246	222	173	R	2	8	0	0	8	R	6.84E-04
7	183987	147	116	224		0	6	0	0	6		7.67E-04
8	183987	173	137	260		7	1	8	9	10		9.72E-04
9	183987	179	178	7		1	17	2	3	20		5.60E-04
10	183987	200	137	455		0	2	0	0	2		1.28E-03
11	183987	171	130	296		0	0	2	3	3		8.81E-04
12	183987	175	137	274		0	0	6	8	8		9.57E-04
13	183987	187	137	361		0	0	1	2	2		1.03E-03
14	183987	121	178	-411		0	0	2	2	2		-1.06E-03
15	183987	131	116	108		0	0	0	0	0		2.93E-04
16	183987	153	130	166		2	0	0	0	0		4.49E-04

[1] Indicate Replicates (R) in the "Comments" column

Result > 0.1 DCGL

Result > 0.5 DCGL

Result > DCGL

Table 2-2. Final Status Results Summary

Survey Unit: SU1-B3298

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	143			5		
Median	242			3		
Standard Deviation	240			6		
Total Activity Range (Direct)	-411	to	455	N/A		
Removable Activity Range (Wipes)	0	to	9	0	to	20
Mean SOF	5.19E-04					
Number of FSS Systematic/Random Measurements	14			14		

Table 2-3. FSS QC Results Summary

Survey Unit: SU1-B3298

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	6	1	64.43	18
C-14	10	10	1	96.45	14

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

Corresponding survey number/location:

5	6

Direct reads (static measurements)

$$RPD = \frac{|X_1 - X_2|}{\overline{X}}$$

1st (cpm)	Replicate (cpm)	RPD (<0.2)
261	245	0.06

where: RPD = Relative range between the two observed values (X1 and X2)

$\overline{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	6	8	0.29	RPD not relavent when result is less than MDC
C-14	0	1	2.00	RPD not relavent when result is less than MDC

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

H-3 spike	H-3 result	Relative bias (±0.2)
4049	3521	-0.1304

C-14 spike	C-14 result	Relative bias (±0.2)
4356	4162	-0.04454

H-3 spike value = 4049 dpm

C-14 spike value= 4356 dpm

Table 2-4. Characterization Survey Results Summary

Survey Unit: SU1-B3298

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	156			6		
Median	141			4		
Standard Deviation	227			5		
Total Activity Range (Direct)	-260	to	779	N/A		
Removable Activity Range (Wipes)	0	to	10	0	to	26
Number of Characterization Survey Measurements	36			36		

Table 2-5. Scan Survey Results

Survey Unit: SU1-B3298

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
125	125	100%

Location Number	Grid	Range (cpm)		
Scans performed with 43-68				
1	B9	98	to	230
2	B6	75	to	257
3	E4	130	to	200
4	E7	185	to	350
5	E10	67	to	257
6	H9	100	to	280
7	H12	150	to	300
8	K10	150	to	200
9	M9	150	to	250
10	K7	150	to	250
11	H5	61	to	255
12	H2	65	to	216
13	K4	86	to	225
14	M5	150	to	200
15	L2 to D3	150	to	356
16	L4 to E4	150	to	232
17	L6 to F8	150	to	232
18	J10 to D10	132	to	232
19	O4 to L10	150	to	356
20	L10 to D12	130	to	232
Scans performed with 43-37				
21	D5 to D8	550	to	1362
22	E5 to E7, F5 to F7, D8 to L8, D9 to L9, J10 to L10, G5 to L5, G6 to L6	500	to	822

Exceeds 2x Background

Survey Unit Data Assessment:

The survey design required 14 direct measurements and wipe samples for the Sign Test. Fourteen measurements were performed. All measurements and wipe sample results were less than the $DCGL_w$ and the sum of fractions was less than 1; therefore the survey unit meets the release criterion and the Sign test was not performed.

Survey Unit Investigations and Results:

No measurements indicated areas of elevated activity, therefore no investigations were performed.

ALARA Statement:

The residual activity within the survey unit is less than the $DCGL_w$ and has been reduced to levels that are ALARA; therefore the ALARA criterion has been met.

Changes in Initial Survey Unit Assumptions:

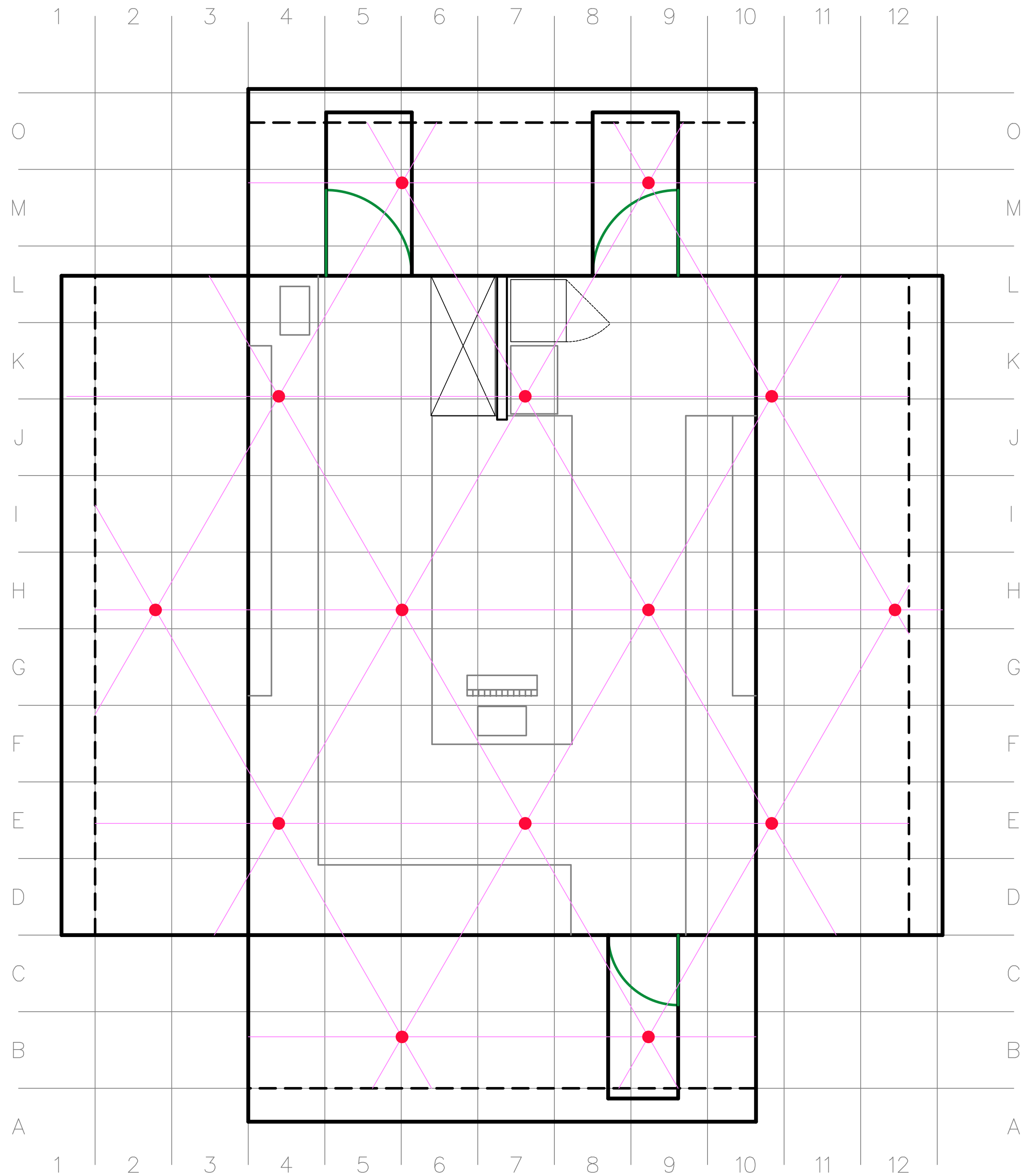
The survey unit was designed as a Class 1 building survey and the sample results are consistent with that classification. The variability of the survey results was less than the assumptions used in survey design, therefore characterization survey results confirm the FSS design.

Conclusion:

The FSS of this survey unit was properly designed as a Class 1 survey based on the decommissioning plan (DP). The required number of direct measurements was made and the scan coverage met the requirement of DP. All of the direct measurements were less than the $DCGL_w$. No investigations were required.

The measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

It is concluded that survey unit SU1 – B3-298 meets the release criteria of 10CFR20.1402.



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 68.5 SQ. M.
   FLOOR SURFACE AREA: 56.87 SQ. M.
   TOTAL SURFACE AREA: 125.37 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 3.22 METERS.

SCALE IN METERS
0 2 4

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS
IN B3-298
SU1-B3298

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Attachment 2:
Instrumentation Used for Final Status and Characterization Surveys

	Removable Activity	Total Activity/Scans	
Instrument	Perkin Elmer TriCarb 2900TR	2221 S/N: 183987 43-68 S/N: PR289329	2360 S/N: 227437 43-37 S/N: PR216990
Source Type	H-3/C-14	C-14	C-14
Source Strength in dpm	H-3: 271800 C-14: 129000	40608	40608
Efficiency	H-3: 63.43 C-14: 96.45	0.11	0.08
MDC in dpm/100cm^2	H-3: 18 C-14: 14	480	265
Background in cpm	H-3: 6 C-14: 10	178	629

Aptuit

Final Status Survey Summary Report

Survey Unit: SU2-B2

Incinerator Room, API Filter Room,

and Health Physics Support Areas

Prepared By:______________________________ **Date:** 3/11/14

Reviewed By:______________________________ **Date:** 3/18/14

Site Supervisor

Reviewed By: Rick Greene **Date:** 3/18/14

Project CHP

Approved By: Clinton Meggs **Date:** 3/18/14

Radiation Safety Officer

FINAL STATUS SURVEY SUMMARY REPORT

Survey Unit:

SU2 – B2
Incinerator Room, API Filter Room, and Health Physics Support Areas

Survey Unit Description:

This Class 2 survey unit consists of the incinerator room, API Filter Room, and Health Physics Support areas. The incinerator room was most currently used for rad waste accumulation. The API Filter Room is a HEPA filter room that serviced the API laboratories. The Health Physics Support Areas consist of rooms B2-116, an accumulation room for LSC vials; B2-117, which houses the liquid scintillation counter for the counting of swipe samples; and B2-119, which comprised the health physics office and work area.

Radionuclides of Concern:

Tritium (H-3) and C-14

Survey Unit Design Information:

The Survey Unit Design Parameters are presented below. Survey Unit details are presented in Table 1. The survey unit measurement locations are depicted on the map in Attachment 1. Fourteen direct measurement locations were needed to meet the design requirements of the statistical test. Scan coverage is required to be 10 to 100% of the impacted area. The survey design calls for wipe samples to be collected at each direct measurement location because of the lack of a reliable means to measure H-3 directly. Wipe samples are to be analyzed for H-3 and C-14 by liquid scintillation counter (LSC). The instruments to be used for the survey along with the minimum detectable concentration (MDC) values are listed in Attachment 2.

1. Scenario A is used. The null hypothesis for Scenario A is - “The residual radioactivity in the survey unit exceeds the release criterion.”
2. The statistical test used in survey design was the Sign test. An average background will be subtracted from each measurement.
3. The derived concentration guideline level over a wide area ($DCGL_w$) for total activity was 10 percent of the NRC screening value for C-14, or 3.7E+05 dpm/100 cm^2.
4. The $DCGL_w$ for removable activity (H-3 plus C-14) was set at 10 percent of the $DCGL_w$ for fixed activity, or 3.7E+04 dpm/100 cm^2.
5. Characterization had not been completed at the time the final status survey (FSS) was planned therefore the average and standard deviation of the contamination in the survey unit was based on reasonable estimates. The

characterization survey (CS) was designed to meet the data quality objectives (DQOs) of the FSS.

a. Lower bound of the gray region (LBGR) was set at 50% of the $DCGL_w$ or, 1.85E5 dpm/100 cm^2.

b. The standard deviation, σ, was assumed to be 30%[1]. 1.85E5 X 0.3 = 5.55E4 dpm/100 cm^2.

c. The relative shift (Δ/σ): $\Delta/\sigma = (DCGL_w - LBGR)/\sigma$

   $\Delta/\sigma = (3.7E5 - 1.85E5)/5.55E4 = 3.3$

d. A relative shift of 3 was used in survey planning since the calculated value was >3 (ref MARSSIM Chapter 5)[2].

6. The Type I (α) and Type II (β) decision errors were each set at 0.05. For $\alpha=\beta=0.05$ and a relative shift of 3, the number of samples (n) required for each survey unit (from Table 5.5 of MARSSIM) for the Sign test is 14 (including a 20% contingency). Therefore at least 14 measurements were made in this survey unit to meet the requirements of the statistical tests.

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[1] Abelquist, Decommissioning Health Physics, (Bristol UK, Institute of Physics Publishing), 272.
[2] *Multi-Agency Radiation Survey and Site Investigation Manual*, Rev. 1, August 2000, 5-32. Characterization surveys were performed in combination with the FSS. The relative shift from characterization data was $\Delta/\sigma = (3.7E5 - 16,038)/32,089 = 11.03$ thus confirming FSS planning assumptions (see Table 2-4).

Table 1. Survey Unit Details

Survey Unit: SU2-B2

Final Status Survey Design Detail	Value	Comments
Survey Unit:	SU2-B2	
Areas in Survey Unit:	B2-103A/112/116/117/119	
Survey Class:	2	
SU Floor Area (m^2):	170	
SU Total Area (m^2):	381	Class 1 and 2 includes walls up to 2 m and floor. Class 3 includes only floors.
DCGL for C-14 (dpm/100cm^2):	370,000	Total Activity DCGL
DCGL for H-3/C-14 (dpm/100cm^2):	37,000	Removable H-3 + C-14
Number of Measurements Required:	14	
Survey Pattern:	Random start systematic on triangular grid	
Scan Coverage Required (%):	10% to 100%	
Triangular Grid Spacing L:	5.61	
Height of Triangle H:	4.86	

Final Status Survey Results:

A total of 14 direct measurements and smears were made in SU2 – B2 as part of the FSS. The results are shown in Table 2-1. Statistical data including the mean, median, and standard deviation are shown in Table 2-2. All of the direct measurements were less than the $DCGL_w$. All of the wipe sample results were less than the $DCGL_w$ and the sum of fractions for the combined measurements was less than 1. The FSS QC results are summarized in Table 2-3.

Characterization Survey Results:

The CS was designed to meet the DQOs of the FSS and was performed concurrently with the FSS. A summary of CS results is presented in Table 2-4. The CS results confirm: 1) the survey unit was properly classified 2) the assumptions used in FSS survey planning were valid.

Scan surveys were performed as part of the CS and the FSS. Several scan locations were identified as areas of elevated activity. The scan results are shown in Table 2-5.

Table 2-1. Measurement Results (Directs for C-14 & Wipes for H-3 and C-14)

Survey Unit: SU2-B2

Sample ID	Instrument ID	C-14 Direct				C-14 & H-3 Wipes (LSC S/N DG12061925)						Sum of Fractions
		Gross CPM	Background CPM	Net DPM (dpm/100 cm^2)	Comments[1]	H-3 CPM	H-3 DPM	C-14 CPM	C-14 DPM	H-3 + C-14 DPM	Comments[1]	
2	237279	801	302	4173		0	3	0	0	3		1.14E-02
3	237279	704	287	3487		7	15	7	8	23		1.00E-02
4	237279	371	287	705		27	33	98	118	151		5.99E-03
5	237279	340	287	446		2	0	10	13	13		1.56E-03
6	237279	310	230	668		6	9	17	21	30		2.62E-03
7	237279	274	287	-105		2	0	22	27	27		4.45E-04
8	237279	292	230	518		4	0	23	29	29		2.18E-03
9	237279	342	287	463		5	13	0	0	13		1.60E-03
10	237279	331	230	844		1	0	19	23	23		2.90E-03
11	237279	288	230	485		2	7	0	0	7		1.50E-03
12	237279	337	287	421		3	12	0	0	12		1.46E-03
13	237279	393	287	889		0	3	0	0	3		2.48E-03
14	237279	336	287	413		0	0	3	4	4		1.22E-03
15	237279	244	230	117		0	0	9	11	11		6.13E-04
16	237279	263	230	276		0	0	0	0	0		7.45E-04
17	237279	251	230	175	R	0	0	5	6	6	R	6.36E-04

[1] Indicate Replicates (R) in the "Comments" column

Result > 0.1 DCGL

Result > 0.5 DCGL

Result > DCGL

Table 2-2. Final Status Results Summary

Survey Unit: SU2-B2

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	920			23		
Median	485			13		
Standard Deviation	1216			37		
Total Activity Range (Direct)	-105	to	4173	N/A		
Removable Activity Range (Wipes)	0	to	118	0	to	151
Mean SOF	3.12E-03					
Number of FSS Systematic/Random Measurements	15			15		

Table 2-3. FSS QC Results Summary

Survey Unit: SU2-B2

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	13	1	63.92	24
C-14	10	49	1	95.93	28

$$\frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}d$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

$$RPD = \frac{|X_1 - X_2|}{\bar{X}}$$

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
263	251	0.05

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	0	0	N/A	RPD not relavent when result is less than MDC
C-14	0	6	2.00	RPD not relavent when result is less than MDC

Bias

$$relative\ \ bias = \frac{measured\ \ result\ - expected\ \ result}{expected\ \ result}$$

H-3 spike	H-3 result	Relative bias (±0.2)
4174	3516	-0.15764

H-3 spike value = 4174 dpm
C-14 spike value= 4354 dpm

C-14 spike	C-14 result	Relative bias (±0.2)
4354	4344	-0.0023

Table 2-4. Characterization Survey Results Summary

Survey Unit: SU2-B2

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	16038			403		
Median	1098			28		
Standard Deviation	32089			1012		
Total Activity Range (Direct)	0	to	133112	N/A		
Removable Activity Range (Wipes)	0	to	3678	1	to	4357
Number of Characterization Survey Measurements	55			55		

Table 2-5. Scan Survey Results

Survey Unit: SU2-B2

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
381	192	50%

Location Number	Grid	Range (cpm)		
Scans performed with 43-68				
2	Z17	250	to	400
6	V24	300	to	500
7	V29	240	to	400
8	P32	300	to	450
Char-004	C3-B6	300	to	600
Char-005	C7-B7	400	to	1000
Char-006	G1-D2	300	to	600
Char-007	I1-H2	300	to	400
Char-008	G1	N/A	to	1600
Char-009	F7-D8	300	to	1000
Char-010	E7-D8	N/A	to	5000
Char-011	G6-F8	400	to	1000
Char-012	I7-G8	300	to	600
Char-013	K3-I4	300	to	600
Char-014	K5-I7	300	to	600
Char-015	K7-I9	300	to	1000
Char-016	J5	N/A	to	1800
Char-017	K9-I10	200	to	300
Char-018	K11-I13	300	to	1000
Char-019	J11	N/A	to	3000
Char-020	I12	N/A	to	2000
Char-028	O5-K7	300	to	600
Char-029	R7-N13	800	to	1000
Char-035	Q13-P15	300	to	500
Char-036	O13-K15	300	to	500
Scans performed with 43-37				
Char-001	Y17-X19	400	to	600
Char-002	S17-O19	400	to	600
Char-003	U23-O32	400	to	600
Char-021	I3-G6	1500	to	3000
Char-022	H3	N/A	to	5000
Char-023	H5	N/A	to	10000
Char-024	G3	N/A	to	4500
Char-025	F3-D6	1000	to	3000
Char-026	E5	N/A	to	4000
Char-027	E6-D6	N/A	to	5000
Char-030	M7-K13	800	to	3000
Char-031	N9	N/A	to	4500

Table 2-5. Scan Survey Results

Survey Unit: SU2-B2

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
381	192	50%

Location Number	Grid	Range (cpm)		
Char-032	M9-M11	6000	to	15000
Char-033	L9	N/A	to	8000
Char-034	L10	N/A	to	4000

Exceeds 2x Background

Survey Unit Data Assessment:

The survey design required 14 direct measurements and wipe samples for the Sign Test. Fifteen measurements were performed. All measurements and wipe sample results were less than the $DCGL_w$ and the sum of fractions was less than 1; therefore the survey unit meets the release criterion and the Sign test was not performed.

Survey Unit Investigations and Results:

During the scans, several areas were identified as being elevated, above twice materials background for scanning. Decontamination was attempted via the removal of floor material, which was chipped up and disposed of as RCM. Wall material was scrubbed and/or removed as necessary. These areas were successfully decontaminated to below the ALARA goal, and because any remaining contamination represents only a fraction of the DCGLw, it was determined that further decontamination activities were unnecessary.

ALARA Statement:

The residual activity within the survey unit is less than the $DCGL_w$ and has been reduced to levels that are ALARA; therefore the ALARA criterion has been met.

Changes in Initial Survey Unit Assumptions:

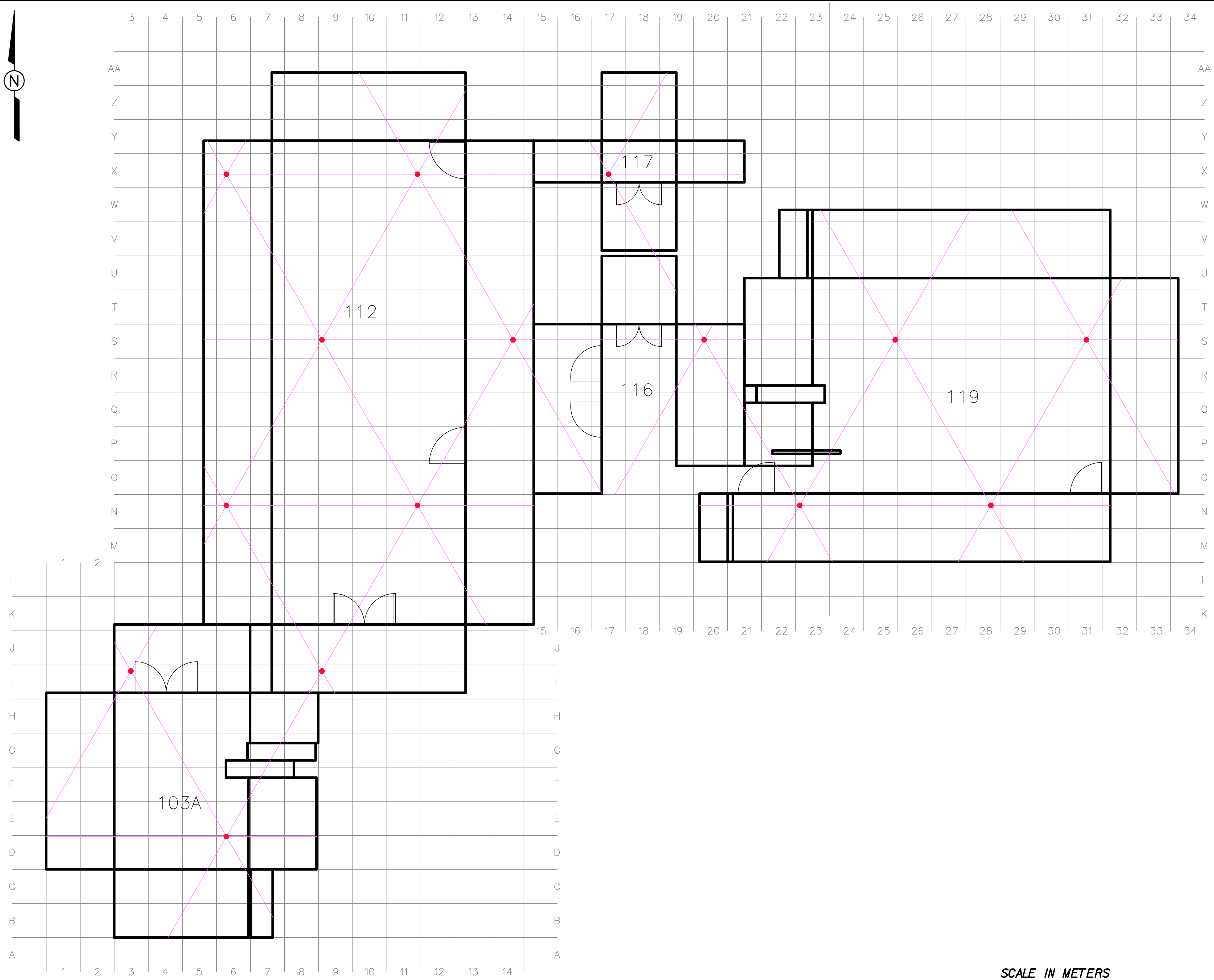
The survey unit was designed as a Class 2 building survey and the sample results are consistent with that classification. The variability of the survey results was less than the assumptions used in survey design, therefore characterization survey results confirm the FSS design.

Conclusion:

The FSS of this survey unit was properly designed as a Class 2 survey based on the decommissioning plan (DP). The required number of direct measurements was made and the scan coverage met the requirement of DP. All of the direct measurements were less than the $DCGL_w$. All identified elevated scans were appropriately investigated.

The measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

It is concluded that survey unit SU2 – B2 meets the release criteria of 10CFR20.1402.



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 211 SQ. M.
   FLOOR SURFACE AREA: 170 SQ. M.
   TOTAL SURFACE AREA: 381 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 5.61 METERS.

SCALE IN METERS
0 3 6

FIGURE X-X
CLASS 2 SAMPLING LOCATIONS IN B2-103A, B2-112, B2-116, B2-117, AND B2-119
SU2-B2

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

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Attachment 2:
Instrumentation Used for Final Status Survey

	Removable Activity	Total Activity/Scans	
Instrument	Perkin Elmer TriCarb 2900TR	2360 S/N: 237279 43-68 S/N: PR190298	2360 S/N: 227437 43-37 S/N: PR216990
Source Type	H-3/C-14	C-14	C-14
Source Strength in dpm	H-3: 271800 C-14: 129000	48343	48343
Efficiency	H-3: 63.92 C-14: 95.93	0.10	0.07
MDC in dpm/100cm^2	H-3: 24 C-14: 28	615	291
Background in cpm	H-3: 13 C-14: 49	230	617

Aptuit

Final Status Survey Summary Report

Survey Unit: SU2-Hill

Rad Waste Storage on the Hill

Prepared By:____________________ **Date:** 3/11/14

Reviewed By:____________________ **Date:** 3/18/14
Site Supervisor

Reviewed By: Rick Greene **Date:** 3/18/14
Project CHP

Approved By: Clinton Meggs **Date:** 3/18/14
Radiation Safety Officer

FINAL STATUS SURVEY SUMMARY REPORT

Survey Unit:

SU2-Hill
Radioactive Waste Storage Building – "The Hill"

Survey Unit Description:

This Class 2 survey unit is a waste storage building that was used for the staging and storing of waste and contaminated equipment. Radioactive materials were stored in a chain link fence cage within the waste storage building. Radioactive materials were also packaged for disposal in this building.

Radionuclides of Concern:

Tritium (H-3) and Carbon-14 (C-14)

Survey Unit Design Information:

The Survey Unit Design Parameters are presented below. Survey Unit details are presented in Table 1. The survey unit measurement locations are depicted on the maps in Attachment 1. Fourteen direct measurement locations are needed to meet the design requirements of the statistical test. Scan coverage is recommended to be 10 to 100% of the impacted area. The survey design calls for wipe samples to be collected at each direct measurement location because of the lack of a reliable means to measure H-3 directly. Wipe samples are to be analyzed for H-3 and C-14 by liquid scintillation counter (LSC). The instruments to be used for the survey along with the minimum detectable concentration (MDC) values are listed in Attachment 2.

1. Scenario A is used. The null hypothesis for Scenario A is - "The residual radioactivity in the survey unit exceeds the release criterion."
2. The statistical test used in survey design was the Sign test. An average background will be subtracted from each measurement.
3. The derived concentration guideline level over a wide area ($DCGL_w$) for total activity was set at 10 percent of the NRC screening value for C-14, or 3.7E+05 dpm/100 cm^2.
4. The $DCGL_w$ for removable activity (H-3 plus C-14) was set at 10 percent of the $DCGL_w$ for fixed activity, or 3.7E+04 dpm/100 cm^2.
5. Characterization had not been completed at the time the final status survey (FSS) was planned therefore the average and standard deviation of the contamination in the survey unit was based on reasonable estimates. The characterization survey (CS) was designed to meet the data quality objectives (DQOs) of the FSS.
    a. Lower bound of the gray region (LBGR) was set at 50% of the $DCGL_w$ or, 1.85E5 dpm/100 cm^2.

b. The standard deviation, σ, was assumed to be 30%[1]. 1.85E5 X 0.3 = 5.55E4 dpm/100 cm^2.

c. The relative shift (Δ/σ): $\Delta/\sigma = (DCGL_w - LBGR)/\sigma$

Δ/σ = (3.7E5 – 1.85E5)/5.55E4 = 3.3

d. A relative shift of 3 was used in survey planning since the calculated value was >3 (ref MARSSIM Chapter 5)[2].

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6. The Type I (α) and Type II (β) decision errors were each set at 0.05. For α=β=0.05 and a relative shift of 3, the number of samples (n) required for each survey unit (from Table 5.5 of MARSSIM) for the Sign test is 14 (including a 20% contingency). Therefore at least 14 measurements are planned in this survey unit to meet the requirements of the statistical test.

[1] Abelquist, Decommissioning Health Physics, (Bristol UK, Institute of Physics Publishing), 272.
[2] *Multi-Agency Radiation Survey and Site Investigation Manual*, Rev. 1, August 2000, 5-32. Characterization surveys were performed in combination with the FSS. The relative shift from characterization data was Δ/σ = (3.7E5 – 2489)/9052 = 41 thus confirming FSS planning assumptions (see Table 2-4).

Table 1. Survey Unit Details

Survey Unit: SU2-Hill

Final Status Survey Design Detail	Value	Comments
Survey Unit:	SU2-Hill	
Areas in Survey Unit:	Rad Waste Storage on the Hill	
Survey Class:	2	
SU Floor Area (m^2):	179	
SU Total Area (m^2):	289	Class 1 and 2 includes walls up to 2 m and floor. Class 3 includes only floors.
DCGL for C-14 (dpm/100cm^2):	370,000	Total Activity DCGL
DCGL for H-3/C-14 (dpm/100cm^2):	37,000	Removable H-3 + C-14
Number of Measurements Required:	14	
Survey Pattern:	Random start systematic on triangular grid	
Scan Coverage Required (%):	10% to 100%	
Triangular Grid Spacing L:	4.88	
Height of Triangle H:	4.23	

Final Status Survey Results:

A total of 17 direct measurements and smears were made in SU2-Hill as part of the FSS. The results are shown in Table 2-1. Statistical data including the mean, median, and standard deviation are shown in Table 2-2. All of the direct measurements were less than the $DCGL_w$. All of the wipe sample results were less than the $DCGL_w$ and the sum of fractions for the combined measurements was less than 1. The FSS QC results are summarized in Table 2-3.

Characterization Survey Results:

The CS was designed to meet the DQOs of the FSS and was performed concurrently with the FSS. A summary of CS results is presented in Table 2-4. The CS results confirm: 1) the survey unit was properly classified 2) the assumptions used in FSS survey planning were valid.

Scan surveys were performed as part of the CS and the FSS. One of the scan measurements indicated an area of elevated activity. The scan results are shown in Table 2-5.

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Table 2-1. Measurement Results (Directs for C-14 & Wipes for H-3 and C-14)

Survey Unit: SU2-Hill

		C-14 Direct				***C-14 & H-3 Wipes (LSC S/N DG12061925)***						
Sample ID	***Instrument ID***	***Gross CPM***	***Background CPM***	***Net DPM (dpm/100 cm²)***	***Comments [1]***	***H-3 CPM***	***H-3 DPM***	***C-14 CPM***	***C-14 DPM***	***H-3 + C-14 DPM***	***Comments [1]***	***Sum of Fractions***
2	237279	165	133	254		0	0	7	9	9		9.30E-04
3	237279	144	133	87		0	0	9	11	11		5.33E-04
4	237279	150	133	135		0	0	0	0	0		3.65E-04
5	237279	164	236	-571		0	0	7	9	9		-1.30E-03
6	237279	348	133	1706		11	34	18	21	55		6.10E-03
7	237279	321	236	675	R	13	45	15	17	62	R	3.50E-03
8	237279	270	236	270		1	0	9	11	11		1.03E-03
9	237279	151	133	143		1	3	0	0	3		4.67E-04
10	237279	219	236	-135		0	0	0	0	0		-3.65E-04
11	237279	201	236	-278		5	14	12	14	28		6.01E-06
12	237279	135	133	16		0	0	0	0	0		4.29E-05
13	237279	100	133	-262		0	0	5	7	7		-5.19E-04
14	237279	191	236	-357		5	20	2	2	22		-3.71E-04
15	237279	124	133	-71		3	11	0	0	11		1.04E-04
16	237279	311	236	595		7	14	22	26	40		2.69E-03
17	237279	111	133	-175		0	0	8	10	10		-2.02E-04
18	237279	123	133	-79		0	0	0	0	0		-2.15E-04
19	237279	392	236	1238		27	78	54	65	143		7.21E-03

[1] Indicate Replicates (R) in the "Comments" column

Result > 0.1 DCGL

Result > 0.5 DCGL

Result > DCGL

Table 2-2. Final Status Results Summary

Survey Unit: SU2-Hill

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	148			21		
Median	16			10		
Standard Deviation	574			35		
Total Activity Range (Direct)	-571	to	1706	N/A		
Removable Activity Range (Wipes)	0	to	65	0	to	143
Mean SOF	9.71E-04					
Number of FSS Systematic/Random Measurements	17			17		

Table 2-3. FSS QC Results Summary

Survey Unit: SU2-Hill

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	7	1	63.6	19
C-14	10	11	1	96.03	15

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}^{d}$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

Direct reads (static measurements)

1st (cpm)	**Replicate (cpm)**	**RPD (<0.2)**
348	321	0.08

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	**Replicate (dpm)**	**RPD (<0.3)**
H-3	34	45	0.28
C-14	21	17	0.21

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

H-3 spike	**H-3 result**	**Relative bias (±0.2)**
4049	3445	-0.14917

C-14 spike	**C-14 result**	**Relative bias (±0.2)**
4356	4326	-0.00689

H-3 spike value = 4049 dpm

C-14 spike value= 4356 dpm

Table 2-4. Characterization Survey Results Summary

Survey Unit: SU2-Hill

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	2489			32		
Median	527			27		
Standard Deviation	9052			23		
Total Activity Range (Direct)	-111	to	77175	N/A		
Removable Activity Range (Wipes)	0	to	95	3	to	137
Number of Characterization Survey Measurements	81			81		

Table 2-5. Scan Survey Results

Survey Unit: SU2-Hill

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
289	190	66%

Location Number	Grid	Range (cpm)		
Scans performed with 43-68				
2	T5	100	to	210
3	T9	120	to	200
4	T14	150	to	220
5	P17	125	to	210
6	P12	225	to	1375
8	P7	210	to	310
9	P2	110	to	190
10	L5	210	to	320
11	L9	210	to	310
12	G2	105	to	190
13	L5	100	to	210
14	G7	210	to	350
15	C9	120	to	190
16	G12	280	to	320
17	C14	110	to	210
18	G17	110	to	190
19	L14	400	to	500
Scans performed with 43-37				
20	D6 to G15, H10 to P15, Q11 to S15	400	to	1000

Exceeds 2x Background

Survey Unit Data Assessment:

The survey design required 14 direct measurements and wipe samples for the Sign Test. Seventeen measurements were performed. All measurements and wipe sample results were less than the $DCGL_w$ and the sum of fractions was less than 1; therefore the survey unit meets the release criterion and the Sign test was not performed.

Survey Unit Investigations and Results:

During the scans, one area was identified as being elevated, above twice materials background for scanning. Decontamination in this area, via vigorous scrubbing with industrial towels and a cleaning detergent, did not result in a reduction of activity. Because the activity represented only a fraction of the $DCGL_w$ and was fixed, it was determined that further decontamination activities were unnecessary.

ALARA Statement:

The residual activity within the survey unit is less than the $DCGL_w$ and has been reduced to levels that are ALARA; therefore the ALARA criterion has been met.

Changes in Initial Survey Unit Assumptions:

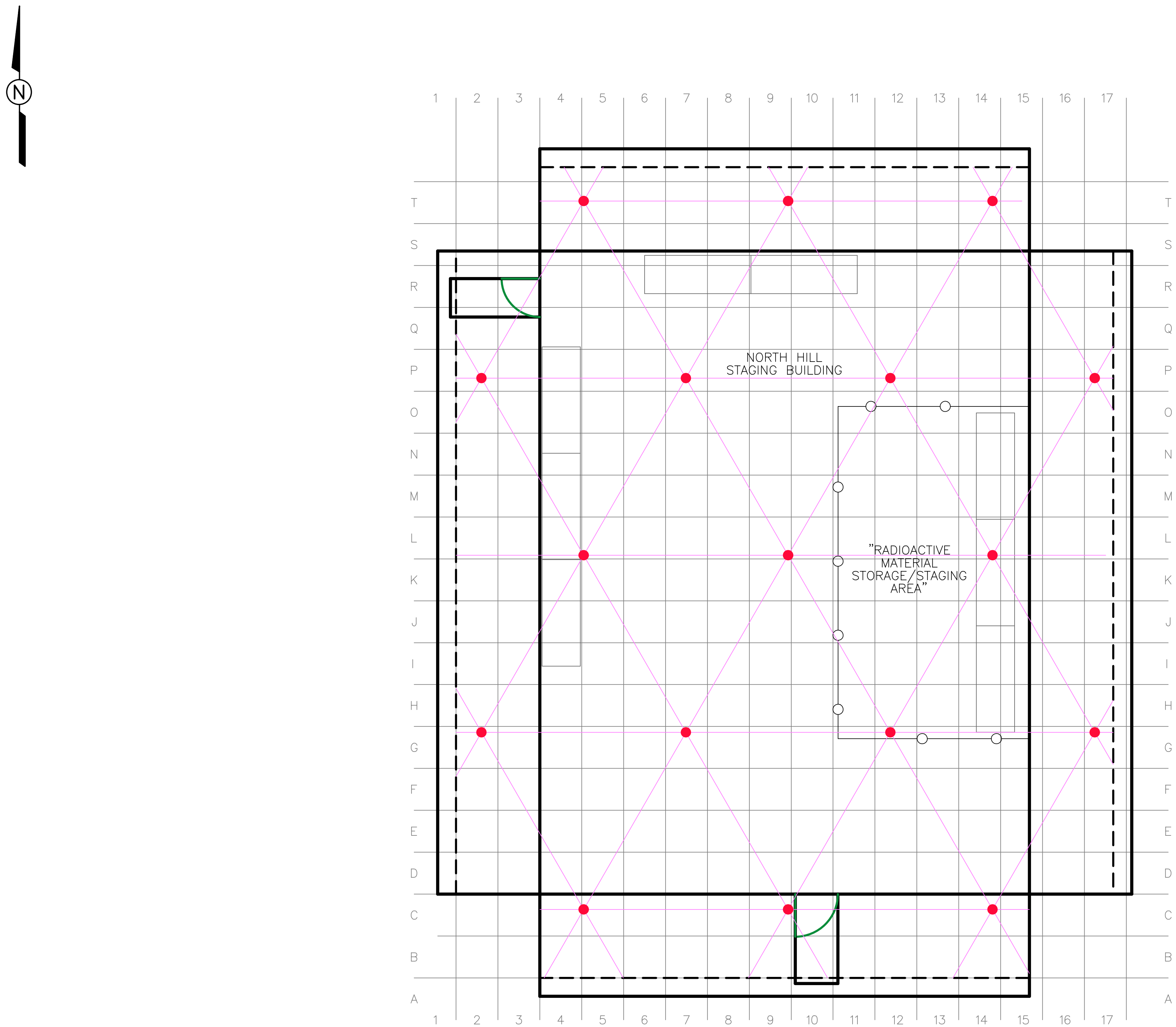
The survey unit was designed as a Class 2 building survey and the sample results are consistent with that classification. The variability of the survey results was less than the assumptions used for survey design therefore characterization survey results confirmed the FSS design. Decontamination was attempted at all areas of elevated activity. The activity was determined to be fixed, and was far enough below the $DCGL_w$ that no further action was deemed necessary.

Conclusion:

The FSS of this survey unit was properly designed as a Class 2 survey based on the decommissioning plan (DP). The required number of direct measurements was made and the scan coverage met the requirement of the DP. All of the direct measurements were less than the $DCGL_w$. Any identified elevated scans were appropriately investigated.

The measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

It is concluded that survey unit SU2-Hill meets the release criteria of 10CFR20.1402.



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 108.15 SQ. M.

   FLOOR SURFACE AREA: 179.41 SQ. M.

   TOTAL SURFACE AREA: 287.56 SQ. M.

2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.88 METERS.

SCALE IN METERS

0 3 6

FIGURE X-X
CLASS 2 SAMPLING LOCATIONS
IN NORTH HILL STAGING BUILDING
SU2-HILL

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

Attachment 2:
Instrumentation Used for Final Status Survey

	Removable Activity	Total Activity/Scans	
Instrument	Perkin Elmer TriCarb 2900TR	2360 S/N: 237279 43-68 S/N: PR190298	2360 S/N: 227437 43-37S/N: PR216990
Source Type	H-3/C-14	C-14	C-14
Source Strength in dpm	H-3: 271800 C-14: 129000	48343	48343
Efficiency	H-3: 63.60 C-14: 96.03	0.10	0.08
MDC in dpm/100cm^2	H-3: 19 C-14: 15	540	265
Background in cpm	H-3: 7 C-14: 11	186	629

Aptuit

Final Status Survey Summary Report

Survey Unit: SU3-B2

Building B Dock 5 and API Common

Prepared By:______________________________ **Date:** 3/11/14

Reviewed By:______________________________ **Date:** 3/18/14

Site Supervisor

Reviewed By: Rick Greene **Date:** 3/18/14

Project CHP

Approved By:______________________________ **Date:** 3/18/14

Radiation Safety Officer

FINAL STATUS SURVEY SUMMARY REPORT

Survey Unit:

SU3 – B2
Building B Dock 5 and API Common

Survey Unit Description:

This Class 3 survey unit consists of the floors in the API Common and Dock 5. Dock 5 is a shipping/receiving area and no contamination is anticipated in this area. API Common comprises the office area adjacent to the API labs. No radioactive materials were used in this area; however a spill from API migrated into this area and was previously remediated to below Aptuit's release limits.

Radionuclides of Concern:

Tritium (H-3) and C-14

Survey Unit Design Information:

The Survey Unit Design Parameters are presented below. Survey Unit details are presented in Table 1. The survey unit measurement locations are depicted on the map in Attachment 1. Fourteen direct measurement locations were needed to meet the design requirements of the statistical test. Scan coverage is required to be 10 to 100% of the impacted area. The survey design calls for wipe samples to be collected at each direct measurement location because of the lack of a reliable means to measure H-3 directly. Wipe samples are to be analyzed for H-3 and C-14 by liquid scintillation counter (LSC). The instruments to be used for the survey along with the minimum detectable concentration (MDC) values are listed in Attachment 2.

1. Scenario A is used. The null hypothesis for Scenario A is - "The residual radioactivity in the survey unit exceeds the release criterion."
2. The statistical test used in survey design was the Sign test. An average background will be subtracted from each measurement.
3. The derived concentration guideline level over a wide area ($DCGL_w$) for total activity was 10 percent of the NRC screening value for C-14, or 3.7E+05 dpm/100 cm^2.
4. The $DCGL_w$ for removable activity (H-3 plus C-14) was set at 10 percent of the $DCGL_w$ for fixed activity, or 3.7E+04 dpm/100 cm^2.
5. Characterization had not been completed at the time the final status survey (FSS) was planned therefore the average and standard deviation of the contamination in the survey unit was based on reasonable estimates. The characterization survey (CS) was designed to meet the data quality objectives (DQOs) of the FSS.

a. Lower bound of the gray region (LBGR) was set at 50% of the $DCGL_w$ or, 1.85E5 dpm/100 cm^2.

b. The standard deviation, σ, was assumed to be 30%[1]. 1.85E5 X 0.3 = 5.55E4 dpm/100 cm^2.

c. The relative shift (Δ/σ): $\Delta/\sigma = (DCGL_w - LBGR)/\sigma$

   $\Delta/\sigma = (3.7E5 - 1.85E5)/5.55E4 = 3.3$

d. A relative shift of 3 was used in survey planning since the calculated value was >3 (ref MARSSIM Chapter 5).

6. The Type I (α) and Type II (β) decision errors were each set at 0.05. For $\alpha=\beta=0.05$ and a relative shift of 3, the number of samples (n) required for each survey unit (from Table 5.5 of MARSSIM) for the Sign test is 14 (including a 20% contingency). Therefore at least 14 measurements were made in this survey unit to meet the requirements of the statistical tests.

[1] Abelquist, Decommissioning Health Physics, (Bristol UK, Institute of Physics Publishing), 272.

Table 1. Survey Unit Details

Survey Unit: SU3-B2

Final Status Survey Design Detail	Value	Comments
Survey Unit:	SU3-B2	
Areas in Survey Unit:	B2 Dock 5/API Common	
Survey Class:	3	
SU Floor Area (m^2):	192	
SU Total Area (m^2):	192	Class 1 and 2 includes walls up to 2 m and floor. Class 3 includes only
DCGL for C-14 (dpm/100cm^2):	370,000	Total Activity DCGL
DCGL for H-3/C-14 (dpm/100cm^2):	37,000	Removable H-3 + C-14
Number of Measurements Required:	14	
Survey Pattern:	Random	
Scan Coverage Required (%):	Discretion of survey team	
Triangular Grid Spacing L:	3.98	
Height of Triangle H:	3.45	

Final Status Survey Results:

A total of 15 direct measurements and smears were made in SU3 – B2 as part of the FSS. The results are shown in Table 2-1. Statistical data including the mean, median, and standard deviation are shown in Table 2-2. All of the direct measurements were less than the $DCGL_w$. All of the wipe sample results were less than the $DCGL_w$ and the sum of fractions for the combined measurements was less than 1. The FSS QC results are summarized in Table 2-3.

Characterization Survey Results:

The CS was designed to meet the DQOs of the FSS and was performed concurrently with the FSS. A summary of CS results is presented in Table 2-4. The CS results confirm: 1) the survey unit was properly classified 2) the assumptions used in FSS survey planning were valid.

Scan surveys were performed as part of the CS and the FSS. One scan location was identified as an area of elevated activity. The scan results are shown in Table 2-5.

Table 2-1. Measurement Results (Directs for C-14 & Wipes for H-3 and C-14)

Survey Unit: SU3-B2

Sample ID	Instrument ID	C-14 Direct				C-14 & H-3 Wipes (LSC S/N DG12061925)						Sum of Fractions
		Gross CPM	Background CPM	Net DPM (dpm/100 cm^2)	Comments[1]	H-3 CPM	H-3 DPM	C-14 CPM	C-14 DPM	H-3 + C-14 DPM	Comments[1]	
2	237279	313	325	-96		0	0	0	0	0		-2.60E-04
3	237279	331	325	54		0	0	2	2	2		2.01E-04
4	237279	290	325	-288		0	0	0	0	0		-7.79E-04
5	237279	282	226	472		2	5	0	0	5		1.41E-03
6	237279	236	233	29		1	2	0	0	2		1.33E-04
7	237279	299	226	614		0	0	6	7	7		1.85E-03
8	237279	270	233	313		0	0	6	8	8		1.06E-03
9	237279	259	233	221		2	7	0	0	7		7.88E-04
10	237279	254	226	238		0	0	10	12	12		9.68E-04
12	237279	274	233	347		0	1	0	0	1		9.64E-04
13	237279	266	233	280		6	16	0	0	16		1.19E-03
14	237279	198	226	-230		0	0	0	0	0		-6.21E-04
15	237279	263	233	255		0	0	0	0	0		6.89E-04
16	237279	214	226	-96		5	15	0	0	15		1.46E-04
17	237279	236	226	88	R	2	2	6	7	9	R	4.80E-04

[1] Indicate Replicates (R) in the "Comments" column

Result > 0.1 DCGL
Result > 0.5 DCGL
Result > DCGL

Table 2-2. Final Status Results Summary

Survey Unit: SU3-B2

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	151			5		
Median	230			4		
Standard Deviation	264			6		
Total Activity Range (Direct)	-288	to	614	N/A		
Removable Activity Range (Wipes)	0	to	12	0	to	16
Mean SOF	5.53E-04					
Number of FSS Systematic/Random Measurements	14			14		

Table 2-3. FSS QC Results Summary

Survey Unit: SU3-B2

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	12	1	63.82	23
C-14	10	31	1	96.32	23

$$\frac{3 + 3.29\sqrt{R_b\, t_g \left(1 + \frac{t_g}{t_b}\right)}}{(Efficiency)(t_g)}$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
214	236	0.10

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	15	2	1.53	RPD not relavent when result is less than MDC
C-14	0	7	2.00	RPD not relavent when result is less than MDC

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

H-3 spike	H-3 result	Relative bias (±0.2)
4174	3611	-0.13488

C-14 spike	C-14 result	Relative bias (±0.2)
4354	4440	0.01975

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Table 2-4. Characterization Survey Results Summary

Survey Unit: SU3-B2

	C-14 Activity (dpm/100 cm^2)			**H-3 + C-14 Activity** (dpm/100 cm^2)		
$DCGL_w$	370,000			37,000		
Mean	4632			39		
Median	4632			39		
Standard Deviation	N/A			N/A		
Total Activity Range (Direct)	4632	to	4632	N/A		
Removable Activity Range (Wipes)	39	to	39	39	to	39
Number of Characterization Survey Measurements	1			1		

Table 2-5. Scan Survey Results

Survey Unit: **SU3-B2**

Survey Area (m^2)	Area Scanned (m^2)	Percent Scanned (%)
192	103	54%

Location Number	Grid	Range (cpm)		
Scans performed with 43-37				
API Common 001	P4-L5	400	to	600
API Common 002	P8-L9	300	to	600
API Common 003	P12-L13	300	to	600
API Common 004	P16-L17	400	to	600
API Common 005	P19-L20	400	to	600
API Common 006	P23-L24	400	to	600
API Common 007	P26-L27	500	to	800
API Common 008	K1-J30	300	to	600
API Common 009	J15-J16	300	to	1300
Dock 5	H2-B5, H5-E7	500	to	800

Exceeds 2x Background

Survey Unit Data Assessment:

The survey design required 14 direct measurements and wipe samples for the Sign Test. Fifteen measurements were performed. All measurements and wipe sample results were less than the $DCGL_w$ and the sum of fractions was less than 1; therefore the survey unit meets the release criterion and the Sign test was not performed.

Survey Unit Investigations and Results:

During the scans, one area was identified as being elevated, above twice materials background for scanning. This area remains above twice materials background for scanning, however because the activity represented only a fraction of the DCGLw and was fixed, it was determined that further decontamination activities were unnecessary.

ALARA Statement:

The residual activity within the survey unit is less than the $DCGL_w$ and has been reduced to levels that are ALARA; therefore the ALARA criterion has been met.

Changes in Initial Survey Unit Assumptions:

The survey unit was designed as a Class 3 building survey and the sample results are consistent with that classification. The variability of the survey results was less than the assumptions used in survey design, therefore characterization survey results confirm the FSS design.

Conclusion:

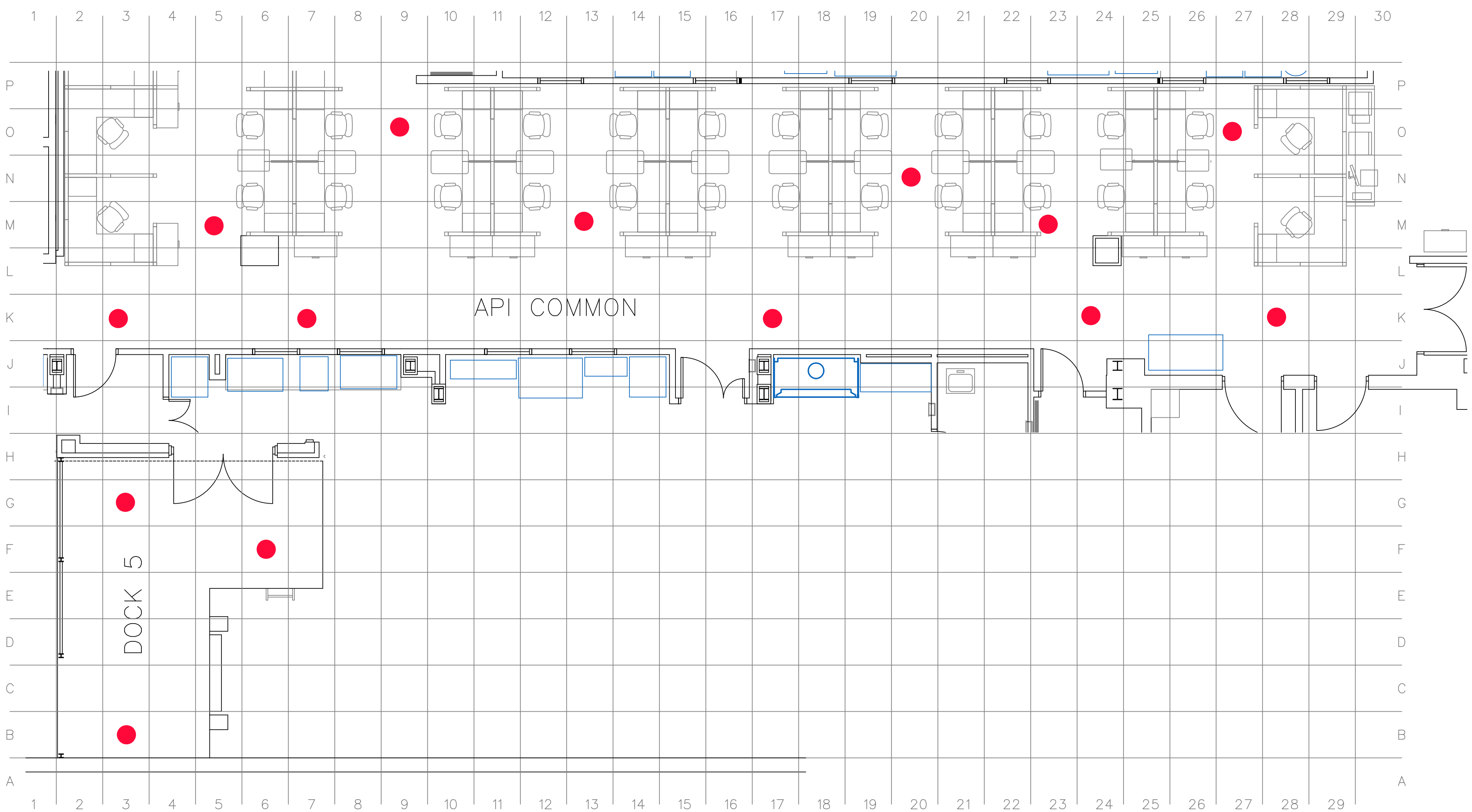
The FSS of this survey unit was properly designed as a Class 3 survey based on the decommissioning plan (DP). The required number of direct measurements was made and the scan coverage met the requirement of DP. All of the direct measurements were less than the $DCGL_w$. All identified elevated scans were appropriately investigated.

The measurement data support rejection of the null hypothesis, providing high confidence that the survey unit satisfied the release criteria and that the data quality objectives were met.

It is concluded that survey unit SU3 – B2 meets the release criteria of 10CFR20.1402.

LEGEND:

● RANDOM SAMPLE LOCATION



SCALE IN METERS

0 3 6

FIGURE X-X
CLASS 3 SAMPLING LOCATIONS
IN B2 DOCK AND API COMMONS
SU3-B2

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

aptuit_api_fssr_temp008.dgn sammccawley 1/10/2014 3:31:18 PM PDF_with_Levels.plt sei_textsub_only.tbl

Attachment 2:
Instrumentation Used for Final Status Survey

	Removable Activity	Total Activity/Scans	
Instrument	Perkin Elmer TriCarb 2900TR	2360 S/N: 237279 43-68 S/N: PR190298	2360 S/N: 227437 43-37 S/N: PR216990
Source Type	H-3/C-14	C-14	C-14
Source Strength in dpm	H-3: 271800 C-14: 129000	48343	48343
Efficiency	H-3: 63.82 C-14: 96.32	0.10	0.07
MDC in dpm/100cm^2	H-3: 23 C-14: 23	615	291
Background in cpm	H-3: 12 C-14: 31	230	617

APPENDIX C

DAILY INSTRUMENT CHECKS

Scaler Instrument Setup and Daily Check Sheet

Source Type	C-14	Source Activity	48343	dpm (decay corrected 2π emission rate)
Source ID:	E1-821	Calibration source area	150	cm^2
		Corrected emission rate	40608	
Date:	2/5/2014			

Background Measurements

Background Count Time = 1.00 minutes

Total counts observed:

176	180	Cb	195.50	counts
166	215			
196	205	SDb	22.43	counts
201	212			
169	235	Cbt	195.50	cpm

Average	196
-2SD	151
+2SD	240
-3SD	128
+3SD	263

= 1.00 minutes

Source counts

15741	15751	Cg	15831.20	counts
15564	15905			
15675	16042	SDg	155.49	counts
15964	15867			
15782	16021	Cn	15635.70	counts
		SDn	157.10	counts
		Cnt	15635.70	cpm

Instrument Eff. (Ei) 0.39 cpm/dpm

STATIC MDC

Sample Count Time	=	1.00	minutes
Instrument eff. (Ei)	=	0.39	
Surface eff. (Es)	=	0.25	
Total eff. (Et)	=	0.10	
Probe size (A) in cm	=	126.00	

Comparison of MDC equations

same times	MDC	554	dpm/100cm2
diff times	MDC	554	dpm/100cm2

Instrument/SN: Ludlum 2221 / 183987

Probe/SN: Ludlum 43-68 / PR289329

Calibration due date: 8/10/2014

Check-Source Reproducibility Determination

Source type C-14

Source ID E1-821

Source Count Time = 1.00 minute

Source Count Rate (cpm) observed:

15741	15751	Cg	15831.20	cpm
15564	15905			
15675	16042	SDg	155.49	cpm
15964	15867			
15782	16021	3SDg	466.48	cpm

Acceptable to use

Background Measurements

Cb 0 Cb

Daily Check Ranges	Average	+3SD	+2SD	-3SD	-2SD
Background	196	263	240	128	151
Check Source	15831	16298	16142	15365	15520

Graph Source Range	
+3SD	16298
+2SD	16142
	16064
	15987
	15909
Cg	15831
	15753
	15676
	15598
-2SD	15520
-3SD	15365

	+3SD	+2SD	avg	-3SD	-2SD
1	16298	16142	15831	15365	15520
2	16298	16142	15831	15365	15520
3	16298	16142	15831	15365	15520
4	16298	16142	15831	15365	15520
5	16298	16142	15831	15365	15520
6	16298	16142	15831	15365	15520
7	16298	16142	15831	15365	15520
8	16298	16142	15831	15365	15520
9	16298	16142	15831	15365	15520
10	16298	16142	15831	15365	15520
11	16298	16142	15831	15365	15520
12	16298	16142	15831	15365	15520
13	16298	16142	15831	15365	15520
14	16298	16142	15831	15365	15520
15	16298	16142	15831	15365	15520
16	16298	16142	15831	15365	15520
17	16298	16142	15831	15365	15520
18	16298	16142	15831	15365	15520
19	16298	16142	15831	15365	15520
20	16298	16142	15831	15365	15520
21	16298	16142	15831	15365	15520
22	16298	16142	15831	15365	15520
23	16298	16142	15831	15365	15520
24	16298	16142	15831	15365	15520
25	16298	16142	15831	15365	15520
26	16298	16142	15831	15365	15520
27	16298	16142	15831	15365	15520
28	16298	16142	15831	15365	15520
29	16298	16142	15831	15365	15520
30	16298	16142	15831	15365	15520
31	16298	16142	15831	15365	15520

Daily Source & Background Check

		SRC cpm		Background cpm	
Day	Date	SRC Start	SRC End	BKG Start	BKG End
1	2-5-14	15510	15715	209	232
2	2-6-14	15657		225	
3	2-7-14	15429		233	
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
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18					
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23					
24					
25					
26					
27					
28					
29					
30					
31					

NO +USIED

Scaler Instrument Setup and Daily Check Sheet

Source Type	C-14	Source Activity	48343	dpm (decay corrected 2π emission rate)
Source ID:	E1-821	Calibration source area	150	cm^2
		Corrected emission rate	40608	
Date:	10/25/13			

Background Measurements

Background Count Time = 1.00 minutes

Total counts observed:

187	240	Cb	224.20	counts
222	225			
243	225	SDb	15.51	counts
232	231			
218	219	Cbt	224.20	cpm

Average	224
-2SD	193
+2SD	255
-3SD	178
+3SD	271

= 1.00 minutes

15194	15383	Cg	15310.40	counts
15157	15509			
15264	15300	SDg	119.93	counts
15214	15346			
15250	15487	Cn	15086.20	counts
		SDn	120.93	counts
		Cnt	15086.20	cpm

Instrument Eff. (Ei) **0.37** cpm/dpm

STATIC MDC

Sample Count Time = 1.00 minutes

Instrument eff. (Ei) = 0.37

Surface eff. (Es) = 0.25

Total eff. (Et) = 0.09

Probe size (A) in cm = 126.00

Comparison of MDC equations

same times	MDC	623	dpm/100cm2
diff times	MDC	624	dpm/100cm2

Instrument/SN: Ludlum 2221 / 183987

Probe/SN: Ludlum 43-68 / PR289329

Calibration due date: 8/10/14

Check-Source Reproducibility Determination

Source type C-14

Source ID E1-821

Source Count Time =. 1.00 minute

Source Count Rate (cpm) observed:

15194	15383	Cg	15310.40	cpm
15157	15509			
15264	15300	SDg	119.93	cpm
15214	15346			
15250	15487	3SDg	359.79	cpm

Acceptable to use

Background Measurements

Cb **0 Cb**

Daily Check Ranges

	Average	+3SD	+2SD	-3SD	-2SD
Background	224	271	255	178	193
Check Source	15310	15670	15550	14951	15071

Graph Source Range

+3SD	15670
+2SD	15550
	15490
	15430
	15370
Cg	15310
	15250
	15190
	15131
-2SD	15071
-3SD	14951

	+3SD	+2SD	avg	-3SD	-2SD
1	15670	15550	15310	14951	15071
2	15670	15550	15310	14951	15071
3	15670	15550	15310	14951	15071
4	15670	15550	15310	14951	15071
5	15670	15550	15310	14951	15071
6	15670	15550	15310	14951	15071
7	15670	15550	15310	14951	15071
8	15670	15550	15310	14951	15071
9	15670	15550	15310	14951	15071
10	15670	15550	15310	14951	15071
11	15670	15550	15310	14951	15071
12	15670	15550	15310	14951	15071
13	15670	15550	15310	14951	15071
14	15670	15550	15310	14951	15071
15	15670	15550	15310	14951	15071
16	15670	15550	15310	14951	15071
17	15670	15550	15310	14951	15071
18	15670	15550	15310	14951	15071
19	15670	15550	15310	14951	15071
20	15670	15550	15310	14951	15071
21	15670	15550	15310	14951	15071
22	15670	15550	15310	14951	15071
23	15670	15550	15310	14951	15071
24	15670	15550	15310	14951	15071
25	15670	15550	15310	14951	15071
26	15670	15550	15310	14951	15071
27	15670	15550	15310	14951	15071
28	15670	15550	15310	14951	15071
29	15670	15550	15310	14951	15071
30	15670	15550	15310	14951	15071
31	15670	15550	15310	14951	15071

Daily Source & Background Check

Day	Date	SRC cpm		Background cpm	
		SRC Start	SRC End	BKG Start	BKG End
1	~~1-8-14~~	~~227~~		~~1~~	
2	~~1-8-14~~	~~15275~~		~~227~~	
3	1-8-14	14953	15233	227	253
4	1-21-14	15065	14982	200	221
5	1-23-14	15142		226	GR
6	1-24-14	15288	15021	227	241
7	1-29-14	15		181	
8	1-30-14	15669	~~15081~~	234	
9	1-31-14	15081		219	
10	2-3-14	14987		234	
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					

GR

Not used Cms 390
Not used 8500 DNU
DNU

Control limits

Background
-3σ $+3\sigma$
178 271
-20% +20%
179 269

Source
-3σ $+3\sigma$
14951 15670
-20% +20%
12248 18372

	+3SD	+2SD	avg	-3SD	-2SD
1	15670	15550	15310	14951	15071
2	15670	15550	15310	14951	15071
3	15670	15550	15310	14951	15071
4	15670	15550	15310	14951	15071
5	15670	15550	15310	14951	15071
6	15670	15550	15310	14951	15071
7	15670	15550	15310	14951	15071
8	15670	15550	15310	14951	15071
9	15670	15550	15310	14951	15071
10	15670	15550	15310	14951	15071
11	15670	15550	15310	14951	15071
12	15670	15550	15310	14951	15071
13	15670	15550	15310	14951	15071
14	15670	15550	15310	14951	15071
15	15670	15550	15310	14951	15071
16	15670	15550	15310	14951	15071
17	15670	15550	15310	14951	15071
18	15670	15550	15310	14951	15071
19	15670	15550	15310	14951	15071
20	15670	15550	15310	14951	15071
21	15670	15550	15310	14951	15071
22	15670	15550	15310	14951	15071
23	15670	15550	15310	14951	15071
24	15670	15550	15310	14951	15071
25	15670	15550	15310	14951	15071
26	15670	15550	15310	14951	15071
27	15670	15550	15310	14951	15071
28	15670	15550	15310	14951	15071
29	15670	15550	15310	14951	15071
30	15670	15550	15310	14951	15071
31	15670	15550	15310	14951	15071

Daily Source & Background Check

		SRC cpm		Background cpm		
Day	Date	SRC Start	SRC End	BKG Start	BKG End	
1	10/25/13	~~222~~ 15,241	15,621	222	243	
2	10/30/13	15461	15331	255	245	
3	10/31/13	15307	15592	251	269	
4	~~10/~~ 11/01/13	15017	15581	183	246	
5	11/02/13	15650	15558	243	254	
6	11/04/13	15477	15603	243	230	
7	11/05/13	15352	15432	220	249	
8	11/06/13	15320	15628	228	231	
9	11/07/13	15237	15473	236	260	
10	11/11/13	15523	15081	234	239	
11	11/12/13	14957	15001	220	223	
12	11/13/13	15023	15395	202	255	
13	11/14/13	15442	15063	255	232	
14	11/15/13	15375	14981	211	242	
15	11/16/13	15611	15547	258	252	
16	11/18/13	15103	15178	256	271	
17	11/19/13	15188	15287	263	218	
18	11/20/13	15560	15390	263	247	
19	11/21/13	15519	15516	257	260	
20	11/22/13	14987		246		
21	11/26/13	15164	15237	239	246	
22	12/02/13	15603	15546	260	242	
23	12/03/13	15645	15600	222	329	* check in AM.
24	12/16/13	15050	15603	209	218	
25	12/17/13	15421	15920	207	248	
26	12/18/13	15256	15862	224	250	
27	12/19/13	15858	16316	210	263	
28	12/20/13	15555	16132	231	260	
29	1-3-14	15321	15558	202	235	
30	1-6-14	15090	14979	215	262	
31	1-7-14	15139	15101	211	228	

Control limits

Background		Source	
-3σ	$+3\sigma$	-3σ	$+3\sigma$
178 ~~164~~	271 ~~273~~	14951	15670
−20%	+20%	−20%	+20%
179 ~~175~~	269 ~~262~~	12248	18372

Scaler Instrument Setup and Daily Check Sheet

Source Type	C-14	Source Activity	48343	dpm (decay corrected 2π emission rate)
Source ID:	E1-821	Calibration source area	150	cm^2
		Corrected emission rate	40608	
Date:	8/20/2013			

Background Measurements

Background Count Time = 1.00 minutes

Total counts observed:

240	236	Cb	218.30	counts
210	228			
230	204	SDb	18.15	counts
196	227			
226	186	Cbt	218.30	cpm

Average	218
-2SD	182
+2SD	255
-3SD	164
+3SD	273

= 1.00 minutes

Source counts

15510	15527	Cg	15613.70	counts
15879	15630			
15502	15538	SDg	115.39	counts
15580	15713			
15604	15654	Cn	15395.40	counts
		SDn	116.81	counts
		Cnt	15395.40	cpm

Instrument Eff. (Ei) 0.38 cpm/dpm

STATIC MDC

Sample Count Time = 1.00 minutes

Instrument eff. (Ei) = 0.38

Surface eff. (Es) = 0.25

Total eff. (Et) = 0.10

Probe size (A) in cm = 126.00

Comparison of MDC equations

same times	MDC	599	dpm/100cm2
diff times	MDC	599	dpm/100cm2

Instrument/SN: Ludlum 2221 / 183987

Probe/SN: Ludlum 43-68 / PR289329

Calibration due date: 8/10/2014

Check-Source Reproducibility Determination

Source type C-14

Source ID E1-821

Source Count Time = 1.00 minute

Source Count Rate (cpm) observed:

15510	15527	Cg	15613.70	cpm
15879	15630			
15502	15538	SDg	115.39	cpm
15580	15713			
15604	15654	3SDg	346.18	cpm

Acceptable to use

Background Measurements

Cb **0 Cb**

Daily Check Ranges

	Average	+3SD	+2SD	-3SD	-2SD
Background	218	273	255	164	182
Check Source	15614	15960	15844	15268	15383

Graph Source Range

+3SD	15960
+2SD	15844
	15787
	15729
	15671
Cg	15614
	15556
	15498
	15441
-2SD	15383
-3SD	15268

	+3SD	+2SD	avg	-3SD	-2SD
1	15960	15844	15614	15268	15383
2	15960	15844	15614	15268	15383
3	15960	15844	15614	15268	15383
4	15960	15844	15614	15268	15383
5	15960	15844	15614	15268	15383
6	15960	15844	15614	15268	15383
7	15960	15844	15614	15268	15383
8	15960	15844	15614	15268	15383
9	15960	15844	15614	15268	15383
10	15960	15844	15614	15268	15383
11	15960	15844	15614	15268	15383
12	15960	15844	15614	15268	15383
13	15960	15844	15614	15268	15383
14	15960	15844	15614	15268	15383
15	15960	15844	15614	15268	15383
16	15960	15844	15614	15268	15383
17	15960	15844	15614	15268	15383
18	15960	15844	15614	15268	15383
19	15960	15844	15614	15268	15383
20	15960	15844	15614	15268	15383
21	15960	15844	15614	15268	15383
22	15960	15844	15614	15268	15383
23	15960	15844	15614	15268	15383
24	15960	15844	15614	15268	15383
25	15960	15844	15614	15268	15383
26	15960	15844	15614	15268	15383
27	15960	15844	15614	15268	15383
28	15960	15844	15614	15268	15383
29	15960	15844	15614	15268	15383
30	15960	15844	15614	15268	15383
31	15960	15844	15614	15268	15383

Daily Source & Background Check

		SRC cpm		Background cpm		
Day	Date	SRC Start	SRC End	BKG Start	BKG End	
1	8/21/13	15339	15910	208	248	
2	10/3/13	15461	15801	210	247	
3	10-21-13	15549		211		DNU
4	10-22-13	15904	15909	210	245	
5	10-23-13	15450	15676	215	250	
6	10-24-13	15617	15664	225	267	
7	10-25-13	15298		195	241	
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Scaler Instrument Setup and Daily Check Sheet

Source Type	C-14	Source Activity	48343 dpm (decay corrected 2π emission rate)
Source ID:	E1-821	Calibration source area	150 cm^2
		Corrected emission rate	40608
Date:	4/9/2013		

Background Measurements

Background Count Time = 1.00 minutes

Total counts observed:

269	274	Cb	263.40	counts	Average	263
268	267				-2SD	229
229	238	SDb	16.95	counts	+2SD	297
263	268				-3SD	213
285	273	Cbt	263.40	cpm	+3SD	314

= 1.00 minutes

Source counts

16554	16542	Cg	16677.10	counts
16542	16475			
16854	16939	SDg	159.15	counts
16687	16863			
16649	16666	Cn	16413.70	counts
		SDn	160.05	counts
		Cnt	16413.70	cpm

Instrument Eff. (Ei) 0.40 cpm/dpm

STATIC MDC

Sample Count Time = 1.00 minutes

Instrument eff. (Ei) = 0.40

Surface eff. (Es) = 0.25

Total eff. (Et) = 0.10

Probe size (A) in cm = 126.00

Comparison of MDC equations

same times	MDC	623	dpm/100cm2
diff times	MDC	623	dpm/100cm2

Instrument/SN: Ludlum 2221 / 183987

Probe/SN: Ludlum 43-68 / PR289329

Calibration due date: 3/20/2014

Check-Source Reproducibility Determination

Source type C-14

Source ID E1-821 48343

Source Count Time = 1.00 minute

Source Count Rate (cpm) observed:

16554	16542	Cg	16677.10	cpm
16542	16475			
16854	16939	SDg	159.15	cpm
16687	16863			
16649	16666	3SDg	477.45	cpm

Acceptable to use

Background Measurements

Cb 0 Cb

Daily Check Ranges

	Average	+3SD	+2SD	-3SD	-2SD
Background	263	314	297	213	229
Check Source	16677	17155	16995	16200	16359

Graph Source Range	
+3SD	17155
+2SD	16995
	16916
	16836
	16757
Cg	16677
	16598
	16518
	16438
-2SD	16359
-3SD	16200

	+3SD	+2SD	avg	-3SD	-2SD
1	17155	16995	16677	16200	16359
2	17155	16995	16677	16200	16359
3	17155	16995	16677	16200	16359
4	17155	16995	16677	16200	16359
5	17155	16995	16677	16200	16359
6	17155	16995	16677	16200	16359
7	17155	16995	16677	16200	16359
8	17155	16995	16677	16200	16359
9	17155	16995	16677	16200	16359
10	17155	16995	16677	16200	16359
11	17155	16995	16677	16200	16359
12	17155	16995	16677	16200	16359
13	17155	16995	16677	16200	16359
14	17155	16995	16677	16200	16359
15	17155	16995	16677	16200	16359
16	17155	16995	16677	16200	16359
17	17155	16995	16677	16200	16359
18	17155	16995	16677	16200	16359
19	17155	16995	16677	16200	16359
20	17155	16995	16677	16200	16359
21	17155	16995	16677	16200	16359
22	17155	16995	16677	16200	16359
23	17155	16995	16677	16200	16359
24	17155	16995	16677	16200	16359
25	17155	16995	16677	16200	16359
26	17155	16995	16677	16200	16359
27	17155	16995	16677	16200	16359
28	17155	16995	16677	16200	16359
29	17155	16995	16677	16200	16359
30	17155	16995	16677	16200	16359
31	17155	16995	16677	16200	16359

Daily Source & Background Check

		SRC cpm		Background cpm	
Day	Date	SRC Start	SRC End	BKG Start	BKG End
1	04/30/13	16,690	17012	293	302
2	05/06/13	16,390	16518	240	257
3	05/09/13	16,270	16,678	290	220
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31					

Scaler Instrument Setup and Daily Check Sheet

Source Type	C-14	Source Activity	48343	dpm (decay corrected 2π emission rate)
Source ID:	E1-821	Calibration source area	150	cm^2
		Corrected emission rate	40608	
Date:	3/4/2013			

Background Measurements

Background Count Time = 1.00 minutes

Total counts observed:

258	245	Cb	246.70	counts
252	218			
261	244	SDb	12.53	counts
239	247			
259	244	Cbt	246.70	cpm

Average	247
-2SD	222
+2SD	272
-3SD	209
+3SD	284

= 1.00 minutes

Source counts

16755	16561	Cg	16555.80	counts
16658	16309			
16843	16297	SDg	175.40	counts
16610	16575			
16475	16475	Cn	16309.10	counts
		SDn	175.85	counts
		Cnt	16309.10	cpm
		Instrument Eff. (Ei)	0.40	cpm/dpm

STATIC MDC

Sample Count Time	=	1.00	minutes
Instrument eff. (Ei)	=	0.40	
Surface eff. (Es)	=	0.25	
Total eff. (Et)	=	0.10	
Probe size (A) in cm	=	126.00	

Comparison of MDC equations

same times	MDC	604	dpm/100cm2
diff times	MDC	604	dpm/100cm2

Instrument/SN:	Ludlum 2221	/	183987
Probe/SN:	Ludlum 43-68	/	PR289329
Calibration due date:	8/9/2013		

Check-Source Reproducibility Determination

Source type	C-14	
Source ID	E1-821	48343

Source Count Time = 1.00 minute

Source Count Rate (cpm) observed:

16755	16561	Cg	16555.80	cpm
16658	16309			
16843	16297	SDg	175.40	cpm
16610	16575			
16475	16475	3SDg	526.20	cpm

Acceptable to use

Background Measurements

Cb 0 **Cb**

Daily Check Ranges

	Average	+3SD	+2SD	-3SD	-2SD
Background	247	284	272	209	222
Check Source	16556	17082	16907	16030	16205

Graph Source Range	
+3SD	17082
+2SD	16907
	16819
	16731
	16644
Cg	16556
	16468
	16380
	16293
-2SD	16205
-3SD	16030

	+3SD	+2SD	avg	-3SD	-2SD
1	17082	16907	16556	16030	16205
2	17082	16907	16556	16030	16205
3	17082	16907	16556	16030	16205
4	17082	16907	16556	16030	16205
5	17082	16907	16556	16030	16205
6	17082	16907	16556	16030	16205
7	17082	16907	16556	16030	16205
8	17082	16907	16556	16030	16205
9	17082	16907	16556	16030	16205
10	17082	16907	16556	16030	16205
11	17082	16907	16556	16030	16205
12	17082	16907	16556	16030	16205
13	17082	16907	16556	16030	16205
14	17082	16907	16556	16030	16205
15	17082	16907	16556	16030	16205
16	17082	16907	16556	16030	16205
17	17082	16907	16556	16030	16205
18	17082	16907	16556	16030	16205
19	17082	16907	16556	16030	16205
20	17082	16907	16556	16030	16205
21	17082	16907	16556	16030	16205
22	17082	16907	16556	16030	16205
23	17082	16907	16556	16030	16205
24	17082	16907	16556	16030	16205
25	17082	16907	16556	16030	16205
26	17082	16907	16556	16030	16205
27	17082	16907	16556	16030	16205
28	17082	16907	16556	16030	16205
29	17082	16907	16556	16030	16205
30	17082	16907	16556	16030	16205
31	17082	16907	16556	16030	16205

Daily Source & Background Check

		SRC cpm		Background cpm	
Day	Date	SRC Start	SRC End	BKG Start	BKG End
1	03/04/13	16574	16299	229	263
2	03/05/13	16252	16151	222	229
3	~~04/03/13~~			~~221~~	
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Scaler Instrument Setup and Daily Check Sheet

Source Type	C-14	Source Activity	48343	dpm (decay corrected 2π emission rate)
Source ID:	E1-821	Calibration source area	150	cm^2
		Corrected emission rate	40608	
Date:	9/21/2012			

Instrument/SN: Ludlum 2221 / 183987

Probe/SN: Ludlum 43-68 / PR289329

Calibration due date: 4/22/2012

Background Measurements

Background Count Time = 1.00 minutes

Total counts observed:

174	216	**Cb**	178.00	counts
155	157			
176	186	**SDb**	17.69	counts
192	182			
173	169	**Cbt**	**178.00**	cpm

Average	**178**
-2SD	**143**
+2SD	**213**
-3SD	**125**
+3SD	**231**

= 1.00 minutes

Source counts

17609	17657	**Cg**	17488.80	counts
17583	17521			
17655	17419	**SDg**	143.08	counts
17516	17338			
17279	17311	**Cn**	17310.80	counts
		SDn	144.17	counts
		Cnt	17310.80	cpm

Instrument Eff. (Ei) 0.43 cpm/dpm

STATIC MDC

Sample Count Time = 1.00 minutes

Instrument eff. (Ei) = 0.43

Surface eff. (Es) = 0.25

Total eff. (Et) = 0.11

Probe size (A) in cm = 126.00

Comparison of MDC equations

same times	MDC	480	dpm/100cm2
diff times	MDC	480	dpm/100cm2

Check-Source Reproducibility Determination

Source type: C-14

Source ID: E1-821 48343

Source Count Time = 1.00 minute

Source Count Rate (cpm) observed:

17609	17657	**Cg**	17488.80	cpm
17583	17521			
17655	17419	**SDg**	143.08	cpm
17516	17338			
17279	17311	**3SDg**	429.25	cpm

Acceptable to use

Background Measurements

Cb **0 Cb**

Daily Check Ranges

	Average	+3SD	+2SD	-3SD	-2SD
Background	178	231	213	125	143
Check Source	17489	17918	17775	17060	17203

Graph Source Range	
+3SD	17918
+2SD	17775
	17703
	17632
	17560
Cg	17489
	17417
	17346
	17274
-2SD	17203
-3SD	17060

Daily Source & Background Check

	+3SD	+2SD	avg	-3SD	-2SD	Day	Date	SRC cpm SRC Start	SRC End	Background cpm BKG Start	BKG End	
1	17918	17775	17489	17060	17203	1	01-24-13	17554		160		Did Not USE
2	17918	17775	17489	17060	17203	2	01-25-13	17178	17565	172	178	
3	17918	17775	17489	17060	17203	3	01-29-13	17502	17784	184	230	
4	17918	17775	17489	17060	17203	4	01-30-13	17594	17499	193	198	
5	17918	17775	17489	17060	17203	5	01-31-13	17162	17765	203	215	
6	17918	17775	17489	17060	17203	6	02-01-13	17317		185		Did not use G2
7	17918	17775	17489	17060	17203	7	~~02-04-13~~	~~17300~~	~~195~~	~~210~~		GB
8	17918	17775	17489	17060	17203	8	02-04-13	17300	17198	216	195	
9	17918	17775	17489	17060	17203	9	02-05-13	17481	17389	223	211	
10	17918	17775	17489	17060	17203	10	2-6-12	17208	17466	184	216	
11	17918	17775	17489	17060	17203	~~11~~	~~02-7-13~~					G2
12	17918	17775	17489	17060	17203	12	02-07-13	17094	17278	201	204	
13	17918	17775	17489	17060	17203	13	02-08-13	17093	17146	225	191	
14	17918	17775	17489	17060	17203	14	02-11-13	17442	17613	218	216	
15	17918	17775	17489	17060	17203	15	02-12-13	17211	17658	198	219	
16	17918	17775	17489	17060	17203	16	02-13-13	17849	17812	218	224	
17	17918	17775	17489	17060	17203	17	02-14-13	17457	17558	208	221	
18	17918	17775	17489	17060	17203	18	02-15-13	17064	17206	220	219	
19	17918	17775	17489	17060	17203	19	02/21/13			166		Did not use.
20	17918	17775	17489	17060	17203	20	02/23/13	17497	17410	200	196	
21	17918	17775	17489	17060	17203	21	02/25/13	17600	17363	172	232	
22	17918	17775	17489	17060	17203	22	02-27-13	17151	17185	227	213	
23	17918	17775	17489	17060	17203	23	02-28-13	17197	17123	227	204	
24	17918	17775	17489	17060	17203	24	03-01-13	17534	17481	229	218	
25	17918	17775	17489	17060	17203	~~25~~	~~03-04-13~~					
26	17918	17775	17489	17060	17203	26						
27	17918	17775	17489	17060	17203	27						
28	17918	17775	17489	17060	17203	28						
29	17918	17775	17489	17060	17203	29						
30	17918	17775	17489	17060	17203	30						
31	17918	17775	17489	17060	17203	31						

Instrument re-setup

Scaler Instrum[illegible]ion Setup Sheet

	+3SD	+2SD	avg	-3SD	-2SD
1	17535	17376	17058	16580	16739
2	17535	17376	17058	16580	16739
3	17535	17376	17058	16580	16739
4	17535	17376	17058	16580	16739
5	17535	17376	17058	16580	16739
6	17535	17376	17058	16580	16739
7	17535	17376	17058	16580	16739
8	17535	17376	17058	16580	16739
9	17535	17376	17058	16580	16739
10	17535	17376	17058	16580	16739
11	17535	17376	17058	16580	16739
12	17535	17376	17058	16580	16739
13	17535	17376	17058	16580	16739
14	17535	17376	17058	16580	16739
15	17535	17376	17058	16580	16739
16	17535	17376	17058	16580	16739
17	17535	17376	17058	16580	16739
18	17535	17376	17058	16580	16739
19	17535	17376	17058	16580	16739
20	17535	17376	17058	16580	16739
21	17535	17376	17058	16580	16739
22	17535	17376	17058	16580	16739
23	17535	17376	17058	16580	16739
24	17535	17376	17058	16580	16739
25	17535	17376	17058	16580	16739
26	17535	17376	17058	16580	16739
27	17535	17376	17058	16580	16739
28	17535	17376	17058	16580	16739
29	17535	17376	17058	16580	16739
30	17535	17376	17058	16580	16739
31	17535	17376	17058	16580	16739

Daily Source & Background Check

		SRC cpm		Background cpm		
Day	Date	SRC Start	SRC End	BKG Start	BKG End	
1	04/27/12	17,141		140		- not used
2	04/30/12	16,774	17502	144	149	
3	05/02/12	16,660	17358	145	166	
4	05/08/12	17,155	17218	167	171	
5	05/10/12	17,283	17447	148	168	
6	05/16/12	16,870		135		- not used
7	05/29/12	17186	17308	138	147	
8	05/30/12	16733	16918	135	152	
9	06/04/12	16944	17259	175	149	
10	06/07/12	16947	16644	182	160	
11	06/18/12	17281	17149	166	170	
12	06/27/12	16903		148		- Not used
13	07/07/12	16897	16964	176	153	
14	01-14-13	16793	17131	172	201	
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N/A

Scaler Instrum etup and Daily Check Sheet

Source Type	C-14	Source Activity	48343	dpm (decay corrected 2π emission rate)
Source ID:	E1-821	Calibration source area	150	cm^2
		Corrected emission rate	40608	

Date: 1/21/14

Background Measurements

Background Count Time = **1.00** minutes

Total counts observed:

227	225	**Cb**	230.30	counts
221	231			
205	214	**SDb**	16.27	counts
229	250			
242	259	**Cbt**	**230.30**	cpm

Average	**230**
-2SD	**198**
+2SD	**263**
-3SD	**181**
+3SD	**279**

= **1.00** minutes

Source counts

15598	15692	**Cg**	15646.10	counts
15500	15638			
15571	15946	**SDg**	179.86	counts
15895	15516			
15744	15361	**Cn**	15415.80	counts
		SDn	180.60	counts
		Cnt	15415.80	cpm

Instrument Eff. (Ei) **0.38** cpm/dpm

STATIC MDC

Sample Count Time	=	**1.00**	minutes
Instrument eff. (Ei)	=	**0.38**	
Surface eff. (Es)	=	**0.25**	
Total eff. (Et)	=	0.10	
Probe size (A) in cm	=	**126.00**	

Comparison of MDC equations

same times	MDC	**615**	dpm/100cm2
diff times	MDC	**615**	dpm/100cm2

Instrument/SN: Ludlum 2360 / 237279

Probe/SN: Ludlum 43-68 / PR190298

Calibration due date: 4/18/14

Check-Source Reproducibility Determination

Source type C-14

Source ID E1-821

Source Count Time = **1.00** minute

Source Count Rate (cpm) observed:

15598	15692	**Cg**	15646.10	cpm
15500	15638			
15571	15946	**SDg**	179.86	cpm
15895	15516			
15744	15361	**3SDg**	539.59	cpm

Acceptable to use

Background Measurements

227	225
221	231
205	214
229	250
242	259
Cb	**230 Cb**

Daily Check Ranges

	Average	+3SD	+2SD	-3SD	-2SD
Background	230	279	263	181	198
Check Source	15646	16186	16006	15107	15286

Graph Source Range

+3SD	16186
+2SD	16006
	15916
	15826
	15736
Cg	15646
	15556
	15466
	15376
-2SD	15286
-3SD	15107

Day	+3SD	+2SD	avg	-3SD	-2SD
1	16186	16006	15646	15107	15286
2	16186	16006	15646	15107	15286
3	16186	16006	15646	15107	15286
4	16186	16006	15646	15107	15286
5	16186	16006	15646	15107	15286
6	16186	16006	15646	15107	15286
7	16186	16006	15646	15107	15286
8	16186	16006	15646	15107	15286
9	16186	16006	15646	15107	15286
10	16186	16006	15646	15107	15286
11	16186	16006	15646	15107	15286
12	16186	16006	15646	15107	15286
13	16186	16006	15646	15107	15286
14	16186	16006	15646	15107	15286
15	16186	16006	15646	15107	15286
16	16186	16006	15646	15107	15286
17	16186	16006	15646	15107	15286
18	16186	16006	15646	15107	15286
19	16186	16006	15646	15107	15286
20	16186	16006	15646	15107	15286
21	16186	16006	15646	15107	15286
22	16186	16006	15646	15107	15286
23	16186	16006	15646	15107	15286
24	16186	16006	15646	15107	15286
25	16186	16006	15646	15107	15286
26	16186	16006	15646	15107	15286
27	16186	16006	15646	15107	15286
28	16186	16006	15646	15107	15286
29	16186	16006	15646	15107	15286
30	16186	16006	15646	15107	15286
31	16186	16006	15646	15107	15286

Daily Source & Background Check

Day	Date	SRC cpm SRC Start	SRC End	Background cpm BKG Start	BKG End
1	1/21/14	15520	15436	251	235
2	1/23/14	15631	15779	247	257
3	1-24-14	15307	15650	270	277
4	1-29-14	15821	15613	256	265
5	1-30-14	15687	15640	242	268
6	1-31-14	15554	15595	252	263
7	~~2-3-14~~				
8	2-3-14	~~15474~~	15623	236	272
9	2-5-14	15626	15777	258	262
10	2-6-14	15460	15595	258	257
11	2-7-14	15777	15623	254	274
12	2-10-14	15574	15372	279	264
13	2-11-14	15325	15462	252	273
14	2-12-14	15703	15714	276	244
15	2-13-14	15360	15778	267	279
16	2-14-14	15649	15312	260	239
17	2-25-14	15799		276	
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					

mp
~~not used~~
GAS 190
GAS 550
NEW TANK 1850
1850

~~178~~-
181 - 279

Scaler Ins[...]ent Setup and Daily Check Sheet

Source Type: **C-14**
Source ID: E1-821

Source Activity: **48343** dpm (decay corrected 2π emission rate)
Calibration source area: **150** cm^2
Corrected emission rate: **40608**

Date: 8/20/2013

Background Measurements

Background Count Time = **1.00** minutes

Total counts observed:

233	234
205	207
221	196
192	216
207	171

Cb	208.20	counts
SDb	19.19	counts
Cbt	**208.20**	cpm

Average	**208**
-2SD	**170**
+2SD	**247**
-3SD	**151**
+3SD	**266**

= **1.00** minutes

Source counts

15348	15680
15716	15717
15730	15807
15698	15571
15538	15639

Cg	15644.40	counts
SDg	130.34	counts
Cn	15436.20	counts
SDn	131.74	counts
Cnt	15436.20	cpm

Instrument Eff. (Ei) **0.38** cpm/dpm

STATIC MDC

Sample Count Time = **1.00** minutes

Instrument eff. (Ei) = **0.38**

Surface eff. (Es) = **0.25**
Total eff. (Et) = **0.10**
Probe size (A) in cm = **126.00**

Comparison of MDC equations

same times	MDC	**586**	dpm/100cm2
diff times	MDC	**586**	dpm/100cm2

Instrument/SN: Ludlum 2360 / 237279

Probe/SN: Ludlum 43-68 / PR190298
Calibration due date: 4/18/2014

Check-Source Reproducibility Determination

Source type: C-14
Source ID: E1-821

Source Count Time = **1.00** minute

Source Count Rate (cpm) observed:

15348	15680
15716	15717
15730	15807
15698	15571
15538	15639

Cg	15644.40	cpm
SDg	130.34	cpm
3SDg	391.02	cpm

Acceptable to use

Background Measurements

Cb **0 Cb**

Daily Check Ranges

	Average	+3SD	+2SD	-3SD	-2SD
Background	208	266	247	151	170
Check Source	15644	16035	15905	15253	15384

Graph Source Range	
+3SD	16035
+2SD	15905
	15840
	15775
	15710
Cg	15644
	15579
	15514
	15449
-2SD	15384
-3SD	15253

	+3SD	+2SD	avg	-3SD	-2SD
1	16035	15905	15644	15253	15384
2	16035	15905	15644	15253	15384
3	16035	15905	15644	15253	15384
4	16035	15905	15644	15253	15384
5	16035	15905	15644	15253	15384
6	16035	15905	15644	15253	15384
7	16035	15905	15644	15253	15384
8	16035	15905	15644	15253	15384
9	16035	15905	15644	15253	15384
10	16035	15905	15644	15253	15384
11	16035	15905	15644	15253	15384
12	16035	15905	15644	15253	15384
13	16035	15905	15644	15253	15384
14	16035	15905	15644	15253	15384
15	16035	15905	15644	15253	15384
16	16035	15905	15644	15253	15384
17	16035	15905	15644	15253	15384
18	16035	15905	15644	15253	15384
19	16035	15905	15644	15253	15384
20	16035	15905	15644	15253	15384
21	16035	15905	15644	15253	15384
22	16035	15905	15644	15253	15384
23	16035	15905	15644	15253	15384
24	16035	15905	15644	15253	15384
25	16035	15905	15644	15253	15384
26	16035	15905	15644	15253	15384
27	16035	15905	15644	15253	15384
28	16035	15905	15644	15253	15384
29	16035	15905	15644	15253	15384
30	16035	15905	15644	15253	15384
31	16035	15905	15644	15253	15384

Daily Source & Background Check

Day	Date	SRC cpm SRC Start	SRC End	Background cpm BKG Start	BKG End	
1	10-21-13	15595		193		Not used
2	10-22-13	15477	15624	236	237	Not Used
3	10-23-13	15576		226		
4	10/24/13	15837	15546	234	244	
5	10/25/13	15627	15870	246	261	
6	10/26/13	15914		248		Not used
7	10/28/13	15482	15944	258	229	
8	10/29/13	15894	15902	231	255	
9	10/30/13	15898	15703	244	246	
10	10/31/13	15417	15687	245	231	
11	11/01/13	15766		239		DNU
12	12-04-13	15739	15809	207	209	
13	12-06-13	15809	15861	233	216	
14	12-09-13	15673	15735	241	199	
15	12-10-13	15562	15470	236	186	
16	12-11-13	15413	15389	201	189	
17	12-12-13	15456	15344	212	231	
18	12/13/13	16592	14668	217	210	
19	12/16/13	15386	15102	225	196	
20	12/17/13	14808	15245	202	236	
21	12/18/13	15324	15963	251	244	
22	12/19/13	15473	14466	247	240	
23	12/20/13	14897	15763	~~251~~ 190	223	← 1st bkg reading high, wiped probe, some contamination removed.
24	1-7-14	15565	15384	255	264	
25	1-8-14	15275	15460	227	262	PSI 450
26	1-9-14	15372	15570	245	235	
27	1/15/14	15308	15260	197	261	450
28	1/29/14	15401	15374	226	258	~~450~~ 425psi
29						
30						
31						

Control limits

Background		Source	
-3σ	+3σ	-3σ	+3σ
151	266	15253	16035
-20%	+20%	-20%	+20%
167	250	12516	18773

Scaler Instr ent Setup and Daily Check Sheet

Source Type: C-14
Source ID: E1-821

Source Activity: 48343 dpm (decay corrected 2π emission rate)
Calibration source area: 150 cm^2
Corrected emission rate: 40608

Date: 5/10/2012

Background Measurements

Background Count Time = 1.00 minutes

Total counts observed:

175	197
202	177
187	193
179	186
170	191

Cb 185.70 counts
SDb 10.32 counts
Cbt 185.70 cpm

Average	186
-2SD	165
+2SD	206
-3SD	155
+3SD	217

= 1.00 minutes

Source counts

16059	16327
15893	15908
16104	15951
15944	15828
15877	16201

Cg 16009.20 counts
SDg 160.19 counts
Cn 15823.50 counts
SDn 160.52 counts
Cnt 15823.50 cpm

Instrument Eff. (Ei) 0.39 cpm/dpm

STATIC MDC

Sample Count Time = 1.00 minutes

Instrument eff. (Ei) = 0.39

Surface eff. (Es) = 0.25
Total eff. (Et) = 0.10
Probe size (A) in cm = 126.00

Comparison of MDC equations

same times MDC 540 dpm/100cm2

diff times MDC 540 dpm/100cm2

Instrument/SN: Ludlum 2360 / 237279

Probe/SN: Ludlum 43-68 / PR190298
Calibration due date: 4/5/2013

Check-Source Reproducibility Determination

Source type: C-14
Source ID: E1-821 48343

Source Count Time = 1.00 minute

Source Count Rate (cpm) observed:

16059	16327
15893	15908
16104	15951
15944	15828
15877	16201

Cg 16009.20 cpm
SDg 160.19 cpm
3SDg 480.57 cpm

Acceptable to use

Background Measurements

Cb 0 Cb

Daily Check Ranges

	Average	+3SD	+2SD	-3SD	-2SD
Background	186	217	206	155	165
Check Source	16009	16490	16330	15529	15689

Graph Source Range

+3SD	16490
+2SD	16330
	16249
	16169
	16089
Cg	16009
	15929
	15849
	15769
-2SD	15689
-3SD	15529

Scaler Instrum 'ion Setup Sheet

	+3SD	+2SD	avg	-3SD	-2SD
1	16490	16330	16009	15529	15689
2	16490	16330	16009	15529	15689
3	16490	16330	16009	15529	15689
4	16490	16330	16009	15529	15689
5	16490	16330	16009	15529	15689
6	16490	16330	16009	15529	15689
7	16490	16330	16009	15529	15689
8	16490	16330	16009	15529	15689
9	16490	16330	16009	15529	15689
10	16490	16330	16009	15529	15689
11	16490	16330	16009	15529	15689
12	16490	16330	16009	15529	15689
13	16490	16330	16009	15529	15689
14	16490	16330	16009	15529	15689
15	16490	16330	16009	15529	15689
16	16490	16330	16009	15529	15689
17	16490	16330	16009	15529	15689
18	16490	16330	16009	15529	15689
19	16490	16330	16009	15529	15689
20	16490	16330	16009	15529	15689
21	16490	16330	16009	15529	15689
22	16490	16330	16009	15529	15689
23	16490	16330	16009	15529	15689
24	16490	16330	16009	15529	15689
25	16490	16330	16009	15529	15689
26	16490	16330	16009	15529	15689
27	16490	16330	16009	15529	15689
28	16490	16330	16009	15529	15689
29	16490	16330	16009	15529	15689
30	16490	16330	16009	15529	15689
31	16490	16330	16009	15529	15689

Daily Source & Background Check

Day	Date	SRC cpm		Background cpm		
		SRC Start	SRC End	BKG Start	BKG End	
1	10/10/12	15,833		199		Did not use
2	10/19/12	15,731	16275	168	184	
3	10/23/12	16,046	15957	191	185	
4	12/10/12	15,545		191		
5	01-14-13	15,885	15591	187	188	
~~6~~	~~01-17-13~~			~~234~~		GR
7	01-17-13	15632	15957	214	202	
~~8~~	~~01-18-13~~	~~15962~~	~~15685~~	~~213~~	~~213~~	GR
9	01-8-13	15962	15685	213	213	GR
10	01-22-13	16156	15457	212	201	
11	01-23-13	15339		216		Did not use
12	01-24-13	15803	15690	198	217	
13	01-25-13	15978	15847	210	206	
14	01-27-13	15978	16256	204	215	
15	01-28-13	15733	15708	200	215	
16	01-29-13	16076	16100	213		Did not use
17	3-6-13	15701	~~1208~~ 16008	207	201	
18	3-7-13	15773	201			Did not use SB
~~19~~	~~3-8-13~~	~~15784~~	~~208~~			
20	3-8-13	15784	15809	208	211	
21	03/26/13	15656	15713	201	214	
22	04/07/13	15766	15982	211	216	
23						
24						
25						
26						
27						
28						
29						
30						
31						

Scaler Instrument Setup and Daily Check Sheet

Source Type	C-14	Source Activity	48343	dpm (decay corrected 2π emission rate)
Source ID:	E1-821	Calibration source area	150	cm^2
		Corrected emission rate	40608	

Date: 8/20/2013

Background Measurements

Background Count Time = 1.00 minutes

Total counts observed:

656	597	Cb	617.40	counts
640	608			
596	604	SDb	28.74	counts
643	637			
631	562	Cbt	617.40	cpm

Average	617
-2SD	560
+2SD	675
-3SD	531
+3SD	704

= 1.00 minutes

Source counts

14428	14008	Cg	14306.10	counts
14286	14356			
14158	14422	SDg	141.95	counts
14272	14484			
14269	14378	Cn	13688.70	counts

SDn 144.83 counts

Cnt 13688.70 cpm

Instrument Eff. (Ei) 0.34 cpm/dpm

STATIC MDC

Sample Count Time = 1.00 minutes

Instrument eff. (Ei) = 0.34

Surface eff. (Es) = 0.25

Total eff. (Et) = 0.09

Probe size (A) in cm = 582.00

Comparison of MDC equations

same times	MDC	240	dpm/100cm2
diff times	MDC	240	dpm/100cm2

Instrument/SN: Ludlum 2360 / 227437

Probe/SN: Ludlum 43-37 / PR216990

Calibration due date: 8/10/2014

Check-Source Reproducibility Determination

Source type C-14

Source ID E1-821

Source Count Time = 1.00 minute

Source Count Rate (cpm) observed:

14428	14008	Cg	14306.10	cpm
14286	14356			
14158	14422	SDg	141.95	cpm
14272	14484			
14269	14378	3SDg	425.84	cpm

Acceptable to use

Background Measurements

Tile		Carpet	
Cb	0	Cb	0

Daily Check Ranges

	Average	+3SD	+2SD	-3SD	-2SD
Background	617	704	675	531	560
Check Source	14306	14732	14590	13880	14022

Graph Source Range	
+3SD	14732
+2SD	14590
	14519
	14448
	14377
Cg	14306
	14235
	14164
	14093
-2SD	14022
-3SD	13880

Daily Source & Background Check

Day	+3SD	+2SD	avg	-3SD	-2SD
1	14732	14590	14306	13880	14022
2	14732	14590	14306	13880	14022
3	14732	14590	14306	13880	14022
4	14732	14590	14306	13880	14022
5	14732	14590	14306	13880	14022
6	14732	14590	14306	13880	14022
7	14732	14590	14306	13880	14022
8	14732	14590	14306	13880	14022
9	14732	14590	14306	13880	14022
10	14732	14590	14306	13880	14022
11	14732	14590	14306	13880	14022
12	14732	14590	14306	13880	14022
13	14732	14590	14306	13880	14022
14	14732	14590	14306	13880	14022
15	14732	14590	14306	13880	14022
16	14732	14590	14306	13880	14022
17	14732	14590	14306	13880	14022
18	14732	14590	14306	13880	14022
19	14732	14590	14306	13880	14022
20	14732	14590	14306	13880	14022
21	14732	14590	14306	13880	14022
22	14732	14590	14306	13880	14022
23	14732	14590	14306	13880	14022
24	14732	14590	14306	13880	14022
25	14732	14590	14306	13880	14022
26	14732	14590	14306	13880	14022
27	14732	14590	14306	13880	14022
28	14732	14590	14306	13880	14022
29	14732	14590	14306	13880	14022
30	14732	14590	14306	13880	14022
31	14732	14590	14306	13880	14022

		SRC cpm		Background cpm		
Day	Date	SRC Start	SRC End	BKG Start	BKG End	
1	08/20/13	14591	14841	657	633	
2	10/01/13	14447	14519	631	662	
3	10/25/13	14722	14703	686	679	
4	11/1/13	14710	14642	656	631	
5	11/5/13	14696	14706	630	648	
6	11/6/13	14678	14551	606	595	
7	11/7/13	14509	14482	645	564	
8	11/11/13	14642	14532	627	612	
9	11/12/13	14047	14261	583	570	
10	11/13/13	14411	14092	591	554	
11	11/14/13	14651	14562	635	657	
12	11/15/13	14627	Not Used	609	Not Used	
13	12/02/13	14693	Not Used	644	Not USED	
14	12/03/13	14684	14811	686	690	+/- 20%
15	12/04/13	14515	Not Used	658	Not Used	
16	1/21/14	14372	14765	567	625	+/- 20%
17	1/23/14	14772	13961	597	579	18.5
18	1-23-14	14456		574		111 GAS
19	1-29-14	14419	14621	545	627	1600
20	1-30-14	15153		646		~~1800~~ +/- 20% DNU
21	2-6-14	14262	14182	594	538	
22	~~2-10-~~	~~14111~~	~~14111~~			GR
23	2-10-14	14111	14145	592	572	
24	2-11-14	14377	14127	580	588	
25	2-12-14	14555	14677	612	639	
26	2-13-14	14712		636		Not USED
27						
28						
29						
30						
31						

531 – 704

Control limits

Background		Source	
-3σ	$+3\sigma$	-3σ	$+3\sigma$
531	704	13880	14732
− 20%	+ 20%	−20%	+ 20%
494	741	11445	17167

Scaler Instrument Setup and Daily Check Sheet

Source Type	C-14	Source Activity	48343	dpm (decay corrected 2π emission rate)
Source ID:	E1-821	Calibration source area	150	cm^2
		Corrected emission rate	48343	

Date: 10/16/2012

Background Measurements

Background Count Time = 1.00 minutes

Total counts observed:

587	631	Cb	628.60	counts
650	655			
646	596	SDb	27.21	counts
659	643			
626	593	Cbt	628.60	cpm

Average	629
-2SD	574
+2SD	683
-3SD	547
+3SD	710

= 1.00 minutes

Source counts

15833	15949	Cg	15848.40	counts
16054	15783			
15808	15850	SDg	92.64	counts
15810	15783			
15738	15876	Cn	15219.80	counts
		SDn	96.55	counts
		Cnt	15219.80	cpm

Instrument Eff. (Ei) 0.31 cpm/dpm

STATIC MDC

Sample Count Time	=	1.00	minutes
Instrument eff. (Ei)	=	0.31	
Surface eff. (Es)	=	0.25	
Total eff. (Et)	=	0.08	
Probe size (A) in cm	=	582.00	

Comparison of MDC equations

same times	MDC	265	dpm/100cm2
diff times	MDC	265	dpm/100cm2

Instrument/SN: Ludlum 2360 / 227437

Probe/SN: Ludlum 43-37 / PR216990

Calibration due date: 9/22/2012

Check-Source Reproducibility Determination

Source type C-14

Source ID E1-821 48369 dpm

Source Count Time = 1.00 minute

Source Count Rate (cpm) observed:

15833	15949	Cg	15848.40	cpm
16054	15783			
15808	15850	SDg	92.64	cpm
15810	15783			
15738	15876	3SDg	277.93	cpm

Acceptable to use

Background Measurements

Tile		Carpet	
483	499	485	524
553	547	495	501
505	525	520	542
503	526	518	543
527	531	533	532
Cb	520	Cb	519

Daily Check Ranges

	Average	+3SD	+2SD	-3SD	-2SD
Background	629	710	683	547	574
Check Source	15848	16126	16034	15570	15663

Graph Source Range

+3SD	16126
+2SD	16034
	15987
	15941
	15895
Cg	15848
	15802
	15756
	15709
-2SD	15663
-3SD	15570

Scaler Instrumentation Setup Sheet

Daily Source & Background Check

Day	+3SD	+2SD	avg	-3SD	-2SD	Day	Date	SRC cpm SRC Start	SRC cpm SRC End	Background cpm BKG Start	Background cpm BKG End	
1	16126	16034	15848	15570	15663	1	10/18/12	15,661	15,746	655	655	
2	16126	16034	15848	15570	15663	2	11/30/12	15,704	15,786	601	601	
3	16126	16034	15848	15570	15663	3	12/20/12	15,650	15,930	627	613	
4	16126	16034	15848	15570	15663	4	1-15-13	15,758	15,609	645	587	
5	16126	16034	15848	15570	15663	5	1-18-13	15617	15629	598	612	
6	16126	16034	15848	15570	15663	6	1-21-13	15719	15610	608	574	
7	16126	16034	15848	15570	15663	7	1-22-13	15669	15861	593	562	
8	16126	16034	15848	15570	15663	8	1-24-13			564		DID NOT USE
9	16126	16034	15848	15570	15663	~~9~~		~~15574~~				GR
10	16126	16034	15848	15570	15663	~~10~~	~~1-24-13~~	~~15724~~				GR
11	16126	16034	15848	15570	15663	11	01-25-13	15724	592	15652	649	
12	16126	16034	15848	15570	15663	12	01-27-13	15736	15582	572	642	CG
13	16126	16034	15848	15570	15663	13	01-28-13			655		-Did not use
14	16126	16034	15848	15570	15663	14	01-29-13	15735	15591	631	609	
15	16126	16034	15848	15570	15663	15	02-26-13	15577	15978	633	631	
16	16126	16034	15848	15570	15663	~~16~~	~~04-01-13~~			~~574~~		
17	16126	16034	15848	15570	15663	17	04/02/13	15950	16208	635	687	
18	16126	16034	15848	15570	15663	18	04/11/13	15595	15628	701	667	
19	16126	16034	15848	15570	15663	19	05/13/13	15587	15601	624	600	
20	16126	16034	15848	15570	15663	20	06/27/13	15682	15658	596	650	CG
21	16126	16034	15848	15570	15663	21	7/29/13	15662	15662	663	678	CG
22	16126	16034	15848	15570	15663	22						
23	16126	16034	15848	15570	15663	23						
24	16126	16034	15848	15570	15663	24						
25	16126	16034	15848	15570	15663	25						
26	16126	16034	15848	15570	15663	26						
27	16126	16034	15848	15570	15663	27						
28	16126	16034	15848	15570	15663	28						
29	16126	16034	15848	15570	15663	29						
30	16126	16034	15848	15570	15663	30						
31	16126	16034	15848	15570	15663	31						

APPENDIX D

FINAL STATUS SURVEY RESULTS

Contamination / Radiation Survey Report

CONTAMINATION / RADIATION SURVEY REPORT	PROJECT NUMBER: 144040
LOCATION: SUI-B3298	SURVEYOR(S): S.Brungardt / G. Robb
	SURVEY NUMBER: 013013-01
	MAP ID: See Attached Map

DATE: 1/30/13 | TIME START: 0905 | TIME COMPLETE: 1100 | PAGE 1 OF ~~15~~ ~~18~~ 15

ACCEPTABLE SURFACE CONTAMINATION LEVELS

Loose N/A dpm/100cm² Alpha 1,000 dpm/100cm² Beta-Gamma

Total N/A dpm/100cm² Alpha 5,000 dpm/100cm² Beta-Gamma

ACCEPTABLE SCAN LIMITS

Less than twice material background. SADS for material background.

Source Check Data	α (LOOSE)	α (TOTAL)	β-γ (LOOSE)	β-γ (TOTAL)	Radiation Surveys Beta-Gamma
Instrument	N/A	N/A	Perkin Elmer TriCarb 2900TR	2221 / 43-68 ~~2360 / 43-37~~ SB	N/A
Source Type and I.D.			H-3/C-14	C-14	
Source Strength in dpm			SADS	40608	µCi
Efficiency				0.10 ~~0.08~~ SB	
MDC in dpm/100 cm²				540 ~~265~~ SB	Sat. ☐ Unsat. ☐
Background in cpm				186 ~~629~~ SB	mrem/hr or µrem/hr

REASON FOR SURVEY

☐ PROCEDURE NO.

☒ SPECIAL Characterization

☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Characterization of B3-298. Survey performed to the standard of Final Status Surveys, including biased scanning, direct measurements, wipes and duplicates. Floor scan with 2360/143-37 performed on 01/29/13

SADS – See Attached Data Sheet /D = Duplicate

Contamination Survey INSTRUMENT / SERIAL #	ALPHA (LOOSE) N/A	BETA-GAMMA (LOOSE)	SADS
	ALPHA (TOTAL)	BETA-GAMMA (TOTAL)	2221 / 43-68 | 183987 / PR289329 2360 / 43-37 | 227437/ PR216990
Radiation Survey INSTRUMENT / SERIAL #	BETA-GAMMA Meter	BETA-GAMMA Probe	N/A

THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta-Gamma Loose dpm/100cm²	Beta-Gamma Total dpm/100cm²	Alpha cpm ☐ / Beta cpm ☐ / Material ☒	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	LBB	Fume Hood
3					LBB	Fume Hood
4					ME	Fume Hood
5					Glass	Fume Hood
6					ME	VBE Vent
7					LBB	VBE
8					ME	VBE
9					ME	VBE Vent
10					ME	Right Intake Vent
11					LBB	Glassware Holder
12					LBB	Front Sink
13					ME	Right Supply Vent
14					ME	Front Cabinet
15					ME	Left Cabinet
16					ME	Large Area Swipe on valves
17					ME	Left Supply Vent
18					LBB	Back Sink
19					LFW	L5
20 D					LFW	L5
21					ME	Glove Box
22					ME	Glove Box
23					ME	Glove Box
24					ME	Glove Box
25					ME	Glove Box

RCS REVIEW [signature] DATE 01/31/13

Contamination / Radiation Survey Report

CONTAMINATION / RADIATION SURVEY REPORT (CONTINUATION SHEET)

PROJECT NUMBER: 144040 | DATE: 1/30/13 | PAGE 2 OF ~~18~~ ~~58~~ ~~16~~ 15

LOCATION: SUI-B3298

SURVEYOR(S): S. Bonngardt / C. Robb

SURVEY NUMBER: 013013-01

MAP ID:

COMMENTS: None

RCS REVIEW [signature] DATE 01/31/13

Item #	Alpha LOOSE dpm/100cm²	Alpha TOTAL dpm/100cm²	Beta-Gamma LOOSE dpm/100cm²	Beta-Gamma TOTAL dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☒	Item or Location
26	N/A	N/A	SADS	SADS	ME	Glove Box
27					ME	Glove Box
28					LFW	L9
29					LFW	K8
30					LFW	D9
31					LFW	F7
32					Sheet Rock	C7
33					Sheet Rock	C6
34					Sheet Rock	C5
35					CF	D5
36					~~LFW~~ SR CF	D6
37					CF	D6
38 D					CF	D6
39					CF	D7
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						

Item #	Alpha LOOSE dpm/100cm²	Alpha TOTAL dpm/100cm²	Beta-Gamma LOOSE dpm/100cm²	Beta-Gamma TOTAL dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☐	Item or Location
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
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75						

THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

Survey 013013-01 SU1-B3298 Characterization Area Description	Sample Location	Gross (cpm)	Background (cpm)	Net (cpm)	Probe area (cm2)	Total efficiency (cpm/dpm)	net (dpm/ 100 cm2)	Instrument Serial #
BKG LSC	1							
Fume Hood Resin Top	2	168	116	52	126	0.11	375	183987
Fume Hood Resin Top	3	178	116	62	126	0.11	447	183987
Fume Hood Back - Metal	4	187	130	57	126	0.11	411	183987
Fume Hood Glass	5	180	186	-6	126	0.11	-43	183987
VBE Vent - Metal	6	121	130	-9	126	0.11	-65	183987
VBE Bottom Resin Top	7	126	116	10	126	0.11	72	183987
VBE Back - Metal	8	156	130	26	126	0.11	188	183987
VBE Vent - Metal	9	164	130	34	126	0.11	245	183987
Intake Vent - Metal	10	154	130	24	126	0.11	173	183987
Glassware holder - Lab Bench	11	146	116	30	126	0.11	216	183987
Front Sink - Lab Bench	12	136	116	20	126	0.11	144	183987
Right Supply Vent - Metal	13	148	130	18	126	0.11	130	183987
Front Metal Cabinet	14	94	130	-36	126	0.11	-260	183987
Left Metal Cabinet	15	105	130	-25	126	0.11	-180	183987
Large Area Wipe on Valves (No Static Taken)	16			0	126	0.11	0	183987
Left Supply Vent	17	153	130	23	126	0.11	166	183987
Back Sink - Lab Bench	18	100	116	-16	126	0.11	-115	183987
Lab Floor Tile	19	132	137	-5	126	0.11	-36	183987
D Lab Floor Tile - Duplicate	20	145	137	8	126	0.11	58	183987
Glove Box Bottom - Metal	21	164	130	34	126	0.11	245	183987
Glove Box Side - Metal	22	134	130	4	126	0.11	29	183987
Glove Box Back - Metal	23	147	130	17	126	0.11	123	183987
Glove Box Center - Metal	24	149	130	19	126	0.11	137	183987
Glove Box Bottom - Metal	25	159	130	29	126	0.11	209	183987
Glove Box Back - Metal	26	160	130	30	126	0.11	216	183987
Globe Box Slide Tray - Metal	27	139	130	9	126	0.11	65	183987
Lab Floor Tile	28	229	137	92	126	0.11	664	183987
Lab Floor Tile	29	182	137	45	126	0.11	325	183987
Lab Floor Tile	30	211	137	74	126	0.11	534	183987
Lab Floor Tile	31	245	137	108	126	0.11	779	183987
Sheet Rock	32	173	186	-13	126	0.11	-94	183987
Sheet Rock	33	148	186	-38	126	0.11	-274	183987
Sheet Rock	34	167	186	-19	126	0.11	-137	183987
Concrete Floor	35	243	222	21	126	0.11	152	183987
Concrete Floor	36	239	222	17	126	0.11	123	183987
Concrete Floor	37	257	222	35	126	0.11	253	183987
Concrete Floor - Duplicate	38	245	222	23	126	0.11	166	183987
Concrete Floor	39	236	222	14	126	0.11	101	183987

Instrument background of 186 cpm used for sheet rock background

Material Specific Background and MDC Sheet for Beta Measurements

Instrument/SN:	Ludlum 2221 / 183987
Probe/SN:	Ludlum 43-68 / PR289329
Background Count Time	1.00 minutes
Total Instrument Effciency	0.11 dpm/cpm

Lab Bench (Black)	**(LBB)**	116	cpm	**MDC**	392	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Bench (Grey)	**(LBG)**	0	cpm	**MDC**	22	dpm/100cm2	**Sample Count Time**	1.00	min
Metal	**(ME)**	130	cpm	**MDC**	414	dpm/100cm2	**Sample Count Time**	1.00	min
Concrete Floor	**(CF)**	222	cpm	**MDC**	534	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Floor (Tile)	**(LFW)**	137	cpm	**MDC**	424	dpm/100cm2	**Sample Count Time**	1.00	min
Carpet	**(C)**	170	cpm	**MDC**	470	dpm/100cm2	**Sample Count Time**	1.00	min
Stairwell Rubber Tread	**(SRT)**	182	cpm	**MDC**	485	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Floor (Resin)	**(LFR)**	167	cpm	**MDC**	466	dpm/100cm2	**Sample Count Time**	1.00	min

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	6	1	63.43	18
C-14	10	9	1	96.45	14

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

Corresponding survey number/location:

37	38

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
257	245	0.05

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	8	5	0.46	RPD not relavent when result is less than MDC
C-14	0	6	2.00	RPD not relavent when result is less than MDC

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

H-3 spike	H-3 result	Relative bias ($\pm$0.2)
4049	3500	-0.135589

C-14 spike	C-14 result	Relative bias ($\pm$0.2)
4356	4182	-0.039945

H-3 spike value = 4049 dpm

C-14 spike value= 4356 dpm

P 6 of 18 15 58

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	6	1	63.43	18
C-14	10	9	1	96.45	14

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

Corresponding survey number/location:

19	20

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
132	145	0.09

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	0	0	N/A	RPD not relavent when result is less than MDC
C-14	0	3	2.00	RPD not relavent when result is less than MDC

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

H-3 spike	H-3 result	Relative bias ($\pm$0.2)
4049	3500	-0.135589

C-14 spike	C-14 result	Relative bias ($\pm$0.2)
4356	4182	-0.039945

H-3 spike value = 4049 dpm

C-14 spike value= 4356 dpm

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 12.55 Date Processed: 1/30/2013 8:56:06 AM
14C Chi Square: 30.55 Date Processed: 1/30/2013 8:56:06 AM
3H E^2/B (1-18.6 keV): 400.99 Date Processed: 1/30/2013 8:56:06 AM
14C E^2/B (4-156 keV): 778.19 Date Processed: 1/30/2013 8:56:06 AM
3H Efficiency (0-18.6 keV): 63.43 Date Processed: 1/30/2013 8:56:06 AM
14C Efficiency (0-156 keV): 96.45 Date Processed: 1/30/2013 8:56:06 AM
IPA Background Date Processed: 1/30/2013 8:56:06 AM
3H Background CPM (0-18.6 keV): 10.02 Date Processed: 1/30/2013 8:56:06 AM
14C Background CPM (0-156 keV): 14.30 Date Processed: 1/30/2013 8:56:06 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Assay Definition-

Assay Description:
SU1-B3 298 CHRACTERIZATION

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20130130_1540
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20130130_1540\20130130_1540.results
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	6	11	0	0	56.15	451.95
2	1.00	0	1	0	2	0.00	455.73
3	1.00	1	6	1	8	4.84	323.02
4	1.00	1	0	4	0	0.00	403.66
5	1.00	0	2	0	2	0.00	415.59
6	1.00	1	0	3	0	131.61	439.58
7	1.00	0	1	0	2	0.00	414.83
8	1.00	0	2	0	3	92.15	435.85
9	1.00	0	0	0	0	0.00	437.56
10	1.00	3	2	7	3	17.03	398.05

11	1.00	4	5	9	6	73.13	407.91
12	1.00	2	0	6	0	0.00	450.49
13	1.00	0	1	0	2	0.00	448.14
14	1.00	1	0	4	0	0.00	370.87
15	1.00	1	4	1	5	111.25	447.20
16	1.00	3	2	7	2	54.28	420.60
17	1.00	1	4	1	5	131.46	429.74
18	1.00	0	0	2	0	0.00	440.36
19	1.00	0	0	0	0	0.00	437.12
D 20	1.00	0	2	0	3	0.00	417.33
21	1.00	0	0	0	0	0.00	434.71
22	1.00	3	1	7	1	31.66	424.83
23	1.00	1	1	2	2	0.00	451.09
24	1.00	7	0	19	0	0.00	434.21
25	1.00	2	5	3	6	104.39	445.82
26	1.00	2	0	5	0	0.00	433.27
27	1.00	1	0	2	0	0.00	450.70
28	1.00	10	0	26	0	65.96	442.23
29	1.00	3	0	8	0	0.00	437.25
30	1.00	3	0	10	0	0.00	407.11
31	1.00	0	0	0	1	0.00	431.86
32	1.00	0	1	0	2	0.00	401.06
33	1.00	1	0	3	0	0.00	434.85
34	1.00	1	0	5	0	0.00	426.03
35	1.00	0	2	0	3	25.28	424.35
36	1.00	4	0	10	0	48.81	425.66
37	1.00	0	8	0	10	60.34	423.69
D 38	1.00	3	5	6	6	39.70	404.84
39	1.00	0	0	0	0	0.00	416.44
~~40~~	~~1.00~~	~~2~~	~~0~~	~~6~~	~~0~~	~~0.00~~	~~390.81~~

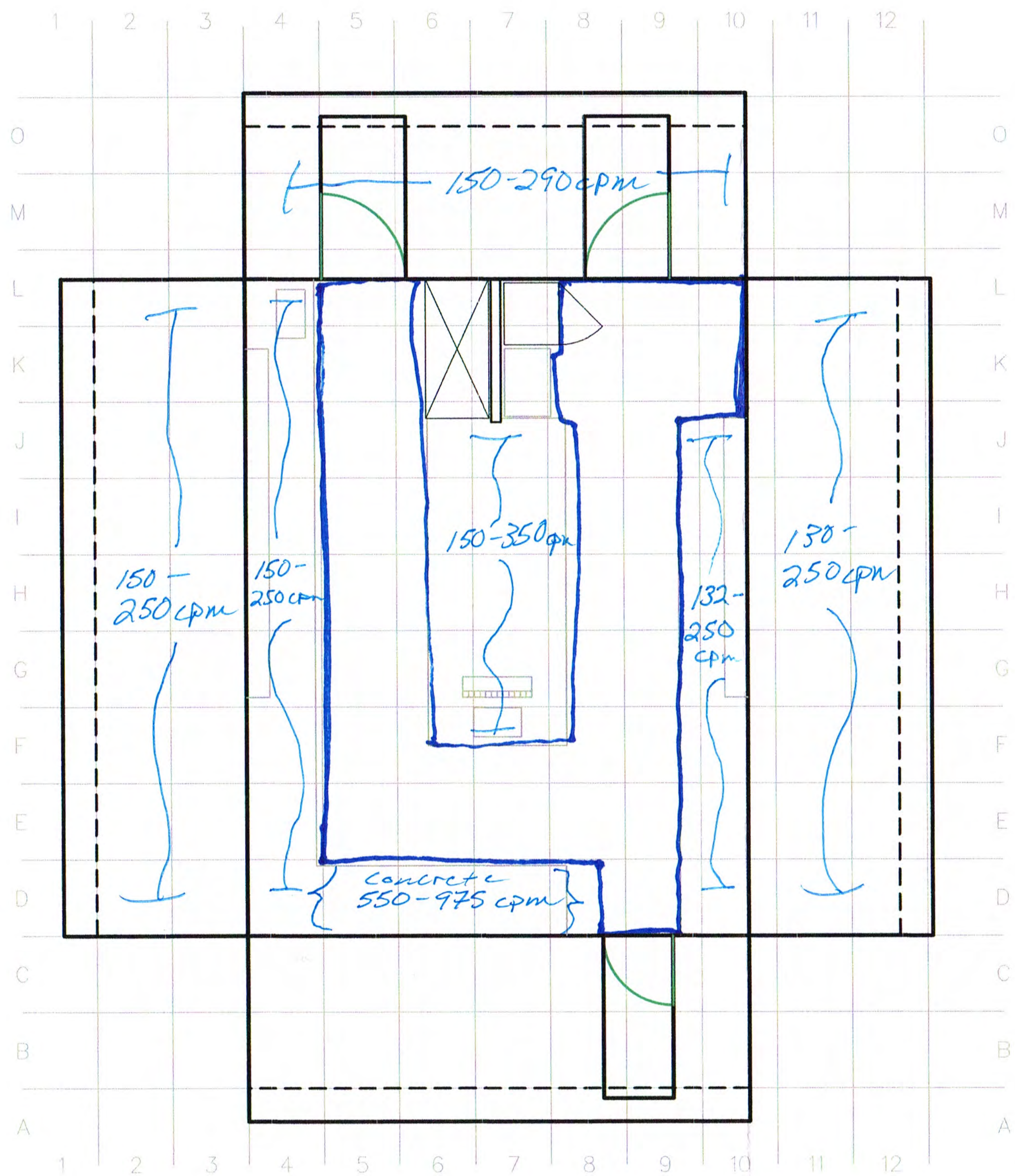
SB

Addition clean wipe counted at end of survey

Missing vial 41.
Missing vial 42.
Missing vial 43.
Missing vial 44.
Missing vial 45.
Missing vial 46.
Missing vial 47.
Missing vial 48.
Missing vial 49.
Missing vial 50.
Missing vial 51.
Missing vial 52.
Missing vial 53.
Missing vial 54.

55	1.00	1883	3570	3500	4182	51.38	452.01

Floor areas within blue - 100% scan with Floor monitor Ludlum 43.37.
Scan Range 550-700 cpm
Concrete Area noted was also 100% scanned with Ludlum 43-37
Scan Range 550-975 cpm
Walls and Benchtops were scanned with Ludlum Model 43-68 Probe.



SEI_TEXTSUB_ONLY.TBL pdf_with_levels.plt 9:38:29 AM 1/24/2013 cbentley aptuit_api_cs_temp001.dgn

FIGURE X-X
SU1-B3298

CHARACTERIZATION SURVEY

APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 2 4

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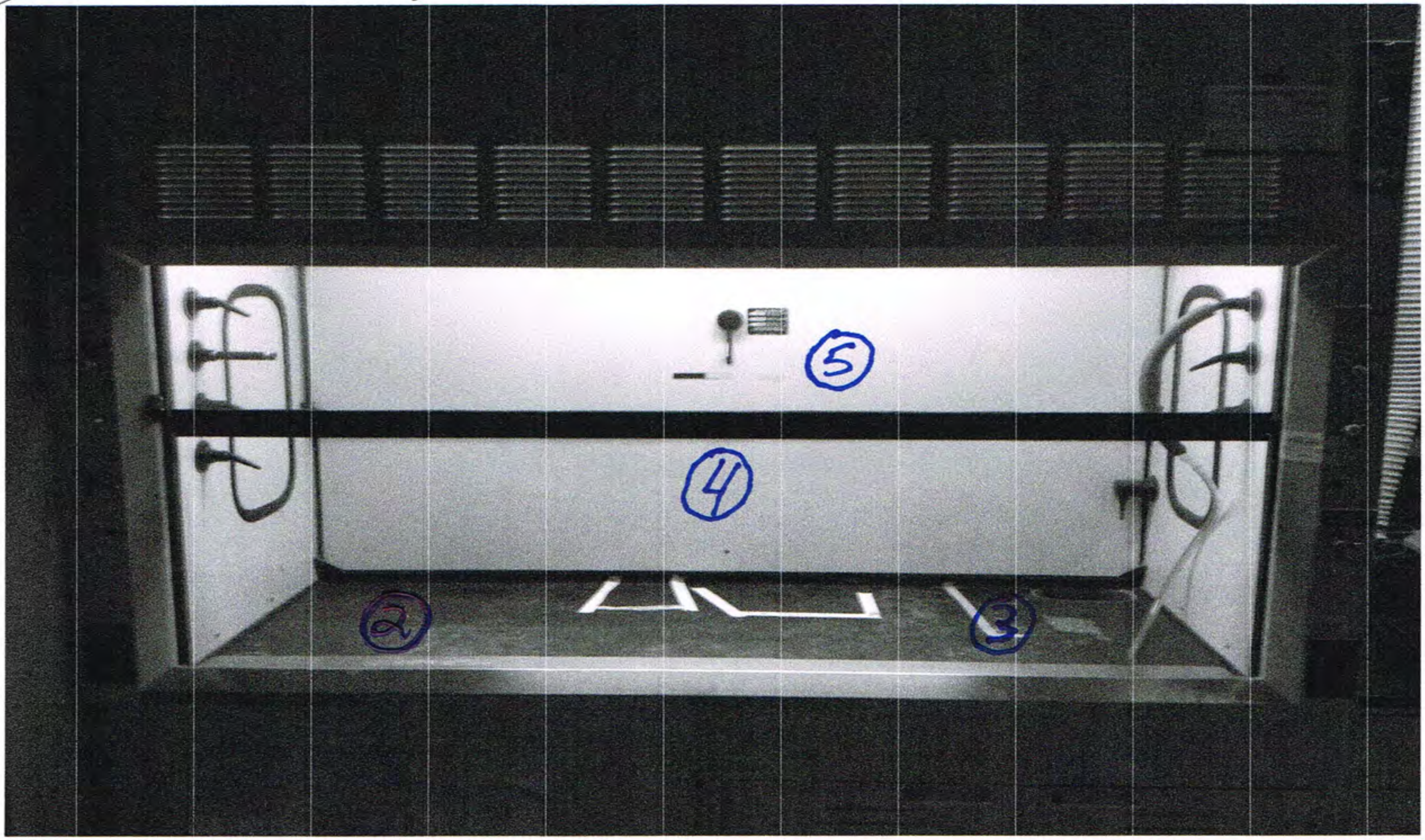
Contamination / Radiation Survey Report

PROJECT NUMBER: 144040	ACTIVITY / LOCATION: SUI-B3298	/ Laboratory-Room	PAGE ~~12~~ 80 OF ~~16~~ ~~88~~ ~~16~~ 85

COMMENTS: None	SURVEYOR(S): S. Baumgardt / G. Robb	SURVEY NUMBER: 013013-01	DATE: 1/30/13
	NOTE: THE KNOWING AND WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.		
RCS REVIEW:	DATE: 01/~~13~~ 31/13		

Gross Static counts
1) 150
2) 168
3) 178
4) 187
5) 180

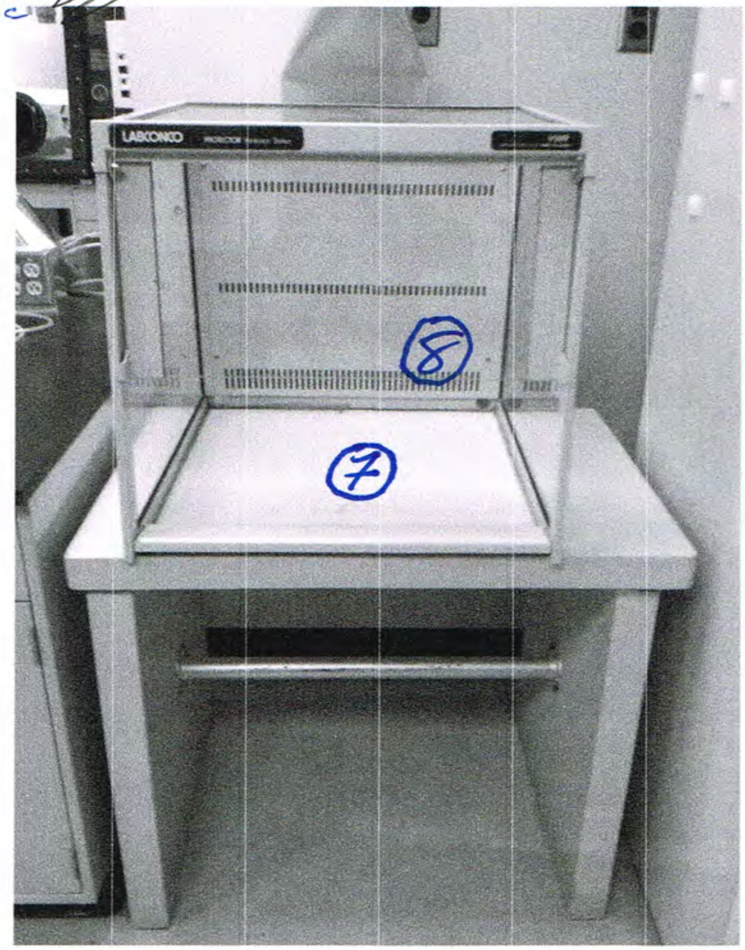


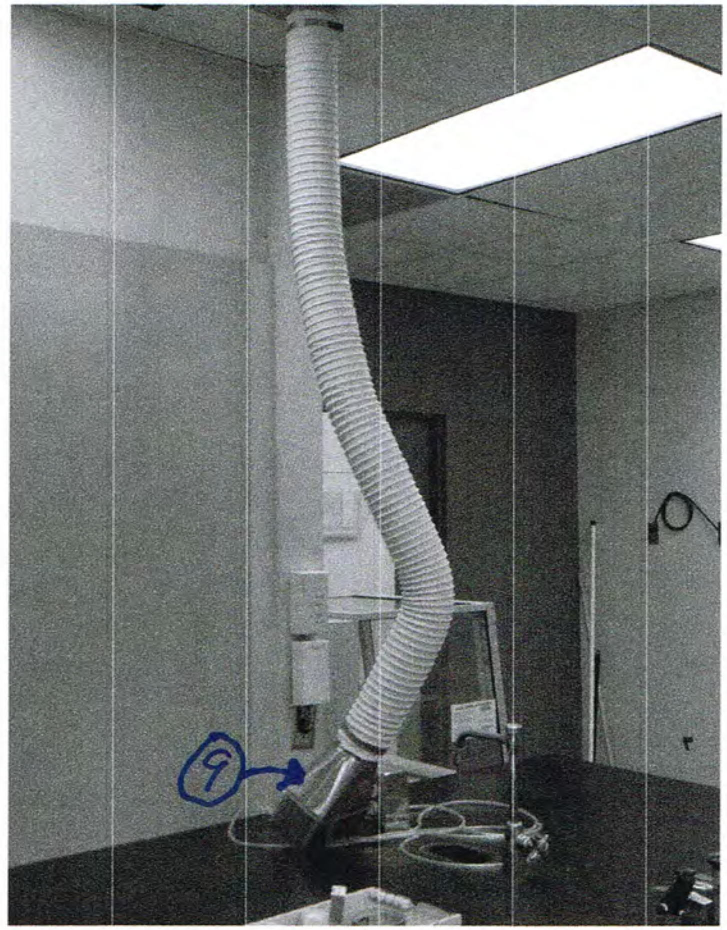
Contamination / I iation Survey Report

1x of 15.

PROJECT NUMBER: 144040	ACTIVITY / LOCATION: SU1 - B3298 / Laboratory-Room		PAGE 12 OF 15
COMMENTS: none	SURVEYOR(S): S. Brumgardt / E. Robb	SURVEY NUMBER: 013013 - 01	DATE: 1/30/13
	NOTE: THE KNOWING AND WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.		
RCS REVIEW: [signature] DATE: 01/31/13			

Gross Static Counts
7) 126
8) 156
9) 164



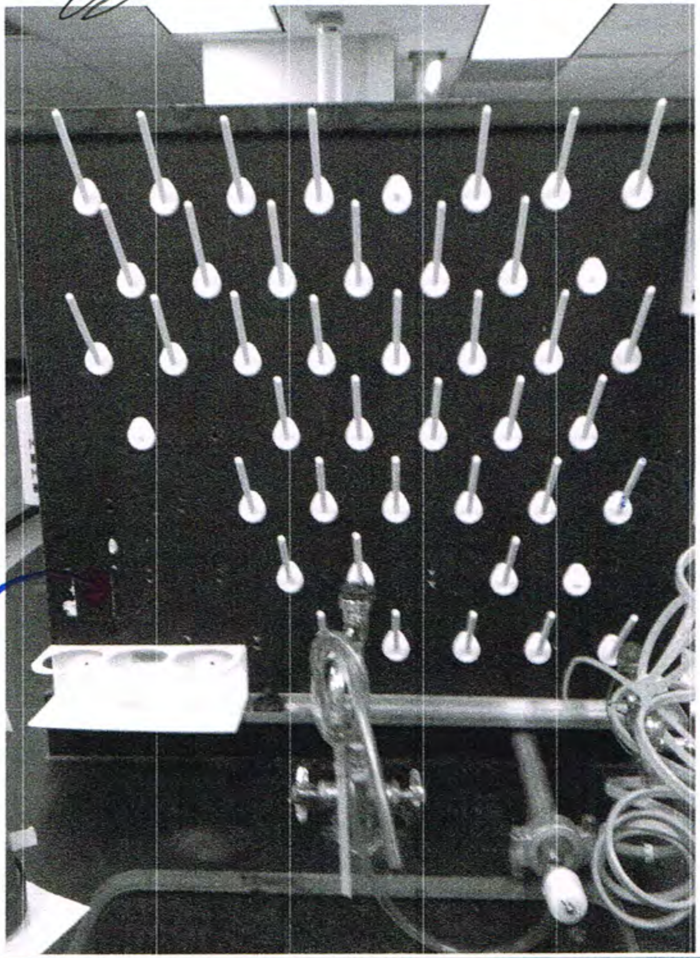


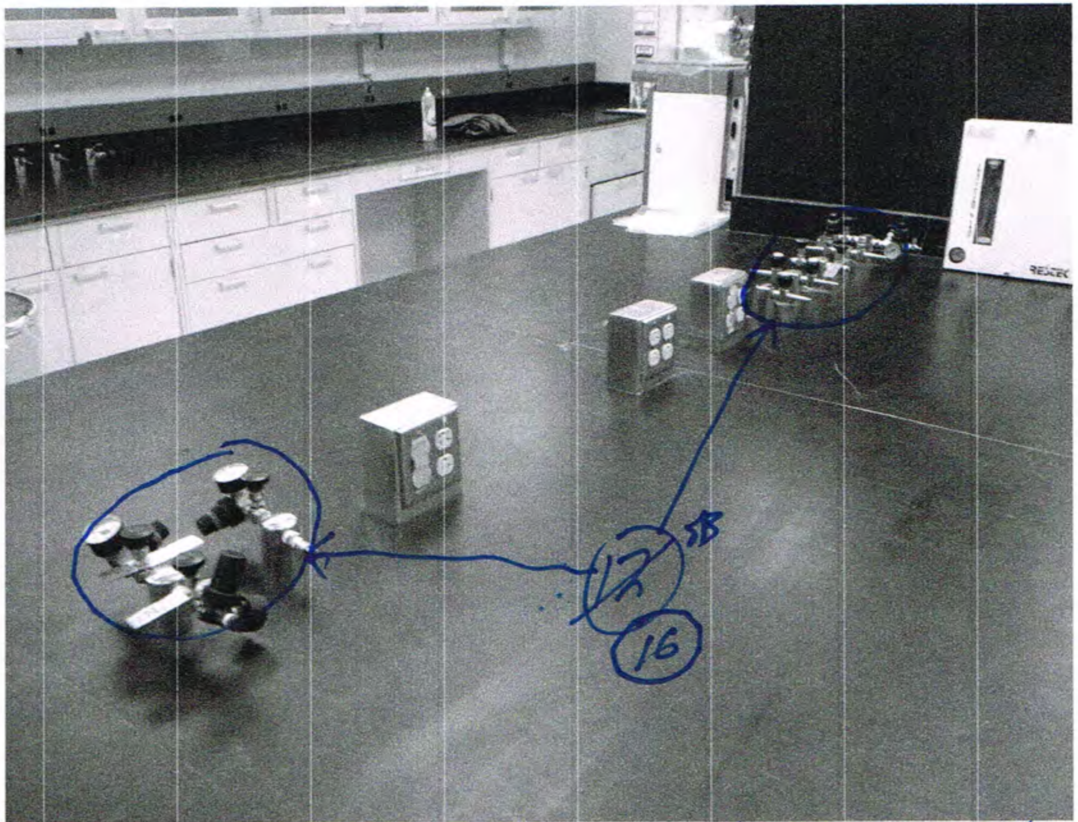
Contamination / Radiation Survey Report

PROJECT NUMBER: 144040	ACTIVITY / LOCATION: SLL- B3298 / Laboratory-Room		PAGE ~~14~~ OF ~~16~~ SB
COMMENTS: none	SURVEYOR(S): J. Brunquist / G. Robb	SURVEY NUMBER: 013013-01	DATE: 1/30/13
	NOTE: THE KNOWING AND WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.		
RCS REVIEW: [signature] DATE: 01/31/13			

11) 146

11



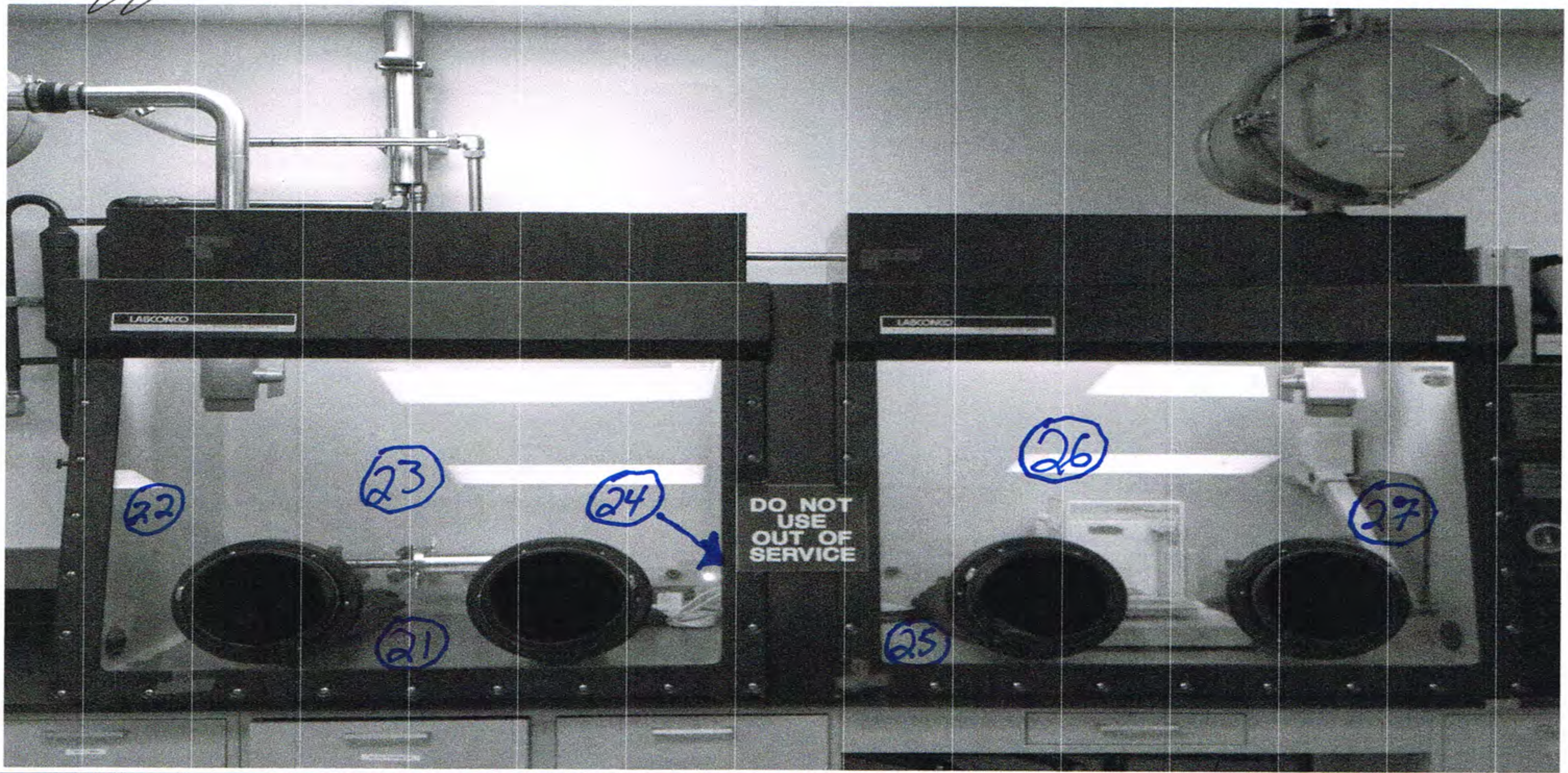


~~17~~ SB 16) Large area wipe on gas valves - no static taken

Contamination / I iation Survey Report

PROJECT NUMBER: 144040	ACTIVITY / LOCATION: SUI- B3298 / Laboratory-Room	PAGE 15 OF ~~15~~ 90

COMMENTS: none	SURVEYOR(S): S. Brumgardt / G. Robb	SURVEY NUMBER: 013013 - 01	DATE: 01/30/13
	NOTE: THE KNOWING AND WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.		
RCS REVIEW: [signature] DATE: 01/31/13			



Gross Static Counts
21) 164 - Bottom metal
22) 134 - Side metal
23) 147 - Back metal
24) 149 - Center console - metal

25) 159 - Bottom - Metal
26) 160 - Back - Metal
27) 139 - Slide Tray - Metal

Gross Static Counts
6) 121 - VBE Vent - Metal
10) 154 - Intake Vent - Metal
12) 136 - Sink (Black Benchtop)
13) 148 - Supply Air Vent - Metal
14) 94 - Cabinet - Metal
15) 105 - Cabinet Metal
17) 153 - Supply Air Vent - Metal
18) 100 - Sink (Black Bench Top)
19) 132 - L5 Lab Floor Tile
20) Duplicate of L5 #19 - 145 cpm
28) 229 - L9 Lab Floor Tile
29) 182 - K8 Lab Floor Tile
30) 211 - D9 Lab Floor Tile
31) 245 - F7 Lab Floor Tile
32) 173 - C7 wall
33) 148 - C6 wall
34) 167 - C5 wall
35) 243 - D5 Concrete Floor
36) 239 - D6 Concrete Floor
37) 257 - D6 Concrete Floor
38) Duplicate of #37 - 245
39) 236 - Concrete Floor

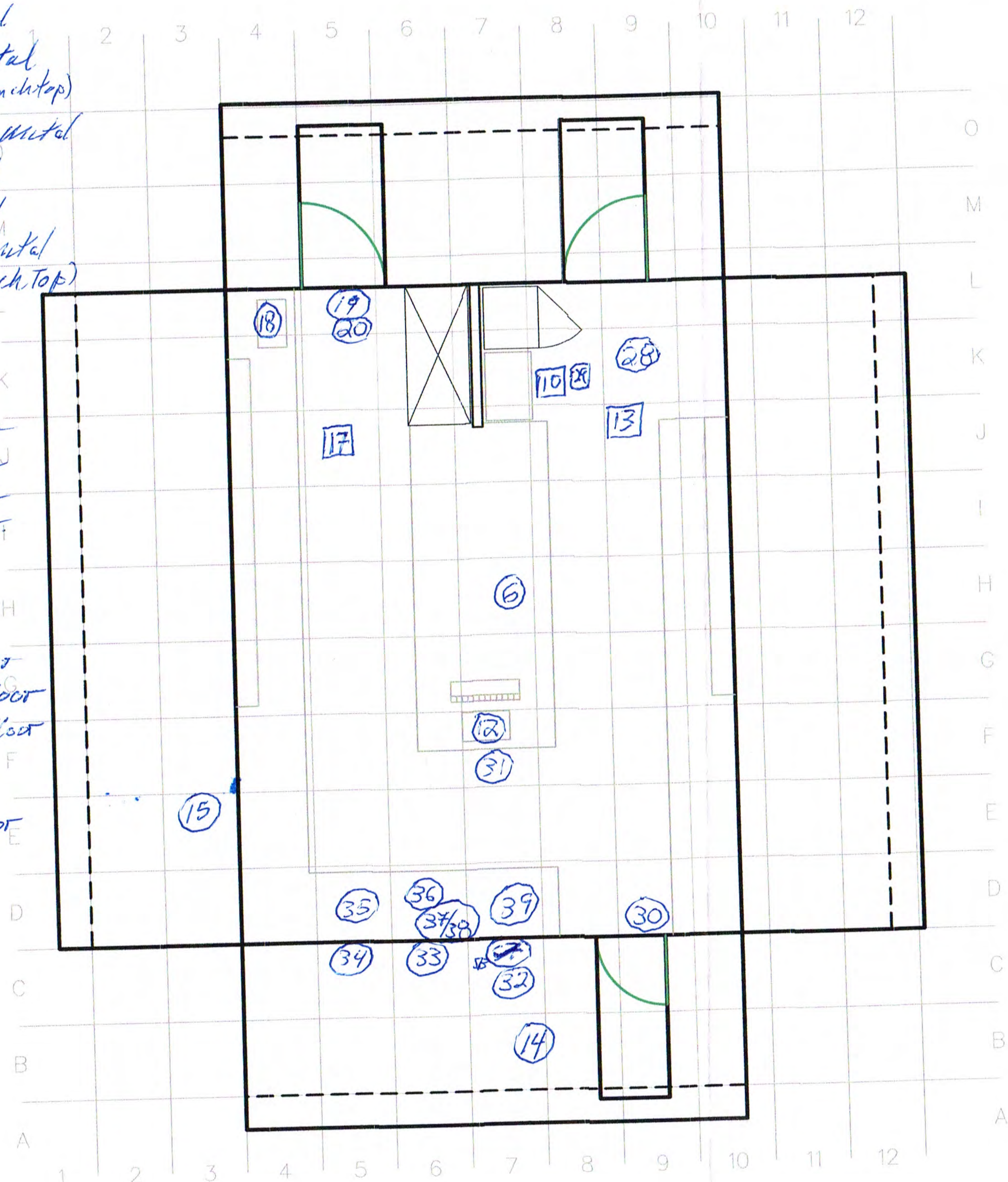


FIGURE X-X
SU1-B3298

SCALE IN METERS
0 2 4

CHARACTERIZATION SURVEY

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Contamination / Radiation Survey Report

CONTAMINATION / RADIATION SURVEY REPORT	PROJECT NUMBER: 144040
LOCATION: SU1-B3298	SURVEYOR(S): S. Brungardt / G. Robb
	SURVEY NUMBER: 013013-02
	MAP ID: See Attached Map

DATE: 1/30/13 | TIME START: 1100 | TIME COMPLETE: 1300 | PAGE 1 OF 8

ACCEPTABLE SURFACE CONTAMINATION LEVELS

Loose N/A dpm/100cm² Alpha 1,000 dpm/100cm² Beta-Gamma

Total N/A dpm/100cm² Alpha 5,000 dpm/100cm² Beta-Gamma

ACCEPTABLE SCAN LIMITS

Less than twice material background. SADS for material background.

Source Check Data	Contamination Surveys α (LOOSE)	α (TOTAL)	β-γ (LOOSE)	β-γ (TOTAL)	Radiation Surveys Beta-Gamma
Instrument	N/A	N/A	Perkin Elmer TriCarb 2900TR	2221 / 43-68 ~~2360 / 43-37~~	N/A
Source Type and I.D.			H-3/C-14	C-14	
Source Strength in dpm			SADS	40608	µCi
Efficiency				~~0.10~~ 0.11 ~~0.08~~	
MDC in dpm/100 cm²				~~540~~ 430 ~~265~~	Sat. ☐ Unsat. ☐
Background in cpm				~~186~~ 173 ~~629~~	mrem/hr or µrem/hr

REASON FOR SURVEY ☐ PROCEDURE NO. ______

☒ SPECIAL Final Status

☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Scans, smears + statics of systematic locations in Class I Survey Units. Characterization survey, including biased sample locations and scanning data available on survey 013013-01

SADS – See Attached Data Sheet / D = Duplicate

Contamination Survey INSTRUMENT / SERIAL #	ALPHA (LOOSE) N/A	BETA-GAMMA (LOOSE) SADS
	ALPHA (TOTAL)	BETA-GAMMA (TOTAL) 2221 / 43-68 | 183987 / PR289329; 2360 / 43-37 | 227437/ PR216990
Radiation Survey INSTRUMENT / SERIAL #	BETA-GAMMA Meter	BETA-GAMMA Probe N/A

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta-Gamma Loose dpm/100cm²	Beta-Gamma Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☒	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Wood	B9
3					Sheet Rock	B6
4					LBB	E4
5					CF ~~CF SB~~	E7
6 D					CF	E7
7					LBB	E10
8					LFW	H9
9					Glass	H12
10					LFW	K10
11					ME	M9
12					LFW	K7
13					LFW	H5
14					Sheet Rock	H2
15					LBB	K4
16					ME	M5
17						
18						
19						
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22						
23						
24						
25						

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RCS REVIEW ______ DATE 01/31/13

Survey 013013-02 SU1-B3298 FSS Area Description	Sample Location	Gross (cpm)	Background (cpm)	Net (cpm)	Probe area (cm2)	Total efficiency (cpm/dpm)	net (dpm/ 100 cm2)	Instrument Serial #
BKG LSC	1							
Wood Door	2	165	178	-13	126	0.11	-94	183987
Sheet Rock Wall	3	149	178	-29	126	0.11	-209	183987
Lab Bench Black	4	155	116	39	126	0.11	281	183987
Concrete Floor	5	261	222	39	126	0.11	281	183987
Concrete Floor Duplicate	6	246	222	24	126	0.11	173	183987
Lab Bench Black	7	147	116	31	126	0.11	224	183987
Lab Floor Tile	8	173	137	36	126	0.11	260	183987
Glass	9	179	178	1	126	0.11	7	183987
Lab Floor Tile	10	200	137	63	126	0.11	455	183987
Metal Door	11	171	130	41	126	0.11	296	183987
Lab Floor Tile	12	175	137	38	126	0.11	274	183987
Lab Floor Tile	13	187	137	50	126	0.11	361	183987
Sheet Rock Wall	14	121	178	-57	126	0.11	-411	183987
Lab Bench Black	15	131	116	15	126	0.11	108	183987
Metal Door	16	153	130	23	126	0.11	166	183987

Instrument background of 178 cpm used for wood, glass and sheet rock background

Material Specific Background and MDC Sheet for Beta Measurements

Instrument/SN: Ludlum 2221 / 183987

Probe/SN: Ludlum 43-68 / PR289329

Background Count Time 1.00 minutes

Total Instrument Effciency 0.11 dpm/cpm

Lab Bench (Black)	**(LBB)**	116	cpm	**MDC**	392	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Bench (Grey)	**(LBG)**	0	cpm	**MDC**	22	dpm/100cm2	**Sample Count Time**	1.00	min
Metal	**(ME)**	130	cpm	**MDC**	414	dpm/100cm2	**Sample Count Time**	1.00	min
Concrete Floor	**(CF)**	222	cpm	**MDC**	534	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Floor (Tile)	**(LFW)**	137	cpm	**MDC**	424	dpm/100cm2	**Sample Count Time**	1.00	min
Carpet	**(C)**	170	cpm	**MDC**	470	dpm/100cm2	**Sample Count Time**	1.00	min
Stairwell Rubber Tread	**(SRT)**	182	cpm	**MDC**	485	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Floor (Resin)	**(LFR)**	167	cpm	**MDC**	466	dpm/100cm2	**Sample Count Time**	1.00	min

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	6	1	64.43	18
C-14	10	10	1	96.45	14

$$\frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

Corresponding survey number/location:

5	6

Direct reads (static measurements)

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

1st (cpm)	Replicate (cpm)	RPD (<0.2)
261	245	0.06

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	6	8	0.29	RPD not relavent when result is less than MDC
C-14	0	1	2.00	RPD not relavent when result is less than MDC

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

H-3 spike	H-3 result	Relative bias ($\pm$0.2)
4049	3521	-0.130403

C-14 spike	C-14 result	Relative bias ($\pm$0.2)
4356	4162	-0.044536

H-3 spike value = 4049 dpm

C-14 spike value= 4356 dpm

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 12.55 Date Processed: 1/30/2013 8:56:06 AM
14C Chi Square: 30.55 Date Processed: 1/30/2013 8:56:06 AM
3H E^2/B (1-18.6 keV): 400.99 Date Processed: 1/30/2013 8:56:06 AM
14C E^2/B (4-156 keV): 778.19 Date Processed: 1/30/2013 8:56:06 AM
3H Efficiency (0-18.6 keV): 63.43 Date Processed: 1/30/2013 8:56:06 AM
14C Efficiency (0-156 keV): 96.45 Date Processed: 1/30/2013 8:56:06 AM
IPA Background Date Processed: 1/30/2013 8:56:06 AM
3H Background CPM (0-18.6 keV): 10.02 Date Processed: 1/30/2013 8:56:06 AM
14C Background CPM (0-156 keV): 14.30 Date Processed: 1/30/2013 8:56:06 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Assay Definition-

Assay Description:
B3-298 FSS

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20130130_1310
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20130130_1310\20130130_1310.results
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

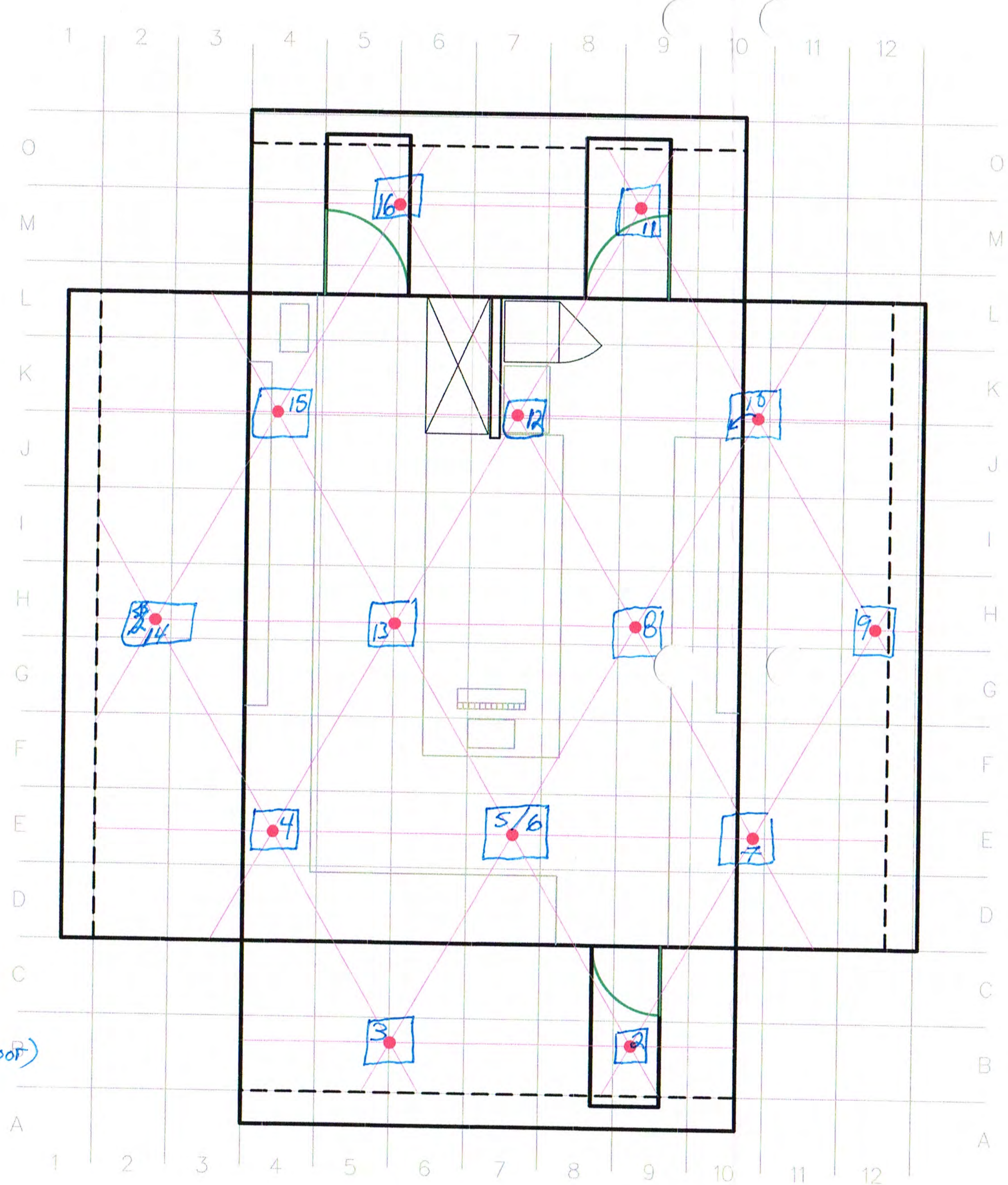
Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	6	10	0	0	52.96	459.78
2	1.00	0	0	0	0	0.00	449.34
3	1.00	1	8	0	9	54.30	446.29
4	1.00	2	0	6	0	0.00	448.50
5	1.00	3	1	8	1	0.00	410.20
D 6	1.00	2	0	6	0	20.29	410.84
7	1.00	0	0	1	0	0.00	456.71
8	1.00	7	8	17	9	29.11	436.55
9	1.00	1	2	2	3	73.03	438.53
10	1.00	0	0	0	0	0.00	418.84

11	1.00	0	2	0	3	216.81	454.33
12	1.00	0	6	0	8	79.05	394.34
13	1.00	0	1	0	2	0.00	417.94
14	1.00	0	2	0	2	702.99	438.08
15	1.00	0	0	0	0	0.00	427.90
16	1.00	2	0	6	0	85.07	454.07
Missing vial 17.							
Missing vial 18.							
19	1.00	1900	3556	3521	4162	52.15	456.18

Gross Counts in CPM
1) LSC Background
2) B9 - 165 (wood)
Range: 98-230
3) B6 - 149 (sheetrock)
Range: 75-257
4) E4 - 155 (Lab Bench)
Range: 130-200
5) E7 - 261 (concrete)
Range: 185-350
6) E7 Duplicate - 246
Range: 185-350
7) E10 - 147 (Lab Bench)
Range: 67-257
8) H9 - 173 (Lab Floor)
Range: 100-280
9) H12 - 179 (Glass)
Range: 150-300
10) K10 - 200 (Lab Floor)
Range 150-200
11) M9 - 171 (Metal Door)
Range: 150-250
12) K7 - 175 (Lab Floor)
Range: 150-250
13) H5 - 187 (Lab Floor)
Range: 61-255
14) H2 - 121 (Wall)
Range: 65-216
15) K4 - 131 (Lab Bench)
Range: 86-225
16) M5 - 153 (Metal Door)
Range 150-200



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 68.5 SQ. M.
   FLOOR SURFACE AREA: 56.87 SQ. M.
   TOTAL SURFACE AREA: 125.37 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 3.22 METERS.

SCALE IN METERS
0 2 4

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS
IN B3-298
SU1-B3298

FINAL STATUS SURVEY

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Contamination / Radiation Survey Report

CONTAMINATION / RADIATION SURVEY REPORT	PROJECT NUMBER: 144040
LOCATION: Aptuit Waste Storage	SURVEYOR(S): S. Brunsardt / G. Robb
	SURVEY NUMBER: 012213-01
	MAP ID: See Attached Map

DATE: 01.22.13 | TIME START: 0935 | TIME COMPLETE: 1330 | PAGE 1 OF 12

ACCEPTABLE SURFACE CONTAMINATION LEVELS	ACCEPTABLE SCAN LIMITS
Loose N/A dpm/100cm² Alpha 1,000 dpm/100cm² Beta-Gamma Total N/A dpm/100cm² Alpha 5,000 dpm/100cm² Beta-Gamma	Less than twice material background. SADS for material background.

Source Check Data	Contamination Surveys				Radiation Surveys
	α (LOOSE)	α (TOTAL)	β-γ (LOOSE)	β-γ (TOTAL)	Beta-Gamma
Instrument	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360 / 43-68 2360 / 43-37	N/A
Source Type and I.D.			H-3/C-14	C-14	
Source Strength in dpm			SADS	48343	µCi
Efficiency				0.10 0.08	
MDC in dpm/100 cm²				540 265	Sat. ☐ Unsat. ☐
Background in cpm				186 629	mrem/hr or µrem/hr

REASON FOR SURVEY
☐ PROCEDURE NO. ______
☒ SPECIAL Characterization / FSS
☐ ROUTINE ______

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐
Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Characterization of the Aptuit waste Storage Building. Survey performed to the standard of Final Status Surveys, including biased scanning, direct measurement, wipes & duplicates
D = Duplicate

SADS – See Attached Data Sheet

Contamination Survey INSTRUMENT / SERIAL #	ALPHA (LOOSE) N/A	BETA-GAMMA (LOOSE) SADS
	ALPHA (TOTAL)	BETA-GAMMA (TOTAL) 2360 / 43-68 | 237279 / PR190298 2360 / 43-37 | 227437/ PR216990
Radiation Survey INSTRUMENT / SERIAL #	BETA-GAMMA Meter	BETA-GAMMA Probe N/A

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta-Gamma Loose dpm/100cm²	Beta-Gamma Total dpm/100cm²	Alpha cpm ☐ / Beta cpm ☐ / Material ☒	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	CF	P15
3						P14
4						P13
5						P11
6						P10
7						O10
8						N10
9						M10
10						L10
11						K10
12						J10
13						I10
14						H10
15						G10
16						G9
17						G8
18						G6
19						F6
20 D						F6
21						E6
22						D6
23						D7
24						E7
25						F7

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RCS REVIEW [signature] DATE 01/25/13

Contamination / Radiation Survey Report

CONTAMINATION / RADIATION SURVEY REPORT (CONTINUATION SHEET)

PROJECT NUMBER: 144040 | DATE: 01.22.13 | PAGE 2 OF 12

LOCATION: Aptuit Waste Storage

SURVEYOR(S): S. Brungardt / C.Robb

SURVEY NUMBER: 012213-01

MAP ID: SADS

COMMENTS:

RCS REVIEW ______________ DATE ______________

Item #	Alpha LOOSE dpm/100cm²	Alpha TOTAL dpm/100cm²	Beta-Gamma LOOSE dpm/100cm²	Beta-Gamma TOTAL dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☒	Item or Location
26	N/A	N/A	SADS	SADS	CF	F8
27						E8
28						D8
29						D9
30						E9
31						F9
32						F10
33						E10
34						D10
35						E11
36						F11
37						G11
38						M13
39						M13
40						M13
41						M13
42						G13
43 D						G13
44						G14
45						G15
46						
47						
48						
49						
50						

Item #	Alpha LOOSE dpm/100cm²	Alpha TOTAL dpm/100cm²	Beta-Gamma LOOSE dpm/100cm²	Beta-Gamma TOTAL dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☐	Item or Location
51						
52						
53						
54						
55						
56						
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Survey 012213-01 Aptuit Waste Storage Area Description	Sample Location	Gross (cpm)	Background (cpm)	Net (cpm)	Probe area (cm2)	Total efficiency (cpm/dpm)	net (dpm/ 100 cm2)	Instrument Serial #
BKG LSC	1							
concrete	2	338	201	137	126	0.10	1087	237279
concrete	3	368	201	167	126	0.10	1325	237279
concrete	4	450	201	249	126	0.10	1976	237279
concrete	5	373	201	172	126	0.10	1365	237279
concrete	6	340	201	139	126	0.10	1103	237279
concrete	7	253	201	52	126	0.10	413	237279
concrete	8	283	201	82	126	0.10	651	237279
concrete	9	262	201	61	126	0.10	484	237279
concrete	10	274	201	73	126	0.10	579	237279
concrete	11	286	201	85	126	0.10	675	237279
concrete	12	296	201	95	126	0.10	754	237279
concrete	13	249	201	48	126	0.10	381	237279
concrete	14	299	201	98	126	0.10	778	237279
concrete	15	355	201	154	126	0.10	1222	237279
concrete	16	279	201	78	126	0.10	619	237279
concrete	17	293	201	92	126	0.10	730	237279
concrete	18	229	201	28	126	0.10	222	237279
concrete	19	255	201	54	126	0.10	429	237279
concrete duplicate	20	249	201	48	126	0.10	381	237279
concrete	21	252	201	51	126	0.10	405	237279
concrete	22	270	201	69	126	0.10	548	237279
concrete	23	228	201	27	126	0.10	214	237279
concrete	24	268	201	67	126	0.10	532	237279
concrete	25	236	201	35	126	0.10	278	237279
concrete	26	256	201	55	126	0.10	437	237279
concrete	27	250	201	49	126	0.10	389	237279
concrete	28	252	201	51	126	0.10	405	237279
concrete	29	222	201	21	126	0.10	167	237279
concrete	30	257	201	56	126	0.10	444	237279
concrete	31	251	201	50	126	0.10	397	237279
concrete	32	287	201	86	126	0.10	683	237279
concrete	33	271	201	70	126	0.10	556	237279
concrete	34	246	201	45	126	0.10	357	237279
concrete	35	300	201	99	126	0.10	786	237279
concrete	36	291	201	90	126	0.10	714	237279
concrete	37	9960	201	9759	126	0.10	77452	237279
concrete	38	1982	201	1781	126	0.10	14135	237279
concrete	39	2456	201	2255	126	0.10	17897	237279
concrete	40	2319	201	2118	126	0.10	16810	237279
concrete	41	2073	201	1872	126	0.10	14857	237279
concrete	42	283	201	82	126	0.10	651	237279
concrete duplicate	43	301	201	100	126	0.10	794	237279
concrete	44	290	201	89	126	0.10	706	237279
concrete	45	336	201	135	126	0.10	1071	237279

Material Specific Background and MDC Sheet for Beta Measurements

Instrument/SN: Ludlum 2360 / 227437

Background Count Time 1.00 minutes

Probe/SN: Ludlum 43-37 / PR216990

Total Instrument Effciency 0.09 dpm/cpm

Lab Bench (Black)	**(LBB)**	0	cpm	**MDC**	26	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Bench (Grey)	**(LBG)**	0	cpm	**MDC**	26	dpm/100cm2	**Sample Count Time**	1.00	min
Metal	**(ME)**	0	cpm	**MDC**	26	dpm/100cm2	**Sample Count Time**	1.00	min
Concrete Floor	**(CF)**	681	cpm	**MDC**	1068	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Floor (Tile)	**(LFW)**	411	cpm	**MDC**	835	dpm/100cm2	**Sample Count Time**	1.00	min
Carpet	**(C)**	531	cpm	**MDC**	946	dpm/100cm2	**Sample Count Time**	1.00	min
Stairwell Rubber Tread	**(SRT)**	695	cpm	**MDC**	1078	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Floor (Resin)	**(LFR)**	544	cpm	**MDC**	957	dpm/100cm2	**Sample Count Time**	1.00	min

Material Specific Background and MDC Sheet for Beta Measurements

Instrument/SN: Ludlum 2360 / 237279

Background Count Time 1.00 minutes

Probe/SN: Ludlum 43-68 / PR190298

Total Instrument Effciency 0.10 dpm/cpm

Lab Bench (Black)	**(LBB)**	149	cpm	**MDC**	487	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Bench (Grey)	**(LBG)**	0	cpm	**MDC**	24	dpm/100cm2	**Sample Count Time**	1.00	min
Metal	**(ME)**	133	cpm	**MDC**	460	dpm/100cm2	**Sample Count Time**	1.00	min
Concrete Floor	**(CF)**	236	cpm	**MDC**	606	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Floor (Tile)	**(LFW)**	154	cpm	**MDC**	494	dpm/100cm2	**Sample Count Time**	1.00	min
Carpet	**(C)**	178	cpm	**MDC**	530	dpm/100cm2	**Sample Count Time**	1.00	min
Stairwell Rubber Tread	**(SRT)**	216	cpm	**MDC**	581	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Floor (Resin)	**(LFR)**	173	cpm	**MDC**	522	dpm/100cm2	**Sample Count Time**	1.00	min

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 19.80 Date Processed: 1/22/2013 9:19:46 AM
14C Chi Square: 14.48 Date Processed: 1/22/2013 9:19:46 AM
3H E^2/B (1-18.6 keV): 403.52 Date Processed: 1/22/2013 9:19:46 AM
14C E^2/B (4-156 keV): 766.77 Date Processed: 1/22/2013 9:19:46 AM
3H Efficiency (0-18.6 keV): 63.60 Date Processed: 1/22/2013 9:19:46 AM
14C Efficiency (0-156 keV): 96.03 Date Processed: 1/22/2013 9:19:46 AM
IPA Background Date Processed: 1/22/2013 9:19:46 AM
3H Background CPM (0-18.6 keV): 10.08 Date Processed: 1/22/2013 9:19:46 AM
14C Background CPM (0-156 keV): 14.45 Date Processed: 1/22/2013 9:19:46 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Assay Definition-

Assay Description:
WASTE STORAGE CHARACTERIZATION

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20130123_1620
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20130123_1620\20130123_1620.results
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	6	9	0	0	44.43	443.91
2	1.00	3	17	1	22	27.15	277.61
3	1.00	8	22	18	28	41.81	276.38
4	1.00	3	19	0	23	41.95	289.62
5	1.00	1	14	0	18	32.26	298.20
6	1.00	3	9	6	10	18.97	387.90
7	1.00	0	9	0	11	5.10	328.75
8	1.00	3	14	5	17	58.71	346.10
9	1.00	4	16	8	19	33.38	311.14
10	1.00	0	9	0	11	16.63	335.85

11	1.00	0	16	0	20	44.28	319.03
12	1.00	0	6	0	7	35.11	312.66
13	1.00	0	22	0	27	49.71	321.66
14	1.00	0	5	0	6	47.69	316.54
15	1.00	6	12	17	14	13.75	304.85
16	1.00	0	8	0	10	56.58	298.04
17	1.00	0	15	0	19	59.31	296.17
18	1.00	5	3	17	3	9.92	301.47
19	1.00	3	10	7	12	15.50	309.70
20 D	1.00	1	11	0	13	40.73	346.21
21	1.00	2	3	6	3	0.00	303.66
22	1.00	0	4	0	6	56.78	322.97
23	1.00	0	5	0	6	148.31	344.04
24	1.00	5	6	15	6	26.23	337.84
25	1.00	2	15	1	18	43.60	318.84
26	1.00	0	8	0	10	90.18	309.33
27	1.00	0	12	0	15	23.91	307.62
28	1.00	0	3	0	4	0.00	339.73
29	1.00	2	2	6	2	1.19	353.28
30	1.00	1	1	3	1	5.39	335.77
31	1.00	2	0	8	0	24.50	357.82
32	1.00	9	16	27	19	22.71	294.92
33	1.00	0	2	1	2	78.00	344.59
34	1.00	0	16	0	20	33.20	304.21
35	1.00	10	8	30	8	19.48	319.32
36	1.00	3	11	3	13	38.91	360.34
37	1.00	25	78	42	95	40.10	347.92
38	1.00	5	24	5	29	33.73	369.29
39	1.00	7	27	10	32	58.12	403.76
40	1.00	3	39	0	47	51.58	403.84
41	1.00	11	20	21	24	41.99	419.49
42	1.00	7	14	19	17	24.54	290.20
43 D	1.00	5	14	10	17	26.43	296.54
44	1.00	5	20	8	24	33.80	327.91
45	1.00	5	1	18	0	0.00	328.70
Missing vial 46.							
Missing vial 47.							
Missing vial 48.							
Missing vial 49.							
Missing vial 50.							
Missing vial 51.							
Missing vial 52.							
Missing vial 53.							
Missing vial 54.							
55	1.00	1867	3459	3488	4047	52.01	454.07

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	6	1	64.11	18
C-14	10	9	1	96.57	14

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

Corresponding survey number/location:

19	20

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
255	249	0.02

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)	
H-3	7	0	2.00	RPD not relavent when result is less than MDC
C-14	12	13	0.08	RPD not relavent when result is less than MDC

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

H-3 spike value = 4049 dpm
C-14 spike value= 4356 dpm

H-3 spike	H-3 result	Relative bias (±0.2)
4049	3488	-0.138553

C-14 spike	C-14 result	Relative bias (±0.2)
4356	4047	-0.070937

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	6	1	64.11	18
C-14	10	9	1	96.57	14

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}^{\,d}}{(Efficiency)(t_g)}$$

Relative Percent Difference (RPD)

The relative percent difference is derived as follows:

Corresponding survey number/location:

42	43

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
283	301	0.06

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)
$\bar{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)
H-3	19	10	0.62
C-14	17	17	0.00

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

H-3 spike	H-3 result	Relative bias (±0.2)
4049	3488	-0.138553

C-14 spike	C-14 result	Relative bias (±0.2)
4356	4047	-0.070937

H-3 spike value = 4049 dpm
C-14 spike value= 4356 dpm

Contamination / Radiation Survey Report

PROJECT NUMBER: 144040	ACTIVITY / LOCATION: Aptrit Waste Storage / Laboratory-Room		PAGE 12 OF 12	
COMMENTS:		SURVEYOR(S): S. Brungardt / G. Robb	SURVEY NUMBER: 012213-01	DATE: 01-22-13
		NOTE: THE KNOWING AND WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.		
RCS REVIEW:	DATE:			

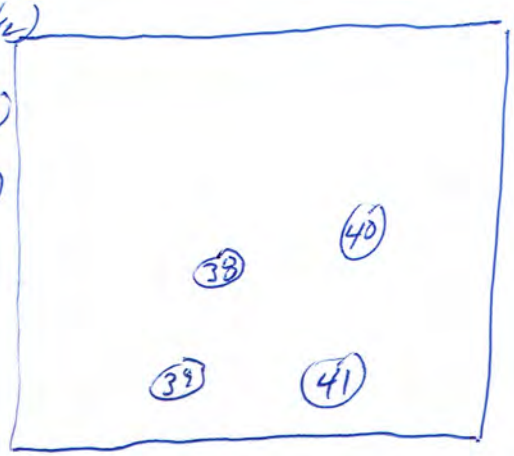
Grid M13

38) M13 - 1982 (Concrete)

39) M13 - 2456 (concrete)

40) M13 - 2319 (concrete)

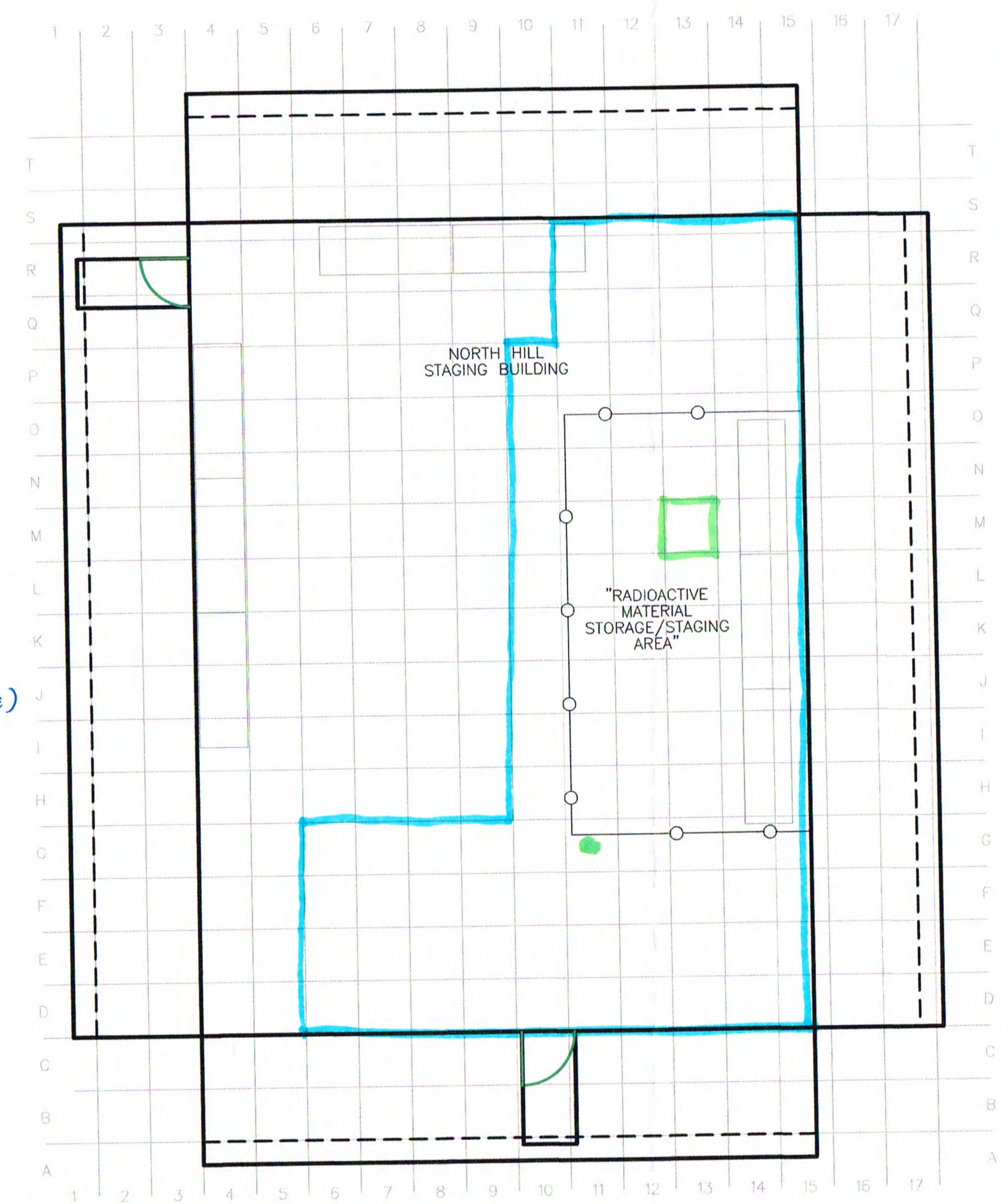
41) M13 - 2073 (concrete)



2) P15-338 (CONCRETE)
3) P14-368 (CONCRETE)
4) P13-450 (CONCRETE)
5) P11-373 (CONCRETE)
6) P10-340 (CONCRETE)
7) O10-253 (CONCRETE)
8) N10-283 (CONCRETE)
9) M10-262 (CONCRETE)
10) L10-274 (CONCRETE)
11) K10-286 (CONCRETE)
12) J10-296 (CONCRETE)
13) I10-249 (CONCRETE)
14) H10-299 (CONCRETE)
15) G10-355 (CONCRETE)
16) G9-279 (CONCRETE)
17) G8-293 (CONCRETE)
18) G6-229 (CONCRETE)
19) F6-255 (CONCRETE)
20) F6-249 Duplicate (CONCRETE)
21) E6-252 (CONCRETE)
22) D6-270 (CONCRETE)
23) D7-228 (CONCRETE)
24) E7-268 (CONCRETE)
25) F7-236 (CONCRETE)
26) F8-256 (CONCRETE)
27) E8-250 (CONCRETE)
28) D8-252 (CONCRETE)
29) D9-222 (CONCRETE)
30) E9-257 (CONCRETE)
31) F9-251 (CONCRETE)
32) F10-287 (CONCRETE)
33) E10-271 (CONCRETE)
GR 34 ~~32~~) D10-246 (CONCRETE)
35) E11-300 (CONCRETE)
GR 36 ~~34~~) F11-291 (CONCRETE)
GR 37 ~~35~~) G11-9960 (CONCRETE

GR 38 ~~36~~) M13-1982 (CONCRETE)
39) M13-2456 (CONCRETE)
GR 40 ~~38~~) M13-2319 (CONCRETE)
GR 41 ~~39~~) M13-2073 (CONCRETE)

~~40~~) GR
42) G13-283 (CONCRETE)
43) G13-301 Duplicate (CONCRETE)
44) G14-290 (CONCRETE)
45) G15-336 (CONCRETE)



Floor area within blue - 100% scan with Floor monitor Ludlum model 43-37.

Scan range: 400 to ~~900~~ 1000 GR cpm excluding hot spots

Green areas represent flagged areas above twice materials background. Results confirmed and recorded with Ludlum model 43-68 handheld instrument.

FIGURE X-X
SU2-HILL

CHARACTERIZATION SURVEY

APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 3 6

Shaw® a world of Solutions™

SEI_TEXTSUB_ONLY.TBL pdf_with_levels.plt 9:41:10 AM 1/24/2013 cbentley aptuit_api_cs_temp002.dgn

Contamination / Radiation Survey Report

CONTAMINATION / RADIATION SURVEY REPORT	PROJECT NUMBER: 144040
LOCATION: Aptuit Waste Storage SU-2 Hill	SURVEYOR(S): Gordon Robb
	SURVEY NUMBER: 013013-01
	MAP ID: See Attached Map

DATE: 01.30.13 TIME START: 1400 TIME COMPLETE: 1530 PAGE 1 OF 8

ACCEPTABLE SURFACE CONTAMINATION LEVELS	ACCEPTABLE SCAN LIMITS
Loose N/A dpm/100cm² Alpha 1,000 dpm/100cm² Beta-Gamma Total N/A dpm/100cm² Alpha 5,000 dpm/100cm² Beta-Gamma	Less than twice material background. SADS for material background.

Source Check Data	α (LOOSE)	α (TOTAL)	β-γ (LOOSE)	β-γ (TOTAL)	Radiation Surveys Beta-Gamma
Instrument	N/A	N/A	Perkin Elmer TriCarb 2900TR	2221 / 43-68	N/A
Source Type and I.D.			H-3/C-14	C-14	
Source Strength in dpm			SADS	40608	µCi
Efficiency				0.11	
MDC in dpm/100 cm²				480	Sat. ☐ Unsat. ☐
Background in cpm				178	mrem/hr or µrem/hr

REASON FOR SURVEY
☐ PROCEDURE NO. ______
☒ SPECIAL Characterzation
☐ ROUTINE ______

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐
Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Supplimental Data For SU-2 Hill Characterization Survey Number 012213-01 wipes and direct measurements taken in each grid of the Rad waste storage AREA

SADS – See Attached Data Sheet

Contamination Survey INSTRUMENT / SERIAL #	ALPHA (LOOSE) N/A	BETA-GAMMA (LOOSE)	SADS
	ALPHA (TOTAL)	BETA-GAMMA (TOTAL)	2221 / 43-68 | 183987 / PR289329
Radiation Survey INSTRUMENT / SERIAL #	BETA-GAMMA Meter	BETA-GAMMA Probe	N/A

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta-Gamma Loose dpm/100cm²	Beta-Gamma Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☒	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	CF	O15
3						O14
4						O13
5						O12
6						O11
7						N11
8						N12
9						N13
10						N14
11						N15
12						M15
13						M14
14						M13
15						M12
16						M11
17						L11
18						L12
19						L13
20						L14
21						L15
22						K15
23						K14
24						K13
25						K12

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RCS REVIEW [signature] DATE 01/31/13

Contamination / Radiation Survey Report

CONTAMINATION / RADIATION SURVEY REPORT (CONTINUATION SHEET)	PROJECT NUMBER: 144040 / DATE: 01.30.13 / PAGE 2 OF 8
LOCATION: Aptuit waste Storage SW-2 Hill / SURVEYOR(S): Gordon Robb / SURVEY NUMBER: 013013-01 / MAP ID: SADS	COMMENTS: NONE
RCS REVIEW / DATE 01/31/13	

Item #	Alpha LOOSE dpm/100cm²	Alpha TOTAL dpm/100cm²	Beta-Gamma LOOSE dpm/100cm²	Beta-Gamma TOTAL dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☒	Item or Location
26	N/A	N/A	SADS	SADS	CF	K11
27						J11
28						J12
29						J13
30						J14
31						J15
32						I15
33						I14
34						I13
35						I12
36						I11
37						H11
38						H12
39						H13
40						H14
41						H15
42						
43						
44						
45						
46						
47						
48						
49						
50						

Item #	Alpha LOOSE dpm/100cm²	Alpha TOTAL dpm/100cm²	Beta-Gamma LOOSE dpm/100cm²	Beta-Gamma TOTAL dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☐	Item or Location
51						
52						
53						
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THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

Survey 013013-01 SU2 Supplemental Area Description	Sample Location	Gross (cpm)	Background (cpm)	Net (cpm)	Probe area (cm2)	Total efficiency (cpm/dpm)	net (dpm/ 100 cm2)	Instrument Serial #
BKG LSC	1							
concrete	2	237	222	15	126	0.11	108	183987
concrete	3	620	222	398	126	0.11	2872	183987
concrete	4	502	222	280	126	0.11	2020	183987
concrete	5	1086	222	864	126	0.11	6234	183987
concrete	6	425	222	203	126	0.11	1465	183987
concrete	7	280	222	58	126	0.11	418	183987
concrete	8	462	222	240	126	0.11	1732	183987
concrete	9	478	222	256	126	0.11	1847	183987
concrete	10	474	222	252	126	0.11	1818	183987
concrete	11	285	222	63	126	0.11	455	183987
concrete	12	275	222	53	126	0.11	382	183987
concrete	13	595	222	373	126	0.11	2691	183987
concrete (data collected on Survey 012213-01)	14			0	126	0.11	0	183987
concrete	15	356	222	134	126	0.11	967	183987
concrete	16	286	222	64	126	0.11	462	183987
concrete	17	295	222	73	126	0.11	527	183987
concrete	18	369	222	147	126	0.11	1061	183987
concrete	19	367	222	145	126	0.11	1046	183987
concrete	20	396	222	174	126	0.11	1255	183987
concrete	21	356	222	134	126	0.11	967	183987
concrete	22	375	222	153	126	0.11	1104	183987
concrete	23	427	222	205	126	0.11	1479	183987
concrete	24	427	222	205	126	0.11	1479	183987
concrete	25	382	222	160	126	0.11	1154	183987
concrete	26	305	222	83	126	0.11	599	183987
concrete	27	230	222	8	126	0.11	58	183987
concrete	28	544	222	322	126	0.11	2323	183987
concrete	29	335	222	113	126	0.11	815	183987
concrete	30	373	222	151	126	0.11	1089	183987
concrete	31	404	222	182	126	0.11	1313	183987
concrete	32	383	222	161	126	0.11	1162	183987
concrete	33	476	222	254	126	0.11	1833	183987
concrete	34	254	222	32	126	0.11	231	183987
concrete	35	386	222	164	126	0.11	1183	183987
concrete	36	343	222	121	126	0.11	873	183987
concrete	37	233	222	11	126	0.11	79	183987
concrete	38	372	222	150	126	0.11	1082	183987
concrete	39	340	222	118	126	0.11	851	183987
concrete	40	282	222	60	126	0.11	433	183987
concrete	41	237	222	15	126	0.11	108	183987

Material Specific Background and MDC Sheet for Beta Measurements

Instrument/SN: Ludlum 2221 / 183987

Background Count Time 1.00 minutes

Probe/SN: Ludlum 43-68 / PR289329

Total Instrument Effciency 0.11 dpm/cpm

Lab Bench (Black)	**(LBB)**	116	cpm	**MDC**	392	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Bench (Grey)	**(LBG)**	0	cpm	**MDC**	22	dpm/100cm2	**Sample Count Time**	1.00	min
Metal	**(ME)**	130	cpm	**MDC**	414	dpm/100cm2	**Sample Count Time**	1.00	min
Concrete Floor	**(CF)**	222	cpm	**MDC**	534	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Floor (Tile)	**(LFW)**	137	cpm	**MDC**	424	dpm/100cm2	**Sample Count Time**	1.00	min
Carpet	**(C)**	170	cpm	**MDC**	470	dpm/100cm2	**Sample Count Time**	1.00	min
Stairwell Rubber Tread	**(SRT)**	182	cpm	**MDC**	485	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Floor (Resin)	**(LFR)**	167	cpm	**MDC**	466	dpm/100cm2	**Sample Count Time**	1.00	min

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 25.17 Date Processed: 1/31/2013 9:44:36 AM
14C Chi Square: 17.04 Date Processed: 1/31/2013 9:44:36 AM
3H E^2/B (1-18.6 keV): 361.69 Date Processed: 1/31/2013 9:44:36 AM
14C E^2/B (4-156 keV): 702.26 Date Processed: 1/31/2013 9:44:36 AM
3H Efficiency (0-18.6 keV): 62.71 Date Processed: 1/31/2013 9:44:36 AM
14C Efficiency (0-156 keV): 96.36 Date Processed: 1/31/2013 9:44:36 AM
IPA Background Date Processed: 1/31/2013 9:44:36 AM
3H Background CPM (0-18.6 keV): 10.92 Date Processed: 1/31/2013 9:44:36 AM
14C Background CPM (0-156 keV): 15.62 Date Processed: 1/31/2013 9:44:36 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Assay Definition-

Assay Description:
SU2-HILL SUPPLIMENT SURVEY

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20130131_0944
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20130131_0944\20130131_0944.results
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	6	13	0	0	60.42	456.79
2	1.00	0	2	0	3	0.00	298.02
3	1.00	21	20	60	22	8.82	343.40
4	1.00	12	33	26	40	25.23	303.65
5	1.00	4	20	5	25	31.82	324.30
6	1.00	10	27	24	33	20.35	301.28
7	1.00	8	12	20	14	24.70	346.45
8	1.00	8	16	20	19	21.75	334.72
9	1.00	5	13	9	15	30.03	393.30
10	1.00	15	42	28	51	40.07	345.43

11	1.00	1	10	0	13	53.50	358.86
12	1.00	16	28	41	33	22.67	325.42
13	1.00	14	29	32	35	23.48	329.79
Missing vial 14.							
15	1.00	11	19	27	22	32.49	337.44
16	1.00	10	22	20	26	12.21	375.00
17	1.00	0	7	0	9	23.87	370.42
18	1.00	13	15	37	18	35.30	333.07
19	1.00	11	22	29	27	14.29	311.24
20	1.00	15	34	33	41	25.76	322.03
21	1.00	9	18	21	21	30.04	329.32
22	1.00	4	22	3	28	37.31	355.65
23	1.00	13	14	36	16	15.01	335.84
24	1.00	6	18	12	21	23.10	329.27
25	1.00	7	20	15	24	18.85	285.26
26	1.00	2	12	1	14	21.22	371.60
27	1.00	7	7	18	7	24.50	389.67
28	1.00	6	15	14	19	33.44	327.16
29	1.00	11	13	34	15	20.64	308.40
30	1.00	9	21	21	25	19.08	296.80
31	1.00	18	31	46	37	22.33	317.89
32	1.00	8	18	19	21	15.75	326.57
33	1.00	9	20	23	24	21.41	311.95
34	1.00	5	14	11	18	14.35	309.99
35	1.00	9	4	28	4	0.00	325.09
36	1.00	5	10	9	12	24.75	361.31
37	1.00	5	7	14	8	0.00	330.28
38	1.00	4	6	12	7	8.65	323.94
39	1.00	1	19	0	24	13.05	325.77
40	1.00	1	22	0	27	37.52	363.51
41	1.00	3	21	1	26	28.96	335.30

Gross CPM
1-LSC
2-015-237
3-014-620
4-013-502
5-012-1086
6-011-425
7-N11-280
8-N12-462
9-N13-478
10-N14-474
11-N15-285
12-M15-275
13-M14-595
14-M13-Data collected on Survey 012213-01
15-M12-356
16-M11-286
17-L11-295
18-L12-369
19-L13-367
20-L14-396
21-L15-356
22-K15-375
23-K14-427
24-K13-427
25-K12-382
26-K11-305
27-J11-230
28-J12-544
29-J13-335
30-J14-373
31-J15-404
32-I15-383
33-I14-476
34 GB ~~32~~-I13-254
35-I12-386
36-I11-343
37-H11-233
38-H12-372
39-H13-340
40-H14-282
41-H15-237

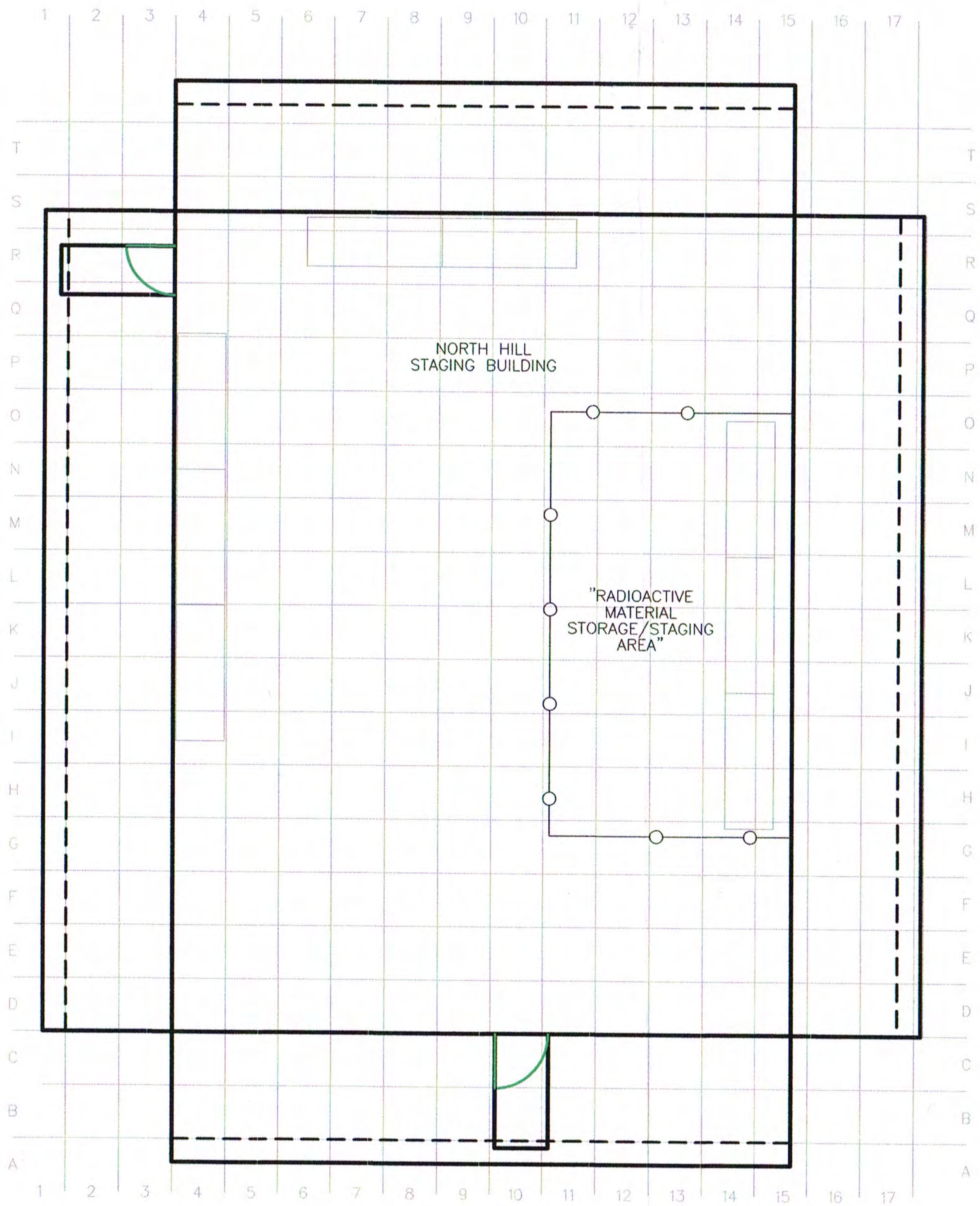

FIGURE X-X
SU2-HILL

CHARACTERIZATION SURVEY

APTUIT, LLC
KANSAS CITY, MISSOURI

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SEI_TEXTSUB_ONLY.TBL pdf_with_levels.plt 9:41:10 AM 1/24/2013 cbentley aptuit_api_cs_temp002.dgn

Contamination / Radiation Survey Report

CONTAMINATION / RADIATION SURVEY REPORT	PROJECT NUMBER: 144040	DATE: 01-22-13	TIME START: 1330	TIME COMPLETE: 1515	PAGE 1 OF 8
LOCATION: Aptus Waste Storage	SURVEYOR(S): S. Brungardt / G. Robb				
	SURVEY NUMBER: 012213-02				
	MAP ID: See Attached Map				

ACCEPTABLE SURFACE CONTAMINATION LEVELS

Loose N/A dpm/100cm² Alpha 1,000 dpm/100cm² Beta-Gamma

Total N/A dpm/100cm² Alpha 5,000 dpm/100cm² Beta-Gamma

ACCEPTABLE SCAN LIMITS

Less than twice material background. SADS for material background.

Source Check Data	Contamination Surveys α (LOOSE)	α (TOTAL)	β-γ (LOOSE)	β-γ (TOTAL)	Radiation Surveys Beta-Gamma
Instrument	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360 / 43-68 2360 / 43-37	N/A
Source Type and I.D.			H-3/C-14	C-14	
Source Strength in dpm			SADS	48343	µCi
Efficiency				0.10 0.08	
MDC in dpm/100 cm²				540 265	Sat. ☐ Unsat. ☐
Background in cpm				186 629	mrem/hr or µrem/hr

REASON FOR SURVEY

☐ PROCEDURE NO. ______

☒ SPECIAL Final Status

☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Scans, smears, statics of systematic locations in Class III Survey Units. Characterization survey, including biased sample locations and scanning data, available on Survey 012213-01 / D= Duplicate

SADS – See Attached Data Sheet

Contamination Survey INSTRUMENT / SERIAL #	ALPHA (LOOSE)	N/A	BETA-GAMMA (LOOSE)	SADS
	ALPHA (TOTAL)		BETA-GAMMA (TOTAL)	2360 / 43-68 | 237279 / PR190298 2360 / 43-37 | 227437/ PR216990
Radiation Survey INSTRUMENT / SERIAL #	BETA-GAMMA Meter		BETA-GAMMA Probe	N/A

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta-Gamma Loose dpm/100cm²	Beta-Gamma Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☒	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	ME	T5
3					ME	T9
4					ME	T14
5					ME	P17
6					CF	P12
7 D					CF	P12
8					CF	P7
9					ME	P2
10					CF	L5
11					CF	L9
12					ME	G2
13					ME	C5
14					CF	G7
15					ME	C9
16					CF	G12
17					ME	C14
18					ME	G17
19					CF	L14
20						
21						
22						
23						
24						
25						

THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

RCS REVIEW ______ DATE 01/25/13

Survey 012213-02 Aptuit Waste Storage FSS

Area Description	Sample Location	Gross (cpm)	Background (cpm)	Net (cpm)	Probe area (cm2)	Total efficiency (cpm/dpm)	net (dpm/ 100 cm2)	Instrument Serial #
BKG LSC	1							
metal	2	165	110	55	126	0.10	437	237279
metal	3	144	110	34	126	0.10	270	237279
metal	4	150	110	40	126	0.10	317	237279
metal	5	164	110	54	126	0.10	429	237279
concrete	6	348	201	147	126	0.10	1167	237279
concrete (duplicate)	7	321	201	120	126	0.10	952	237279
concrete	8	270	110	160	126	0.10	1270	237279
metal	9	151	201	-50	126	0.10	-397	237279
concrete	10	219	201	18	126	0.10	143	237279
concrete	11	201	201	0	126	0.10	0	237279
metal	12	135	110	25	126	0.10	198	237279
metal	13	100	110	-10	126	0.10	-79	237279
concrete	14	191	201	-10	126	0.10	-79	237279
metal	15	124	110	14	126	0.10	111	237279
concrete	16	311	201	110	126	0.10	873	237279
metal	17	111	110	1	126	0.10	8	237279
metal	18	123	110	13	126	0.10	103	237279
concrete	19	392	201	191	126	0.10	1516	237279

Material Specific Background and MDC Sheet for Beta Measurements

Instrument/SN: Ludlum 2360 / 237279

Background Count Time 1.00 minutes

Probe/SN: Ludlum 43-68 / PR190298

Total Instrument Effciency 0.10 dpm/cpm

Lab Bench (Black)	**(LBB)**	149	cpm	**MDC**	487	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Bench (Grey)	**(LBG)**	0	cpm	**MDC**	24	dpm/100cm2	**Sample Count Time**	1.00	min
Metal	**(ME)**	133	cpm	**MDC**	460	dpm/100cm2	**Sample Count Time**	1.00	min
Concrete Floor	**(CF)**	236	cpm	**MDC**	606	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Floor (Tile)	**(LFW)**	154	cpm	**MDC**	494	dpm/100cm2	**Sample Count Time**	1.00	min
Carpet	**(C)**	178	cpm	**MDC**	530	dpm/100cm2	**Sample Count Time**	1.00	min
Stairwell Rubber Tread	**(SRT)**	216	cpm	**MDC**	581	dpm/100cm2	**Sample Count Time**	1.00	min
Lab Floor (Resin)	**(LFR)**	173	cpm	**MDC**	522	dpm/100cm2	**Sample Count Time**	1.00	min

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 19.80 Date Processed: 1/22/2013 9:19:46 AM
14C Chi Square: 14.48 Date Processed: 1/22/2013 9:19:46 AM
3H E^2/B (1-18.6 keV): 403.52 Date Processed: 1/22/2013 9:19:46 AM
14C E^2/B (4-156 keV): 766.77 Date Processed: 1/22/2013 9:19:46 AM
3H Efficiency (0-18.6 keV): 63.60 Date Processed: 1/22/2013 9:19:46 AM
14C Efficiency (0-156 keV): 96.03 Date Processed: 1/22/2013 9:19:46 AM
IPA Background Date Processed: 1/22/2013 9:19:46 AM
3H Background CPM (0-18.6 keV): 10.08 Date Processed: 1/22/2013 9:19:46 AM
14C Background CPM (0-156 keV): 14.45 Date Processed: 1/22/2013 9:19:46 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Assay Definition-

Assay Description:
WASTE STORAGE FSS

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20130123_1515
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20130123_1515\20130123_1515.results
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	7	11	0	0	52.08	446.74
2	1.00	0	7	0	9	53.20	369.81
3	1.00	0	9	0	11	137.33	402.89
4	1.00	0	0	0	0	0.00	390.81
5	1.00	0	7	0	9	98.49	372.47
6	1.00	11	18	34	21	4.68	275.82
D 7	1.00	13	15	45	17	18.82	281.73
8	1.00	1	9	0	11	1.70	266.38
9	1.00	1	0	3	0	0.00	393.61
10	1.00	0	0	0	0	0.00	297.63

11	1.00	5	12	14	14	3.73	300.80
12	1.00	0	0	0	0	0.00	399.32
13	1.00	0	5	0	7	48.85	406.97
14	1.00	5	2	20	2	0.00	286.88
15	1.00	3	0	11	0	0.00	359.60
16	1.00	7	22	14	26	13.47	287.35
17	1.00	0	8	0	10	42.30	378.56
18	1.00	0	0	0	0	0.00	382.39
19	1.00	27	54	78	65	24.89	277.39
Missing vial 20.							
Missing vial 21.							
Missing vial 22.							
Missing vial 23.							
Missing vial 24.							
Missing vial 25.							
Missing vial 26.							
Missing vial 27.							
Missing vial 28.							
Missing vial 29.							
Missing vial 30.							
Missing vial 31.							
Missing vial 32.							
Missing vial 33.							
Missing vial 34.							
Missing vial 35.							
Missing vial 36.							
37	1.00	1891	3688	3445	4326	53.67	456.49

LSC MDC

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	7	1	64.11	19
C-14	10	11	1	96.57	15

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)} d$$

Relative Percent Difference (RPD)

Direct reads (static measurements)

1st (cpm)	Replicate (cpm)	RPD (<0.2)
348	321	0.08

The relative percent difference is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)
$\bar{x}$ = Arithmetic mean of the two samples.

Smears

	1st ct (dpm)	Replicate (dpm)	RPD (<0.3)
H-3	34	45	0.28
C-14	21	17	0.21

Bias

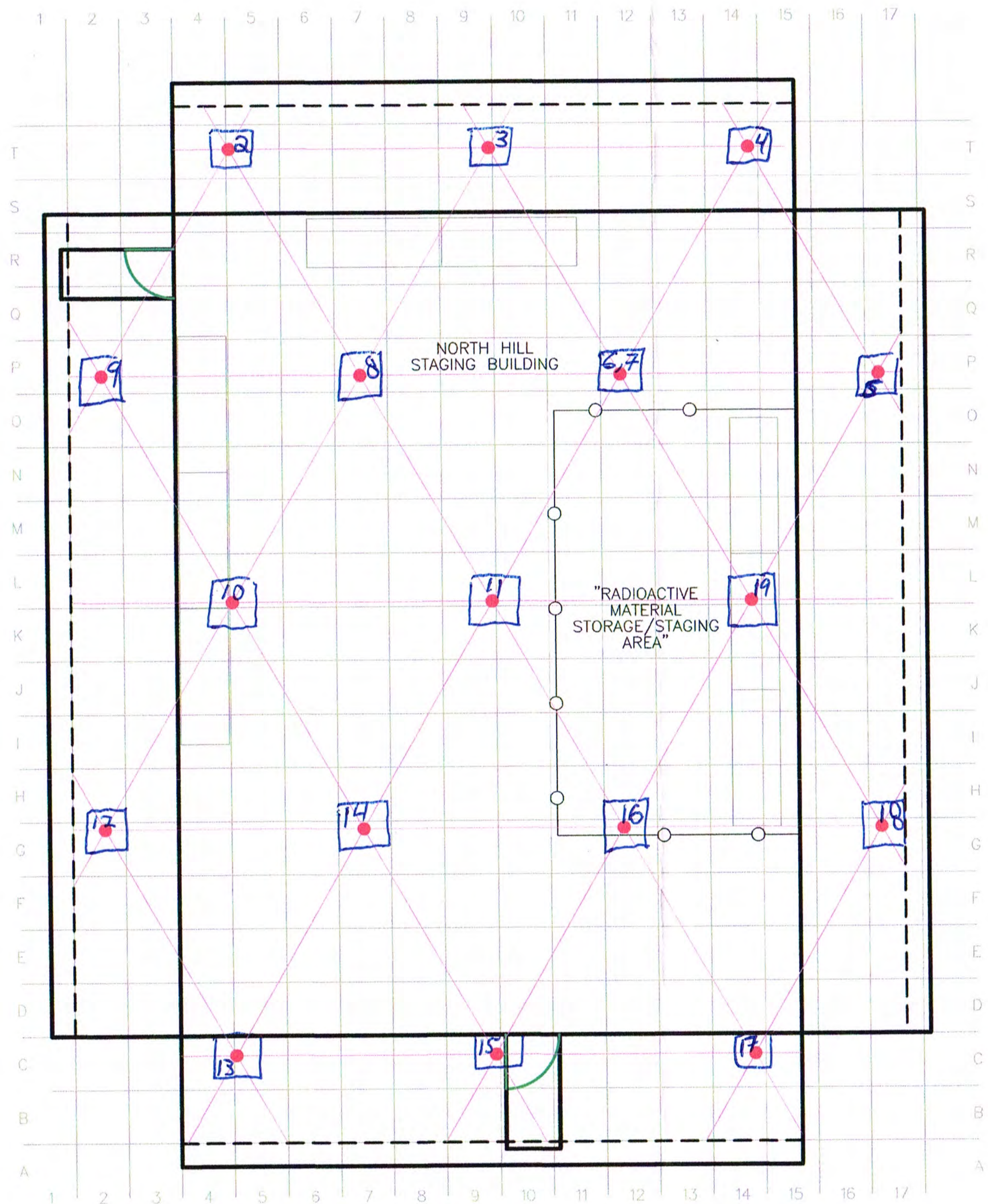
$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

H-3 spike	H-3 result	Relative bias ($\pm$0.2)
4049	3445	-0.149173

C-14 spike	C-14 result	Relative bias ($\pm$0.2)
4356	4326	-0.006887

H-3 spike value = 4049 dpm
C-14 spike value= 4356 dpm

1) LSC BKG
Gross Counts in cpm
2) T5 - 165 (Metal)
Range 100-210
3) T9 - 144 (metal)
Range - 120-200
4) T14 - 150 (Metal)
Range - 150-220
5) P17 - 164 (metal)
Range - 125-210
6) P12 - 348 (concrete)
Range - 225-1,375
7) P12 - Duplicate 321
Range - 225-1,375
8) P7 - 270 (concrete)
Range - 210-310
9) P2 - 151 (Metal)
Range - 110-190
10) L5 - 219 (concrete)
Range - 210-320
11) L9 - 201 (concrete)
Range - 210-310
12) G2 - 135 (metal)
Range - 105-190
13) C5 - 100 (metal)
Range - 100-210
14) G7 - 191 (concrete)
Range - 210-350
15) C9 - 124 (metal)
Range - 120-190
16) G12 - 311 (concrete)
Range - 250-320
17) C14 - 111 (Metal)
Range - 110-210
18) G17 - 123 (metal)
Range - 110-190
19) L14 - 392 (concrete)
Range - 400-500



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: 108.15 SQ. M.
FLOOR SURFACE AREA: 179.41 SQ. M.
TOTAL SURFACE AREA: 287.56 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.88 METERS.

SCALE IN METERS
0 3 6

FIGURE X-X
CLASS 2 SAMPLING LOCATIONS IN NORTH HILL STAGING BUILDING
SU2-HILL

FINAL STATUS SURVEY

APTUIT, LLC
KANSAS CITY, MISSOURI

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Contamination/Radiation Survey Report		Project Number: 144040	
Date:	2/3/2014	Time Start: 1300	Time Complete: 1630
Page 1 of ~~8~~ 9			

Location:	Room 165 Overhead	Surveyors:	Gordon Robb
Survey Unit:	SU2-B2165O		Shane Brungardt
		Survey Number:	020314-02
		Map ID:	see attached

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys α (Loose)	α (Total)	β (Loose)	β (Total)	Radiation Surveys γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm²)				615	
Background (cpm)				230	

REASON FOR SURVEY

- ☐ PROCEDURE NO.
- ☑ SPECIAL: FSS/Characterization
- ☐ ROUTINE

Contamination	☐	By Shift ☐	Daily ☐	Weekly ☐	Monthly ☐
Radiation	☐	By Shift ☐	Daily ☐	Weekly ☐	Monthly ☐

COMMENTS: FSS/characterization of overhead areas in room 165.

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Drywall	B9
3					Drywall	B6
4					Drywall	E1
5					Fire Retardant	E4
6					Fire Retardant	E8
7					Fire Retardant	E11
8					Drywall	E14
9					Drywall	E14 - duplicate
10					Drywall	H13
11					Fire Retardant	H9
12					Fire Retardant	H6
13					Drywall	H3
14					Drywall	L/M 11
15					Drywall	L/M 9
16					Drywall	L/M 6
17						
18						
19						
20						
21						
22						
23						
24						
25						

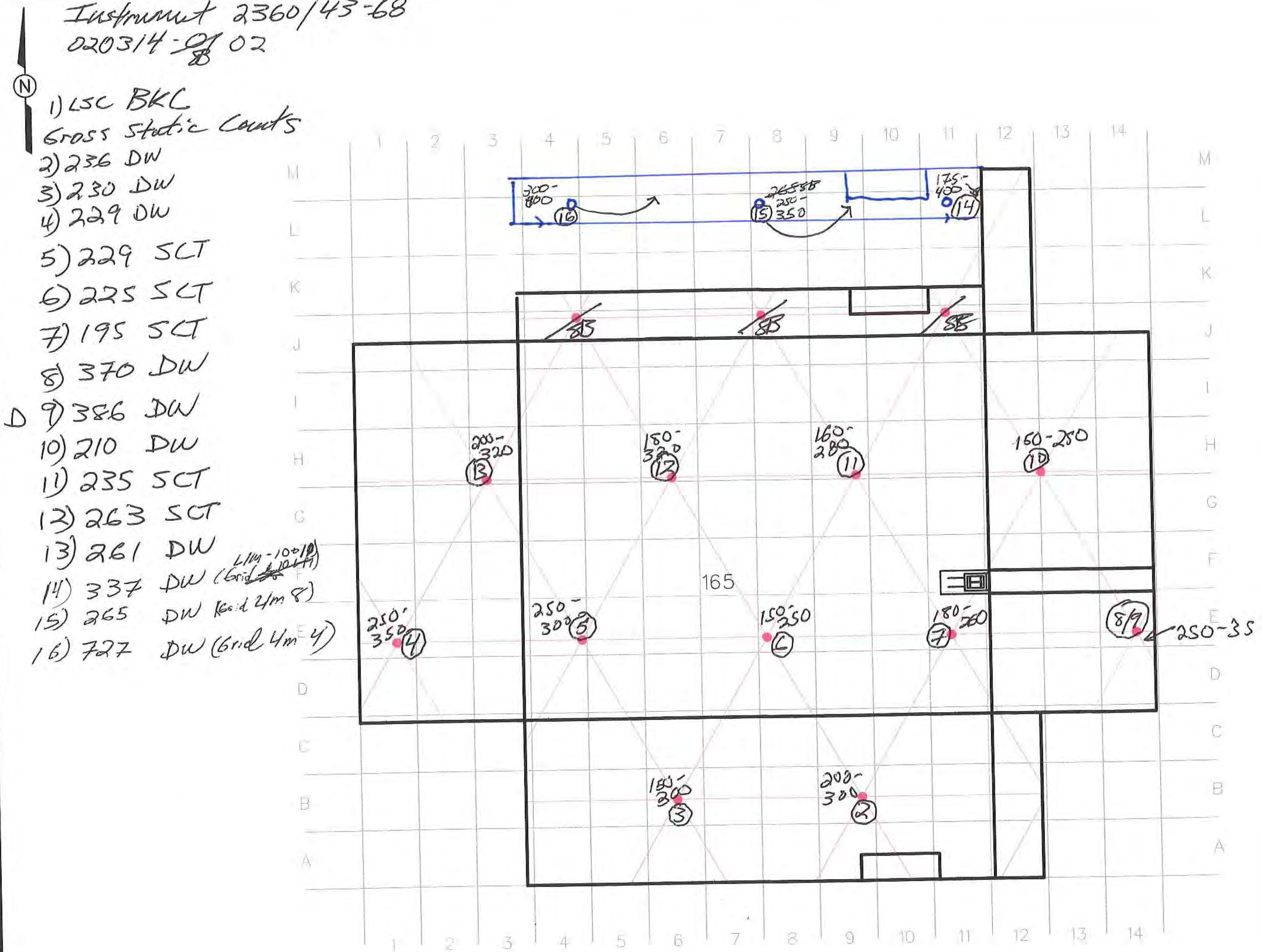
RCS REVIEW [signature] DATE 02/06/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
	LSC Background	1							
237279	B9	2	236	Drywall	216.1	19.9	126	0.095	166
237279	B6	3	230	Drywall	216.1	13.9	126	0.095	116
237279	E1	4	229	Drywall	216.1	12.9	126	0.095	108
237279	E4	5	229	Fire Retardant	182.9	46.1	126	0.095	385
237279	E8	6	225	Fire Retardant	182.9	42.1	126	0.095	352
237279	E11	7	195	Fire Retardant	182.9	12.1	126	0.095	101
237279	E14	8	370	Drywall	216.1	153.9	126	0.095	1286
237279	E14 - duplicate	9	386	Drywall	216.1	169.9	126	0.095	1419
237279	H13	10	210	Drywall	216.1	-6.1	126	0.095	-51
237279	H9	11	235	Fire Retardant	182.9	52.1	126	0.095	435
237279	H6	12	263	Fire Retardant	182.9	80.1	126	0.095	669
237279	H3	13	261	Drywall	216.1	44.9	126	0.095	375
237279	L/M 11	14	337	Drywall	216.1	120.9	126	0.095	1010
237279	L/M 9	15	265	Drywall	216.1	48.9	126	0.095	409
237279	L/M 6	16	727	Drywall	216.1	510.9	126	0.095	4268

Instrument 2360/43-68
020314-~~01~~ 02

1) LSC BKC
Gross Static Counts
2) 236 DW
3) 230 DW
4) 229 DW
5) 229 SCT
6) 225 SCT
7) 195 SCT
8) 370 DW
D 9) 386 DW
10) 210 DW
11) 235 SCT
12) 263 SCT
13) 261 DW
14) 337 DW (L/m-10/11 Grid)
15) 265 DW (Grid 2/m 8)
16) 727 DW (Grid 4/m 4)



DW = Dry Wall
SCT = Spray on Ceiling

LEGEND:

● SYSTEMATIC SAMPLE LOCATION

NOTES:

1. WALL SURFACE AREA: (ABOVE 2 M) 73 SQ. M.
   CEILING SURFACE AREA: 54 SQ. M.
   TOTAL SURFACE AREA: 127 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 3.24 METERS.

FIGURE X-X
CLASS 2 SAMPLING LOCATIONS
IN B2-165 OVERHEAD
SU2-B21650

FINAL STATUS SURVEY

APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 2 4

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}^{\,d}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	12	1	63.79%	23
C-14	10	34	1	95.72%	24

Bias

$$relative \quad bias = \frac{measured \quad result \; - e\,xp\,ected \quad result}{e\,xp\,ected \quad result}$$

	Spike	Result	Relative bias (±0.2)
H-3	4174	3554	-0.1485386
C-14	4354	4382	0.00643087

H-3 spike value =	4174	dpm
C-14 spike value=	4354	dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm) H-3			Smears (dpm) C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
8	9	370	386	0.042328	0	0	0	18	34	0.62

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

Assay Definition-

Assay Description:
020314-02 SU2 B2165 SYSTEMATIC DUPE AND SPIKE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140206_1510\20140206_1510.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	11	39	0	0	77.30	522.77
Missing vial 2.							
3	1.00	0	27	0	34	88.13	514.89
Missing vial 4.							
5	1.00	2	0	7	0	0.00	549.63
6	1.00	2012	3752	3554	4382	59.00	488.70

Assay Definition-

Assay Description:
020314-02 SU2 B2165 SYSTEMATICS

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140205_1113\20140205_1113.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	12	34	0	0	71.22	521.08
2	1.00	1	1	2	1	335.68	497.49
3	1.00	3	8	4	10	56.32	484.17
4	1.00	0	12	0	15	126.20	489.33
5	1.00	2	9	2	11	66.61	505.14
6	1.00	0	2	0	3	201.62	513.25
7	1.00	1	4	1	4	111.68	502.26
8	1.00	0	15	0	18	86.05	510.43
9	1.00	7	28	6	33	70.03	512.17

7 of 8 9

10	1.00	2	0	9	0	0.00	493.64
11	1.00	4	0	11	0	360.09	501.42
12	1.00	4	0	14	0	0.00	501.79
13	1.00	12	28	19	33	48.86	498.36
14	1.00	0	6	0	8	136.27	508.65
15	1.00	1	1	2	2	3.60	504.72
16	1.00	33	185	12	224	61.60	485.63
Missing vial 17.							
18	1.00	2	0	5	0	172.08	550.57
19	1.00	2027	3663	3640	4272	57.96	485.38

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 19.37 Date Processed: 2/5/2014 9:31:16 AM
14C Chi Square: 15.31 Date Processed: 2/5/2014 9:31:16 AM
3H E^2/B (1-18.6 keV): 385.50 Date Processed: 2/5/2014 9:31:16 AM
14C E^2/B (4-156 keV): 768.20 Date Processed: 2/5/2014 9:31:16 AM
3H Efficiency (0-18.6 keV): 63.79 Date Processed: 2/5/2014 9:31:16 AM
14C Efficiency (0-156 keV): 95.72 Date Processed: 2/5/2014 9:31:16 AM
IPA Background Date Processed: 2/5/2014 9:31:16 AM
3H Background CPM (0-18.6 keV): 10.57 Date Processed: 2/5/2014 9:31:16 AM
14C Background CPM (0-156 keV): 14.83 Date Processed: 2/5/2014 9:31:16 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 18.26 Date Processed: 2/6/2014 8:23:48 AM
14C Chi Square: 18.33 Date Processed: 2/6/2014 8:23:48 AM
3H E^2/B (1-18.6 keV): 388.97 Date Processed: 2/6/2014 8:23:48 AM
14C E^2/B (4-156 keV): 738.11 Date Processed: 2/6/2014 8:23:48 AM
3H Efficiency (0-18.6 keV): 63.86 Date Processed: 2/6/2014 8:23:48 AM
14C Efficiency (0-156 keV): 96.31 Date Processed: 2/6/2014 8:23:48 AM
IPA Background Date Processed: 2/6/2014 8:23:48 AM
3H Background CPM (0-18.6 keV): 10.65 Date Processed: 2/6/2014 8:23:48 AM
14C Background CPM (0-156 keV): 15.22 Date Processed: 2/6/2014 8:23:48 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040
Location: Room 165	Surveyors: Gordon Robb, Shane Brungardt
Survey Unit: SU1-B2165	
	Survey Number: 020314-01
	Map ID: see attached

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys				Radiation Surveys
	α (Loose)	α (Total)	β (Loose)	β (Total)	γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm²)				615	
Background (cpm)				230	

REASON FOR SURVEY
- ☐ PROCEDURE NO.
- ☑ SPECIAL FSS/Characterization
- ☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: FSS and characterization survey of B2-165

Date: 2/3/2014	Time Start: 0800	Time Complete: 1200	Page 1 of ~~8~~ 9

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ / Beta cpm ☐ / Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Drywall	D2
3					Concrete Floor (bare)	D5
4					Concrete Floor (bare)	D8
5					Concrete Floor (bare)	D8 - duplicate
6					Drywall	D11
7					Concrete Floor (bare)	G10
8					Concrete Floor (bare)	G7
9					Concrete Floor (bare)	G3
10					Drywall	I2
11					Concrete Floor (bare)	I5
12					Concrete Floor (bare)	I8
13					Drywall	I11
14					Metal	L10
15					Drywall	L7
16					Drywall	L3
17					Concrete Floor (bare)	H4
18					Concrete Floor (bare)	D3
19					Concrete Floor (bare)	D4
20					Concrete Floor (bare)	I9
21					Drywall	K11
22						
23						
24						
25						

RCS REVIEW DATE 02/06/14

Data Type	Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net $dpm/100cm^2$
Background		LSC Background	1							
FS5	237279	D2	2	296	Drywall	216.1	79.9	126	0.095	668
FS5	237279	D5	3	235	Concrete Floor (bare)	324.5	-89.5	126	0.095	-748
FS5	237279	D8	4	269	Concrete Floor (bare)	324.5	-55.5	126	0.095	-464
Duplicate - FSS	237279	D8 - duplicate	5	257	Concrete Floor (bare)	324.5	-67.5	126	0.095	-564
FSS	237279	D11	6	647	Drywall	216.1	430.9	126	0.095	3600
FSS	237279	G10	7	347	Concrete Floor (bare)	324.5	22.5	126	0.095	188
FSS	237279	G7	8	273	Concrete Floor (bare)	324.5	-51.5	126	0.095	-430
FSS	237279	G3	9	219	Concrete Floor (bare)	324.5	-105.5	126	0.095	-881
FSS	237279	I2	10	334	Drywall	216.1	117.9	126	0.095	985
FSS	237279	I5	11	268	Concrete Floor (bare)	324.5	-S6.5	126	0.095	-472
FSS	237279	I8	12	636	Concrete Floor (bare)	324.5	311.5	126	0.095	2602
FSS	237279	I11	13	282	Drywall	216.1	65.9	126	0.095	551
FS5	237279	L10	14	367	Metal	208.2	158.8	126	0.095	1327
FSS	237279	L7	15	349	Drywall	216.1	132.9	126	0.095	1110
FS5	237279	L3	16	300	Drywall	216.1	83.9	126	0.095	701
Biased	237279	H4	17	1034	Concrete Floor (bare)	324.5	709.5	126	0.095	5927
Biased	237279	D3	18	734	Concrete Floor (bare)	324.5	409.5	126	0.095	3421
Biased	237279	D4	19	768	Concrete Floor (bare)	324.5	443.5	126	0.095	3705
Biased	237279	I9	20	394	Concrete Floor (bare)	324.5	69.5	126	0.095	581
Biased	237279	K11	21	812	Drywall	216.1	595.9	126	0.095	4978

Instr. 2360/4368
020314-~~0/38~~ 01

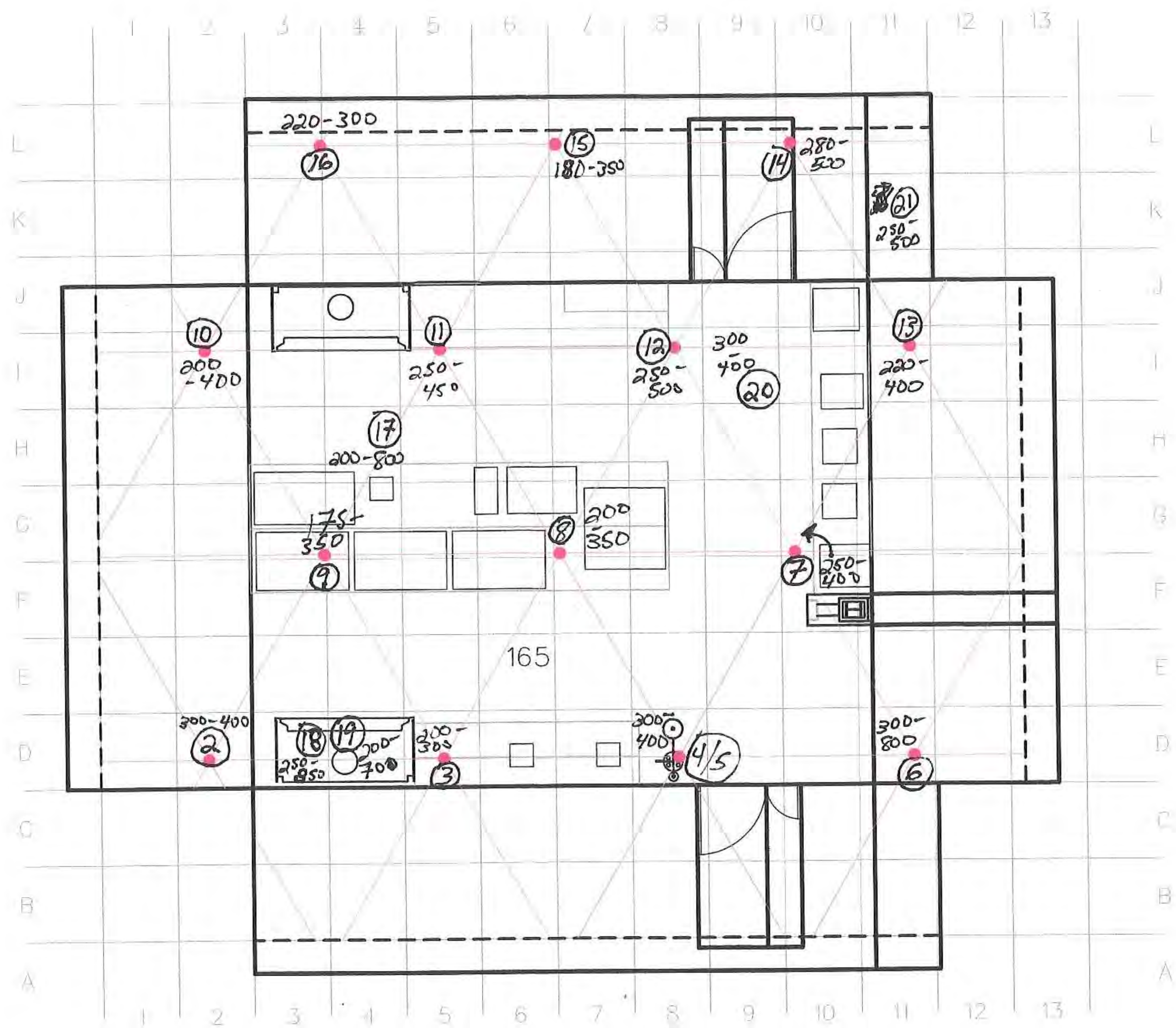
N

1) LSC Background Gross Static Counts
2) 296 DW
3) 235 C
4) 269 C
D 5) 257 C
6) 647 DW
7) 347 C
8) 273 C
9) 219 C
10) 334 DW
11) ~~268C~~ 268 C
12) ~~2~~ 636 C
13) 282 DW
14) 367 Metal Door
15) 349 DW
16) 300 DW
B 17) 1034 C
B 18) 734 C
B 19) 768 C
B 20) 394 C
B 21) 812 DW

LEGEND:

● SYSTEMATIC SAMPLE LOCATION

Note: Characterization and systematic combined in this survey



DW = Dry Wall
C = Concrete
B = Bias

Room 166

NOTES:

1. WALL SURFACE AREA: 62 SQ. M.
   FLOOR SURFACE AREA: 54 SQ. M.
   TOTAL SURFACE AREA: 116 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 3.10 METERS.

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS IN B2-165
SU1-B2165

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 2 4

CBI Shaw Environmental & Infrastructure, Inc. (A CB&I Company)

optuit_opi_fssr_temp004.dgn sommccawley 1/10/2014 3:27:33 PM PDF_with_Levels.plt sei_textsub_only.tbl

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	11	1	63.79%	23
C-14	10	30	1	95.72%	23

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

	Spike	Result	Relative bias
H-3	4174	3616	-0.13368
C-14	4354	4347	-0.00161

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm)					
					H-3			C-14		
Original	Duplicate	Original	Duplicate	RPD	Original	Duplicate	RPD	Original	Duplicate	RPD
4	5	269	257	0.0456274	0	0	0	0	18	2

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

A green cell indicates that the result is less than the MDC. The RPD is not relevant when the result is less than the MDC.

Assay Definition-

Assay Description:
020314-01 SU1 B2165 SYSTEMATIC DUPE AND SPIKE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140206_1448\20140206_1448.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	11	29	0	0	69.52	537.44
Missing vial 2.							
3	1.00	0	14	0	18	114.36	518.86
Missing vial 4.							
5	1.00	2	0	8	0	0.00	548.56
6	1.00	2035	3726	3616	4347	58.59	489.91

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 19.37 Date Processed: 2/5/2014 9:31:16 AM
14C Chi Square: 15.31 Date Processed: 2/5/2014 9:31:16 AM
3H E^2/B (1-18.6 keV): 385.50 Date Processed: 2/5/2014 9:31:16 AM
14C E^2/B (4-156 keV): 768.20 Date Processed: 2/5/2014 9:31:16 AM
3H Efficiency (0-18.6 keV): 63.79 Date Processed: 2/5/2014 9:31:16 AM
14C Efficiency (0-156 keV): 95.72 Date Processed: 2/5/2014 9:31:16 AM
IPA Background Date Processed: 2/5/2014 9:31:16 AM
3H Background CPM (0-18.6 keV): 10.57 Date Processed: 2/5/2014 9:31:16 AM
14C Background CPM (0-156 keV): 14.83 Date Processed: 2/5/2014 9:31:16 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Assay Definition-

Assay Description:
020314-01 B2165 SYSTEMATICS SUI Recount

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140205_0949\20140205_0949.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	11	30	0	0	69.94	530.75
2	1.00	0	5	0	7	0.00	524.92
3	1.00	7	13	13	16	32.28	506.47
4	1.00	0	0	0	0	0.00	518.95
5	1.00	5	4	9	5	51.38	519.97
6	1.00	8	25	10	29	74.80	523.78
7	1.00	8	7	17	7	57.83	499.40
8	1.00	3	18	0	22	47.66	515.71
9	1.00	6	3	15	4	54.57	478.14

10	1.00	0	0	1	0	0.00	517.05
11	1.00	1	6	1	8	82.14	505.91
12	1.00	3	5	6	5	0.00	513.18
13	1.00	5	6	11	7	52.80	513.45
14	1.00	5	3	11	3	115.48	522.98
15	1.00	0	0	0	0	0.00	491.83
16	1.00	4	9	7	10	81.55	513.48
17	1.00	4	0	9	0	0.00	524.12
18	1.00	7	5	14	6	18.25	524.68
19	1.00	6	8	12	9	68.29	515.91
20	1.00	0	16	0	19	142.36	461.69
21	1.00	1	47	0	57	101.88	515.98
Missing vial 22.							
23	1.00	0	0	0	0	0.00	547.75
24	1.00	1988	3719	3504	4343	58.89	489.75

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 18.26 Date Processed: 2/6/2014 8:23:48 AM
14C Chi Square: 18.33 Date Processed: 2/6/2014 8:23:48 AM
3H E^2/B (1-18.6 keV): 388.97 Date Processed: 2/6/2014 8:23:48 AM
14C E^2/B (4-156 keV): 738.11 Date Processed: 2/6/2014 8:23:48 AM
3H Efficiency (0-18.6 keV): 63.86 Date Processed: 2/6/2014 8:23:48 AM
14C Efficiency (0-156 keV): 96.31 Date Processed: 2/6/2014 8:23:48 AM
IPA Background Date Processed: 2/6/2014 8:23:48 AM
3H Background CPM (0-18.6 keV): 10.65 Date Processed: 2/6/2014 8:23:48 AM
14C Background CPM (0-156 keV): 15.22 Date Processed: 2/6/2014 8:23:48 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report		Project Number: 144040	
Location:	RM 165	Surveyors:	Gordon Robb
Survey Unit:	SU1-B2165		Shane Brungardt
		Survey Number:	012414-01
		Map ID:	see attached

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument information	Contamination Surveys				Radiation Surveys
	α (Loose)	α (Total)	β (Loose)	β (Total)	γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY

- ☐ PROCEDURE NO.
- ☑ SPECIAL Characterization
- ☐ ROUTINE

		By Shift		Daily		Weekly		Monthly	
Contamination	☐	By Shift	☐	Daily	☐	Weekly	☐	Monthly	☐
Radiation	☐	By Shift	☐	Daily	☐	Weekly	☐	Monthly	☐

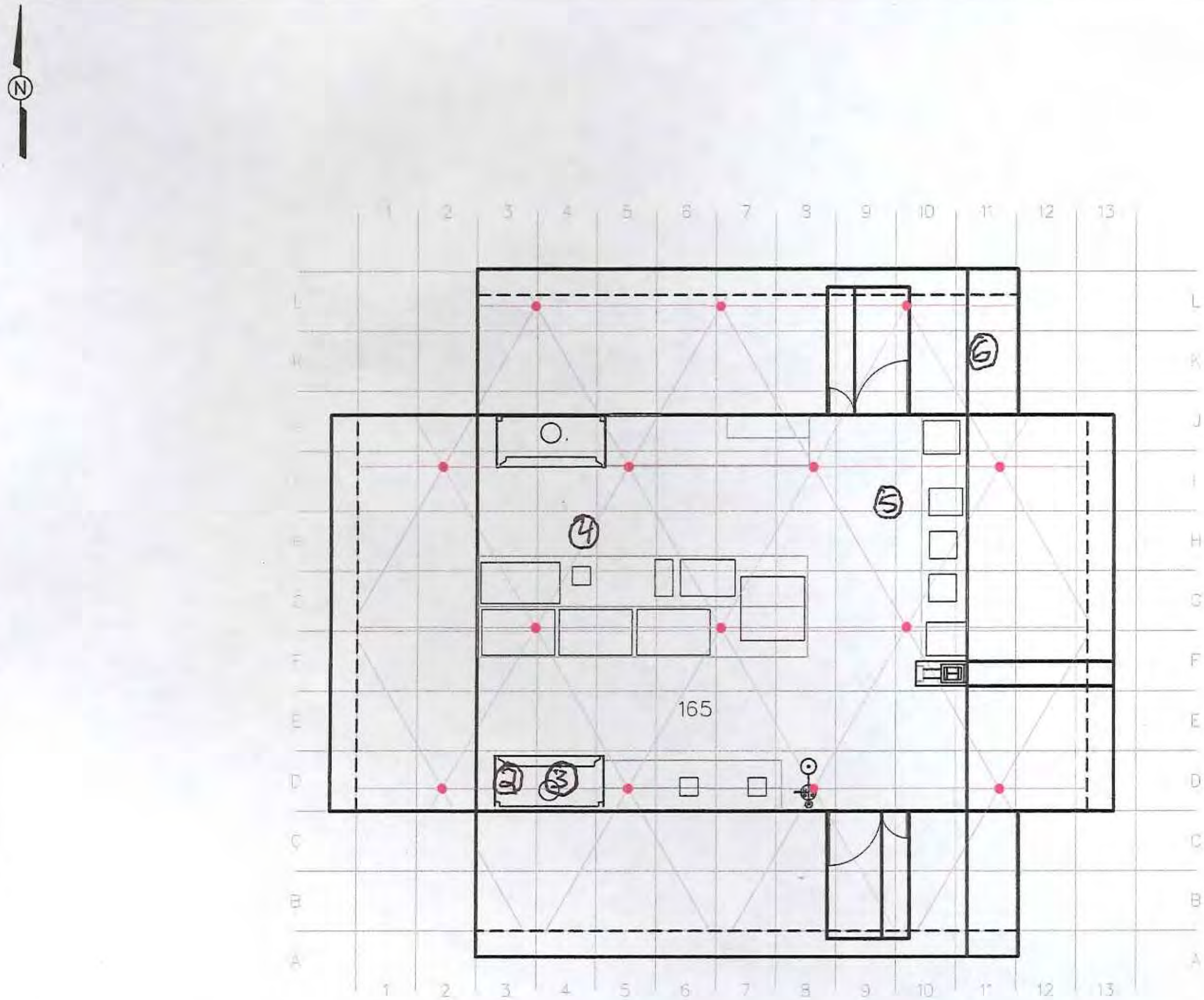
COMMENTS: Survey of Areas in Survey Unit 1-B2165 Post Decontamination Effort

Date: 1/24/2014	Time Start: 8:00		Time Complete: 12:00			Page 1 of 5
	Alpha		Beta		Alpha cpm ☐	
	Loose	Total	Loose	Total	Beta cpm ☐	Item or Location
Item #	dpm/100cm^2	dpm/100cm^2	dpm/100cm^2	dpm/100cm^2	Material ☑	
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	oncrete Floor (bar	Floor D3
3					oncrete Floor (bar	Floor D4
4					oncrete Floor (bar	Floor H4
5					oncrete Floor (bar	Floor I9
6					Drywall	Wall K11
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17					N/A	
18						
19						
20						
21						
22						
23						
24						
25						

RCS REVIEW DATE 02/~~14~~ 07/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
	LSC Background	1							
237279	Floor D3	2	780	Concrete Floor (bare)	324.5	455.5	126	0.095	3805
237279	Floor D4	3	784	Concrete Floor (bare)	324.5	459.5	126	0.095	3839
237279	Floor H4	4	795	Concrete Floor (bare)	324.5	470.5	126	0.095	3931
237279	Floor I9	5	405	Concrete Floor (bare)	324.5	80.5	126	0.095	673
237279	Wall K11	6	606	Drywall	216.1	389.9	126	0.095	3257



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

1) BKG LSC Gross Static Counts
2) 780
3) 784
4) 795
5) 405
6) 606

NOTES:

1. WALL SURFACE AREA: 62 SQ. M.
   FLOOR SURFACE AREA: 54 SQ. M.
   TOTAL SURFACE AREA: 116 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 3.10 METERS.

SCALE IN METERS 0 2 4

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS
IN B2-165
SU1-B2165

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

CBI Shaw Environmental & Infrastructure, Inc. (A CB&I Company)

aptuit_opi_fssr_temp004.dgn sammccawley 1/10/2014 3:27:33 PM PDF_with_Levels.plt sei_textsub_only.tbl

Assay Definition-

Assay Description:
165 DECON

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140124_1055\20140124_1055.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	13	28	0	0	68.82	533.88
2	1.00	2	5	4	6	102.47	527.29
3	1.00	5	14	6	17	51.78	534.25
4	1.00	0	11	0	13	112.84	531.15
5	1.00	0	6	0	7	124.60	525.36
6	1.00	3	0	8	0	0.00	521.75

5-55
58

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 9.90 Date Processed: 1/24/2014 8:24:29 AM
14C Chi Square: 22.65 Date Processed: 1/24/2014 8:24:29 AM
3H E^2/B (1-18.6 keV): 409.02 Date Processed: 1/24/2014 8:24:29 AM
14C E^2/B (4-156 keV): 723.43 Date Processed: 1/24/2014 8:24:29 AM
3H Efficiency (0-18.6 keV): 64.11 Date Processed: 1/24/2014 8:24:29 AM
14C Efficiency (0-156 keV): 95.63 Date Processed: 1/24/2014 8:24:29 AM
IPA Background Date Processed: 1/24/2014 8:24:29 AM
3H Background CPM (0-18.6 keV): 10.03 Date Processed: 1/24/2014 8:24:29 AM
14C Background CPM (0-156 keV): 14.83 Date Processed: 1/24/2014 8:24:29 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report		Project Number: 144040	
Location:	Room 165	Surveyors:	Shane Brungardt
Survey Unit:	SU1-B2165		Gordon Robb
			Tina Piquet
		Survey Number:	012314-02
		Map ID:	see attached

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys				Radiation Surveys
	α (Loose)	α (Total)	β (Loose)	β (Total)	γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY								
	☐	PROCEDURE NO.						
	☑	SPECIAL	Characterization					
	☐	ROUTINE						
Contamination	☐	By Shift	☐	Daily	☐	Weekly	☐	Monthly ☐
Radiation	☐	By Shift	☐	Daily	☐	Weekly	☐	Monthly ☐

COMMENTS: Characterization survey of room 165. Floor monitor used for floor scans (2360 SN# 227437 /43-37 SN# PR216990 /Eff: 0.07 / MDC: 291 /Bkg: 617), handheld (43-68) used for all other scans and all statics.

Date:	1/23/2014	Time Start:	10:30	Time Complete:	16:00	Page 1 of [illegible]

Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Drywall	B3 - wall
3					Drywall	B5 - wall
4					Drywall	B6 - wall
5					Drywall	C8 - wall
6					Metal	B9 - door
7					Drywall	B10-11 - wall
8					Metal	E12 - door
9					Metal	E11 - door
10					Drywall	F12 - wall
11					Drywall	K11 - wall
12					Drywall	H12 - wall
13					Drywall	I13 - wall
14					Drywall	J12 - wall
15					Drywall	L10 - wall
16					Drywall	K10 - wall
17					Metal	K9 - door
18					Drywall	L8 - wall
19					Drywall	L7 - wall
20					Drywall	K6 - wall
21					Drywall	duplicate of 20
22					Drywall	L5 - wall
23					Drywall	K4 - wall
24					Drywall	K3 - wall
25					Drywall	J1 - wall

RCS REVIEW [signature] DATE 02/07/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Contamination/Radiation Survey Report (Continuation Sheet)		Project Number: 144040	Date: 1/23/2014	Page 2 of ~~20~~ 11
RCS Review: [signature]	Location: Room 165	COMMENTS:		
Date: 02/14/14	Survey Number: 012314-02			
	Map ID: see attached			

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
26	N/A	N/A	SADS	SADS	Drywall	I2 - wall
27					Glass	G1 - window
28					Drywall	F2 - wall
29					Glass	E1 - window
30					Concrete Floor (bare)	D3 - floor
31					Concrete Floor (bare)	E4 - floor
32					Concrete Floor (bare)	H4 - floor
33					Concrete Floor (bare)	I9 - floor
34					Concrete Floor (bare)	J9 - floor
35					Concrete Floor (bare)	G9 - floor
36					Concrete Floor (bare)	D9 - floor
37					Concrete Floor (bare)	E8 - floor
38					Concrete Floor (bare)	G8 - floor
39					Concrete Floor (bare)	J8 - floor
40					Concrete Floor (bare)	I7 - floor
41					Concrete Floor (bare)	duplicate of 40
42					Concrete Floor (bare)	G7 - floor
43					Concrete Floor (bare)	E7 - floor
44					Concrete Floor (bare)	D6 - floor
45					Concrete Floor (bare)	H6 - floor
46					Concrete Floor (bare)	I5 - floor
47					Concrete Floor (bare)	G4 - floor
48					Concrete Floor (bare)	F4 - floor
49					Concrete Floor (bare)	D4 - floor
50					Concrete Floor (bare)	F3 - floor

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
51	N/A	N/A	SADS	SADS	Concrete Floor (bare)	I3 - floor
52						
53						
54						
55						
56						
57						
58						
59						
60						
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62						
63						
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74						
75						

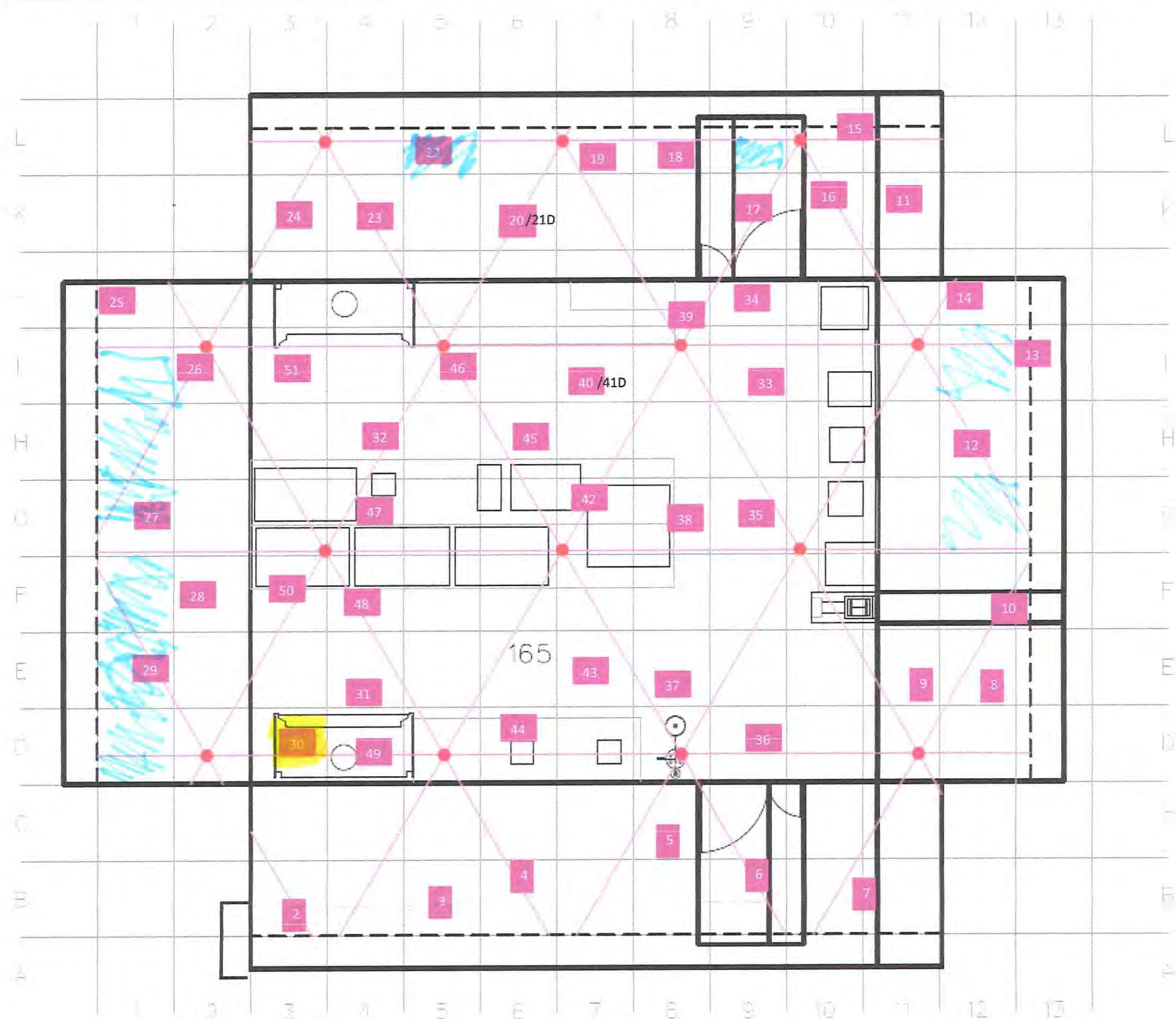
Data Type	Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
Background		LSC Background	1							
Biased	237279	B3 - wall	2	212	Drywall	216.1	-4.1	126	0.095	-34
Biased	237279	B5 - wall	3	456	Drywall	216.1	239.9	126	0.095	2004
Biased	237279	B6 - wall	4	564	Drywall	216.1	347.9	126	0.095	2906
Biased	237279	C8 - wall	5	287	Drywall	216.1	70.9	126	0.095	592
Biased	237279	B9 - door	6	2617	Metal	208.2	2408.8	126	0.095	20124
Biased	237279	B10-11 - wall	7	332	Drywall	216.1	115.9	126	0.095	968
Biased	237279	E12 - door	8	1581	Metal	208.2	1372.8	126	0.095	11469
Biased	237279	E11 - door	9	336	Metal	208.2	127.8	126	0.095	1068
Biased	237279	F12 - wall	10	369	Drywall	216.1	152.9	126	0.095	1277
Biased	237279	K11 - wall	11	1095	Drywall	216.1	878.9	126	0.095	7343
Biased	237279	H12 - wall	12	341	Drywall	216.1	124.9	126	0.095	1043
Biased	237279	I13 - wall	13	412	Drywall	216.1	195.9	126	0.095	1637
Biased	237279	J12 - wall	14	882	Drywall	216.1	665.9	126	0.095	5563
Biased	237279	L10 - wall	15	360	Drywall	216.1	143.9	126	0.095	1202
Biased	237279	K10 - wall	16	928	Drywall	216.1	711.9	126	0.095	5947
Biased	237279	K9 - door	17	1422	Metal	208.2	1213.8	126	0.095	10140
Biased	237279	L8 - wall	18	308	Drywall	216.1	91.9	126	0.095	768
Biased	237279	L7 - wall	19	276	Drywall	216.1	59.9	126	0.095	500
Biased	237279	K6 - wall	20	312	Drywall	216.1	95.9	126	0.095	801
Duplicate - Biased	237279	duplicate of 20	21	352	Drywall	216.1	135.9	126	0.095	1135
Biased	237279	L5 - wall	22	230	Drywall	216.1	13.9	126	0.095	116
Biased	237279	K4 - wall	23	253	Drywall	216.1	36.9	126	0.095	308
Biased	237279	K3 - wall	24	222	Drywall	216.1	5.9	126	0.095	49
Biased	237279	J1 - wall	25	355	Drywall	216.1	138.9	126	0.095	1160
Biased	237279	I2 - wall	26	281	Drywall	216.1	64.9	126	0.095	542
Biased	237279	G1 - window	27	322	Glass	265.6	56.4	126	0.095	471
Biased	237279	F2 - wall	28	350	Drywall	216.1	133.9	126	0.095	1119
Biased	237279	E1 - window	29	449	Glass	265.6	183.4	126	0.095	1532
Biased	237279	D3 - floor	30	6293	Concrete Floor (bare)	324.5	5968.5	126	0.095	49862
Biased	237279	E4 - floor	31	778	Concrete Floor (bare)	324.5	453.5	126	0.095	3789
Biased	237279	H4 - floor	32	2556	Concrete Floor (bare)	324.5	2231.5	126	0.095	18642
Biased	237279	I9 - floor	33	1289	Concrete Floor (bare)	324.5	964.5	126	0.095	8058
Biased	237279	J9 - floor	34	340	Concrete Floor (bare)	324.5	15.5	126	0.095	129
Biased	237279	G9 - floor	35	374	Concrete Floor (bare)	324.5	49.5	126	0.095	414
Biased	237279	D9 - floor	36	298	Concrete Floor (bare)	324.5	-26.5	126	0.095	-221
Biased	237279	E8 - floor	37	358	Concrete Floor (bare)	324.5	33.5	126	0.095	280
Biased	237279	G8 - floor	38	288	Concrete Floor (bare)	324.5	-36.5	126	0.095	-305

Biased	237279	J8 - floor	39	239	Concrete Floor (bare)	324.5	-85.5	126	0.095	-714
Biased	237279	I7 - floor	40	266	Concrete Floor (bare)	324.5	-58.5	126	0.095	-489
Duplicate - Biased	237279	duplicate of 40	41	344	Concrete Floor (bare)	324.5	19.5	126	0.095	163
Biased	237279	G7 - floor	42	283	Concrete Floor (bare)	324.5	-41.5	126	0.095	-347
Biased	237279	E7 - floor	43	266	Concrete Floor (bare)	324.5	-58.5	126	0.095	-489
Biased	237279	D6 - floor	44	220	Concrete Floor (bare)	324.5	-104.5	126	0.095	-873
Biased	237279	H6 - floor	45	306	Concrete Floor (bare)	324.5	-18.5	126	0.095	-155
Biased	237279	I5 - floor	46	307	Concrete Floor (bare)	324.5	-17.5	126	0.095	-146
Biased	237279	G4 - floor	47	507	Concrete Floor (bare)	324.5	182.5	126	0.095	1525
Biased	237279	F4 - floor	48	206	Concrete Floor (bare)	324.5	-118.5	126	0.095	-990
Biased	237279	D4 - floor	49	243	Concrete Floor (bare)	324.5	-81.5	126	0.095	-681
Biased	237279	F3 - floor	50	203	Concrete Floor (bare)	324.5	-121.5	126	0.095	-1015
Biased	237279	I3 - floor	51	229	Concrete Floor (bare)	324.5	-95.5	126	0.095	-798

43-68 Scans (cpm)								
Grid	Min Scan	Max Scan	Grid	Min Scan	Max Scan	Grid	Min Scan	Max Scan
B2	180	380	E12	200	1000	H12	250	475
B3	200	320	E13	180	320	H13	350	475
B4	160	200	L3	180	300	I1	225	400
B5	180	600	L4	200	340	I2	240	375
B6	220	600	L5	150	350	I11	250	550
B7	200	480	L6	225	350	I12	250	600
B8	180	360	L7	160	400	I13	175	300
B9	200	2400	L8	125	350	J3	250	350
B10	180	300	L9	200	600	J4	200	300
B11	180	400	L10	200	425	J5	125	275
C3	200	520	L11	250	350	J6	175	300
C4	160	320	J11	275	350	J7	150	300
C5	220	360	J12	250	800	J8	175	300
C6	180	300	J13	350	475	J9	125	320
C7	160	280	F1	200	460	J10	200	300
C8	200	800	F2	200	375	J11	150	250
C9	200	800	F11	200	380	K3	175	350
C10	180	360	F12	160	1500	K4	225	325
C11	160	420	F13	250	300	K5	225	600
D1	150	380	G1	150	350	K6	150	500
D2	250	360	G2	220	380	K7	150	450
D11	200	360	G11	200	300	K8	250	400
D12	200	600	G12	250	600	K9	225	1200
D13	180	320	G13	150	300	K10	250	600
E1	150	800	H1	160	380	K11	250	1000
E2	200	350	H2	150	600			
E11	290	340	H11	200	350			

43-37 Scans (cpm)		
Grid	Min Scan	Max Scan
D3-J3	400	3800
D4-J4	400	2200
D5-J5	400	1000
D6-J6	400	1000
D7-J7	400	1000
D8-J8	400	1000
D9-J9	400	1200
D10-J10	400	1000

43-68 Statics			
Location	cpm	Location	cpm
1.	LSC Bkg	26.	281
2.	212	27.	322
3.	456	28.	350
4.	564	29.	449
5.	287	30.	6293
6.	2617	31.	778
7.	332	32.	2556
8.	1581	33.	1289
9.	336	34.	340
10.	369	35.	374
11.	1095	36.	298
12.	341	37.	358
13.	412	38.	288
14.	882	39.	239
15.	360	40.	266
16.	928	41.	344
17.	1422	42.	283
18.	308	43.	266
19.	276	44.	220
20.	312	45.	306
21.	352	46.	307
22.	230	47.	507
23.	253	48.	206
24.	222	49.	243
25.	355	50.	203
		51.	229



LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}\ d$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	11	1	63.96%	23
C-14	10	27	1	75.97%	28

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

	Spike	Result	Relative bias (±0.2)
H-3	4174	3601	-0.137278
C-14	4354	4259	-0.021819

H-3 spike value =	4174	dpm
C-14 spike value=	4354	dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm) H-3			Smears (dpm) C-14		
Original	Duplicate	Original	Duplicate	RPD	Original	Duplicate	RPD	Original	Duplicate	RPD
20	21	312	352	0.1204819	0	0	0	14	4	1.11
40	41	266	344	0.2557377	7	1	1.5	20	24	0.18

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

A green cell indicates that the result is less than the MDC. The RPD is not relevant when the result is less than the MDC.

Assay Definition-

Assay Description:
012314-02 ~~SU2~~-B2165 CHARACTERIZATION SPIKE AND DUPE
of SU1
Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140207_1015\20140207_1015.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.1sa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	10	31	0	0	69.11	540.42
Missing vial 2.							
3	1.00	0	3	0	4	0.00	526.19
Missing vial 4.							
5	1.00	4	20	1	24	94.52	513.16
Missing vial 6.							
7	1.00	0	1	0	2	0.00	549.62
8	1.00	2017	3653	3601	4259	57.69	489.44

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 14.14 Date Processed: 1/30/2014 9:19:03 AM
14C Chi Square: 20.69 Date Processed: 1/30/2014 9:19:03 AM
3H E^2/B (1-18.6 keV): 375.13 Date Processed: 1/30/2014 9:19:03 AM
14C E^2/B (4-156 keV): 737.59 Date Processed: 1/30/2014 9:19:03 AM
3H Efficiency (0-18.6 keV): 63.96 Date Processed: 1/30/2014 9:19:03 AM
14C Efficiency (0-156 keV): 95.97 Date Processed: 1/30/2014 9:19:03 AM
IPA Background Date Processed: 1/30/2014 9:19:03 AM
3H Background CPM (0-18.6 keV): 10.87 Date Processed: 1/30/2014 9:19:03 AM
14C Background CPM (0-156 keV): 15.15 Date Processed: 1/30/2014 9:19:03 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

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Assay Definition-

Assay Description:
012314-02 SU1 B2-165 CHARACTERIZATION RECOUNT

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140130_0949\20140130_0949.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	11	27	0	0	67.22	542.03
2	1.00	2	17	0	21	46.42	509.70
3	1.00	10	43	7	51	91.50	514.58
4	1.00	10	129	0	156	85.79	510.03
5	1.00	12	48	12	57	67.66	505.80
6	1.00	3	24	0	29	71.83	523.97
7	1.00	22	131	5	158	81.53	512.11
8	1.00	60	97	108	112	58.54	524.49
9	1.00	17	127	0	153	89.18	517.60

10	1.00	4	35	0	43	102.29	527.10
11	1.00	21	67	24	79	69.84	527.73
12	1.00	10	23	16	27	59.14	521.65
13	1.00	3	40	0	48	81.27	511.26
14	1.00	0	23	0	28	80.95	524.76
15	1.00	3	9	4	11	42.07	530.13
16	1.00	11	23	17	27	51.99	531.16
17	1.00	4	12	5	14	167.71	538.37
18	1.00	0	14	0	18	94.58	532.37
19	1.00	0	6	0	7	119.55	527.12
20	1.00	0	11	0	14	27.36	524.71
21	1.00	0	4	0	5	126.79	526.77
22	1.00	0	5	0	6	26.67	524.45
23	1.00	0	0	0	0	0.00	526.19
24	1.00	0	9	0	11	114.37	523.89
25	1.00	1	13	0	16	129.85	539.08
26	1.00	1	5	1	6	156.82	530.03
27	1.00	26	104	25	125	68.27	466.55
28	1.00	1	14	0	17	75.00	524.27
29	1.00	14	66	10	80	73.48	468.28
30	1.00	13	84	0	102	80.65	502.69
31	1.00	0	28	0	35	120.40	508.91
32	1.00	0	44	0	54	109.24	529.58
33	1.00	5	35	0	42	87.91	502.77
34	1.00	0	11	0	14	163.98	489.01
35	1.00	7	15	10	17	62.94	511.76
36	1.00	3	21	0	26	108.29	512.92
37	1.00	0	10	0	13	203.61	518.25
38	1.00	0	20	0	25	69.19	496.29
39	1.00	0	14	0	18	74.71	488.17
40	1.00	6	17	7	20	53.85	510.33
41	1.00	7	24	8	29	60.68	519.35
42	1.00	2	13	0	16	60.64	507.78
43	1.00	9	15	17	18	69.89	493.05
44	1.00	2	3	4	3	111.89	517.20
45	1.00	3	8	5	9	79.29	504.35
46	1.00	6	2	14	2	99.98	521.01
47	1.00	1	17	0	21	100.78	527.67
48	1.00	0	0	0	0	0.00	476.82
49	1.00	0	7	0	9	145.63	508.26
50	1.00	0	17	0	21	101.19	486.44
51	1.00	0	9	0	12	221.18	518.71
Missing vial 52.							
53	1.00	0	10	0	12	84.14	547.36
54	1.00	2080	3833	3636	4472	61.25	501.97

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 11.84 Date Processed: 2/14/2014 9:29:21 AM
14C Chi Square: 23.73 Date Processed: 2/14/2014 9:29:21 AM
3H E^2/B (1-18.6 keV): 363.71 Date Processed: 2/14/2014 9:29:21 AM
14C E^2/B (4-156 keV): 694.29 Date Processed: 2/14/2014 9:29:21 AM
3H Efficiency (0-18.6 keV): 63.77 Date Processed: 2/14/2014 9:29:21 AM
14C Efficiency (0-156 keV): 96.64 Date Processed: 2/14/2014 9:29:21 AM
IPA Background Date Processed: 2/14/2014 9:29:21 AM
3H Background CPM (0-18.6 keV): 11.43 Date Processed: 2/14/2014 9:29:21 AM
14C Background CPM (0-156 keV): 16.52 Date Processed: 2/14/2014 9:29:21 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report		Project Number: 144040		Date: 2/5/2014	Time Start: 0900	Time Complete: 1600	Page 1 of ~~11~~ 12
Location:	166 overhead surfaces	Surveyors:	Gordon Robb				
Survey Unit:	SU2-B21660		Shane Brungardt				
		Survey Number:	020514-01				
		Map ID:	see attached				

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys α (Loose)	α (Total)	β (Loose)	β (Total)	Radiation Surveys γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY

- ☐ PROCEDURE NO.
- ☑ SPECIAL FSS
- ☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: FSS of overhead surfaces above six feet in room 166

Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Drywall	F17
3					Fire Retardant	F12
4					Fire Retardant	F7
5					Drywall	F2
6					Drywall	J0
7					Fire Retardant	J5
8					Fire Retardant	J9
9					Fire Retardant	J14
10					Drywall	J19
11					Drywall	N17
12					Drywall	N12
13					Drywall	N12 - duplicate
14					Drywall	N21
15					Drywall	N7
16					Drywall	N2
17					Drywall	E14
18					Glass	C13
19					Drywall	D12
20					Drywall	C11
21					Drywall	D10
22					Drywall	D8
23					Drywall	E8
24					Drywall	D7
25					Drywall	C4

RCS REVIEW [signature] DATE 02/07/14

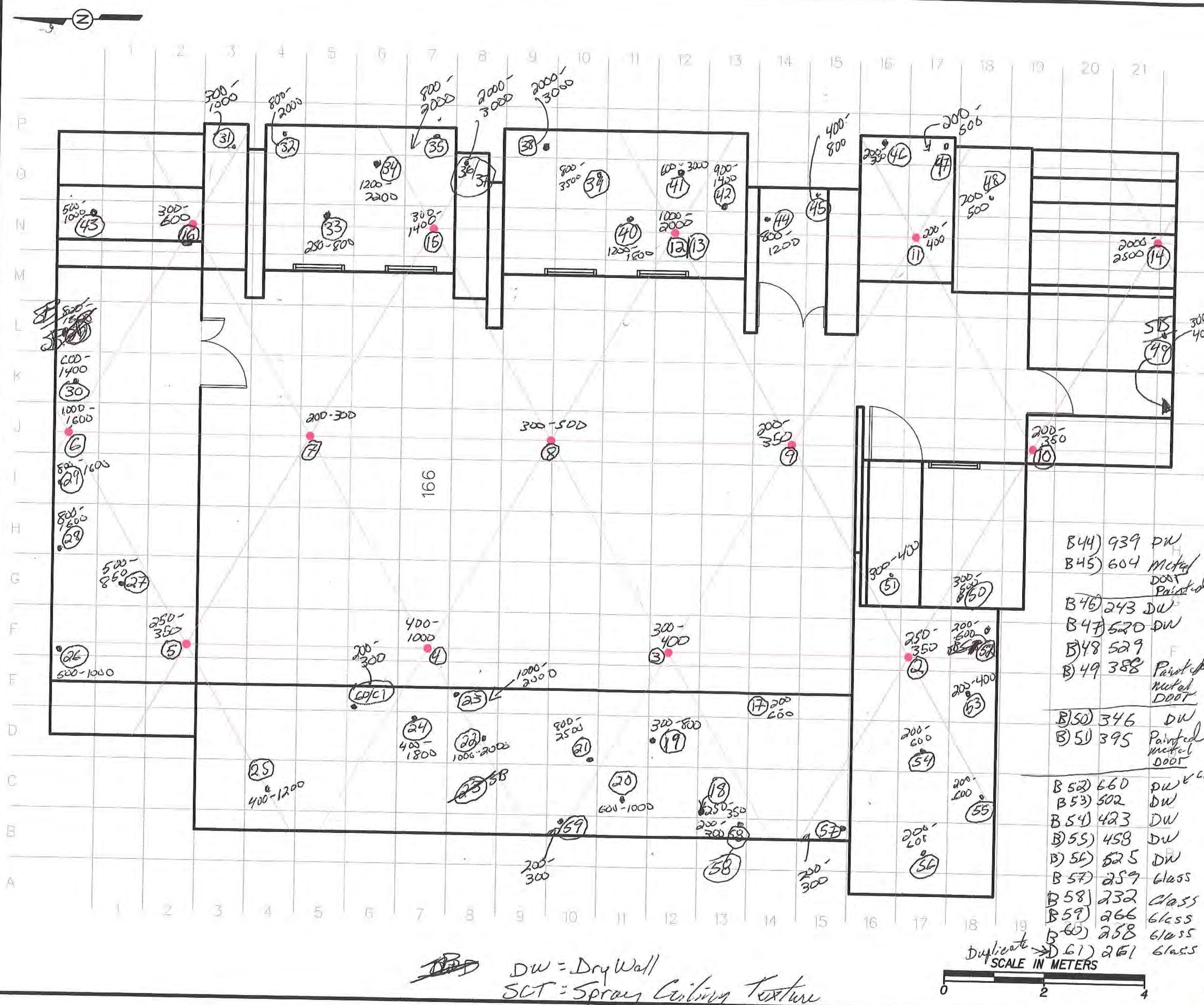
The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Contamination/Radiation Survey Report (Continuation Sheet)		Project Number: 144040	Date: 2/5/2014	Page 2 of ~~11~~ 12
RCS Review:	Location: 166 overhead surfaces	COMMENTS:		
Date: 02/07/14	Survey Number: 020514-01			
	Map ID: see attached			

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location	Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
26	N/A	N/A	SADS	SADS	Drywall	F0	51	N/A	N/A	SADS	SADS	Metal	G16
27					Drywall	G1	52					Drywall	F18
28					Drywall	H0	53					Drywall	E18
29					Drywall	I0	54					Drywall	D17
30					Drywall	K0	55					Drywall	C18
31					Drywall	P3	56					Drywall	B17
32					Drywall	P4	57					Glass	B15
33					Drywall	N5	58					Glass	B13
34					Drywall	O6	59					Glass	B10
35					Drywall	P7	60					Glass	E6
36					Drywall	O8	61					Glass	E6 - duplicate
37					Drywall	O8 - duplicate	62						
38					Drywall	P9	63						
39					Drywall	O10	64						
40					Drywall	N11	65						
41					Drywall	O12	66						
42					Drywall	O13	67						
43					Drywall	N0	68						
44					Drywall	N14	69						
45					Metal	O15	70						
46					Drywall	P16	71						
47					Drywall	P17	72						
48					Drywall	O18	73						
49					Metal	K22	74						
50					Drywall	G18	75						

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net $dpm/100cm^2$
	LSC Background	1							
237279	F17	2	313	Drywall	216.1	96.9	126	0.095	810
237279	F12	3	337	Fire Retardant	182.9	154.1	126	0.095	1287
237279	F7	4	502	Fire Retardant	182.9	319.1	126	0.095	2666
237279	F2	5	316	Drywall	216.1	99.9	126	0.095	835
237279	J0	6	1572	Drywall	216.1	1355.9	126	0.095	11327
237279	J5	7	249	Fire Retardant	182.9	66.1	126	0.095	552
237279	J9	8	410	Fire Retardant	182.9	227.1	126	0.095	1897
237279	J14	9	215	Fire Retardant	182.9	32.1	126	0.095	268
237279	J19	10	256	Drywall	216.1	39.9	126	0.095	333
237279	N17	11	246	Drywall	216.1	29.9	126	0.095	250
237279	N12	12	1381	Drywall	216.1	1164.9	126	0.095	9732
237279	N12 - duplicate	13	1332	Drywall	216.1	1115.9	126	0.095	9322
237279	N21	14	2283	Drywall	216.1	2066.9	126	0.095	17267
237279	N7	15	1123	Drywall	216.1	906.9	126	0.095	7576
237279	N2	16	624	Drywall	216.1	407.9	126	0.095	3408
237279	E14	17	470	Drywall	216.1	253.9	126	0.095	2121
237279	C13	18	195	Glass	265.6	-70.6	126	0.095	-590
237279	D12	19	589	Drywall	216.1	372.9	126	0.095	3115
237279	C11	20	939	Drywall	216.1	722.9	126	0.095	6039
237279	D10	21	1783	Drywall	216.1	1566.9	126	0.095	13090
237279	D8	22	1722	Drywall	216.1	1505.9	126	0.095	12581
237279	E8	23	977	Drywall	216.1	760.9	126	0.095	6357
237279	D7	24	1074	Drywall	216.1	857.9	126	0.095	7167
237279	C4	25	988	Drywall	216.1	771.9	126	0.095	6449
237279	F0	26	771	Drywall	216.1	554.9	126	0.095	4636
237279	G1	27	897	Drywall	216.1	680.9	126	0.095	5688
237279	H0	28	1045	Drywall	216.1	828.9	126	0.095	6925
237279	I0	29	1089	Drywall	216.1	872.9	126	0.095	7292
237279	K0	30	1280	Drywall	216.1	1063.9	126	0.095	8888
237279	P3	31	1001	Drywall	216.1	784.9	126	0.095	6557
237279	P4	32	1387	Drywall	216.1	1170.9	126	0.095	9782
237279	N5	33	999	Drywall	216.1	782.9	126	0.095	6541

237279	O6	34	1866	Drywall	216.1	1649.9	126	0.095	13784
237279	P7	35	1883	Drywall	216.1	1666.9	126	0.095	13926
237279	O8	36	2734	Drywall	216.1	2517.9	126	0.095	21035
237279	O8 - duplicate	37	2789	Drywall	216.1	2572.9	126	0.095	21495
237279	P9	38	2564	Drywall	216.1	2347.9	126	0.095	19615
237279	O10	39	1233	Drywall	216.1	1016.9	126	0.095	8495
237279	N11	40	1629	Drywall	216.1	1412.9	126	0.095	11804
237279	O12	41	2907	Drywall	216.1	2690.9	126	0.095	22480
237279	O13	42	1124	Drywall	216.1	907.9	126	0.095	7585
237279	N0	43	1038	Drywall	216.1	821.9	126	0.095	6866
237279	N14	44	939	Drywall	216.1	722.9	126	0.095	6039
237279	O15	45	604	Metal	208.2	395.8	126	0.095	3307
237279	P16	46	243	Drywall	216.1	26.9	126	0.095	225
237279	P17	47	520	Drywall	216.1	303.9	126	0.095	2539
237279	O18	48	529	Drywall	216.1	312.9	126	0.095	2614
237279	K22	49	388	Metal	208.2	179.8	126	0.095	1502
237279	G18	50	346	Drywall	216.1	129.9	126	0.095	1085
237279	G16	51	395	Metal	208.2	186.8	126	0.095	1561
237279	F18	52	660	Drywall	216.1	443.9	126	0.095	3708
237279	E18	53	502	Drywall	216.1	285.9	126	0.095	2388
237279	D17	54	423	Drywall	216.1	206.9	126	0.095	1728
237279	C18	55	458	Drywall	216.1	241.9	126	0.095	2021
237279	B17	56	525	Drywall	216.1	308.9	126	0.095	2581
237279	B15	57	259	Glass	265.6	-6.6	126	0.095	-55
237279	B13	58	232	Glass	265.6	-33.6	126	0.095	-281
237279	B10	59	266	Glass	265.6	0.4	126	0.095	3
237279	E6	60	258	Glass	265.6	-7.6	126	0.095	-63
237279	E6 - duplicate	61	261	Glass	265.6	-4.6	126	0.095	-38



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

Instrument 2360/4368
Survey 020514-01
1) LSC BK6
~~2) GT~~ Gross Static Counts

2) 313 DW
3) 337 SCT
4) 502 SCT
5) 316 DW
6) 1,572 DW
7) 249 SCT
8) 410 SCT
9) 215 SCT
10) 256 DW
11) 246 DW
12) 1381 DW
D 13) 1332 DW
14) 2283 DW
15) 1,123 DW
16) 624 DW
B17) 470 DW
B18) 195 Glass
B19) 589 DW
B20) 939 DW
B21) 1783 DW
B22) 1722 DW
B23) 977 DW
B24) 1,074 DW
B25) 988 DW
B26) 771 DW
B27) 897 DW
B28) 1045 DW
B29) 1,089 DW
B30) 1280 DW
B31) 1001 DW
B32) 1387 DW
B33) 999 DW
B34) 1866 DW
B36) 1883 DW
B36) 2,734 DW
D37) 2,789 DW
B38) 2,564 DW
B39) 1233 DW
B40) 1629 DW
B41) 2907 DW
B) 42) 1124 DW
B) 43) 1038 DW
B44) 939 DW
B45) 604 metal DOOr Painted
B46) 243 DW
B47) 520 DW
B) 48 529
B) 49 388 Painted metal DOOr
B) 50) 346 DW
B) 51) 395 Painted metal DOOr
B 52) 660 DW ← Grid F18
B 53) 502 DW
B 54) 423 DW
B) 55) 458 DW
B) 56) 525 DW
B 57) 259 Glass
B 58) 232 Glass
B 59) 266 Glass
B 60) 258 Glass
Duplicate → D 61) 261 Glass

NOTES:

1. WALL SURFACE AREA: (ABOVE 2 METERS) 164 SQ. M.
   CEILING SURFACE AREA: 115 SQ. M.
   TOTAL SURFACE AREA: 279 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.79 METERS.

SCALE IN METERS
0 2 4

FIGURE X-X
CLASS 2 SAMPLING LOCATIONS IN B2-166 OVERHEAD SU2-B21660

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc. (A CB&I Company)

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}^{\,d}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	18	1	63.79%	28
C-14	10	30	1	95.72%	23

Bias

$$relative\ \ bias = \frac{measured\ \ result\ \ - e\,xp\,ected\ \ result}{e\,xp\,ected\ \ result}$$

	Spike	Result	Relative bias
H-3	4174	3755	-0.10038
C-14	4354	4285	-0.01585

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm) H-3			Smears (dpm) C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
12	13	1381	1332	0.0361224	8	0	2	52	87	0.5035971
36	37	2734	2789	0.0199167	10	9	0.1052632	15	40	0.9090909
60	61	258	261	0.0115607	0	0	0	7	26	1.1515152

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

Assay Definition-

Assay Description:
020514-01 SU2-B2166 SYSTEMATIC AND BIASED

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140207_0943\20140207_0943.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	11	29	0	0	65.80	539.33
Missing vial 2.							
3	1.00	10	72	0	87	95.48	519.42
Missing vial 4.							
5	1.00	9	34	9	40	68.79	533.96
Missing vial 6.							
7	1.00	1	22	0	26	108.65	529.20
Missing vial 8.							
9	1.00	0	1	0	2	0.00	552.16

10	1.00	2020	3817	3548	4460	59.01	489.16

Assay Definition-

Assay Description:
020514-01 SU2 B2166 SYSTEMATICS

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140205_1633\20140205_1633.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	18	30	0	0	58.17	532.91
2	1.00	5	11	7	13	28.01	498.78
3	1.00	0	15	0	18	68.97	485.32
4	1.00	12	64	6	78	63.65	470.25
5	1.00	2	31	0	37	69.17	497.61
6	1.00	13	32	20	38	49.33	517.62
7	1.00	3	19	0	23	68.38	492.00
8	1.00	7	45	0	54	69.25	497.50
9	1.00	6	3	15	3	0.00	484.60

10	1.00	5	37	0	45	67.67	480.25
11	1.00	9	19	15	22	63.67	508.95
12	1.00	10	43	8	52	63.99	508.37
13	1.00	10	27	14	32	60.93	517.37
14	1.00	7	47	0	57	67.15	518.01
15	1.00	11	31	14	36	62.22	512.98
16	1.00	22	48	36	57	63.14	505.10
17	1.00	0	34	0	42	80.24	512.19
18	1.00	3	36	0	43	88.51	505.37
19	1.00	1	26	0	32	97.27	514.21
20	1.00	3	32	0	39	71.28	517.45
21	1.00	0	14	0	17	97.18	514.46
22	1.00	4	16	5	19	64.41	507.67
23	1.00	8	28	8	33	64.89	497.23
24	1.00	0	11	0	14	113.72	512.78
25	1.00	34	235	0	284	82.39	511.23
26	1.00	0	2	0	3	63.13	515.12
27	1.00	0	16	0	20	67.87	506.47
28	1.00	16	26	28	31	70.65	518.46
29	1.00	30	150	15	180	85.46	524.45
30	1.00	5	55	0	67	82.08	504.30
31	1.00	0	3	0	3	1915.57	510.46
32	1.00	12	28	18	33	66.46	514.20
33	1.00	8	57	0	69	80.75	508.48
34	1.00	4	25	0	30	73.46	516.28
35	1.00	3	46	0	56	73.28	506.48
36	1.00	6	13	10	15	79.10	522.27
37	1.00	1	16	0	20	83.63	516.63
38	1.00	52	176	59	210	64.60	515.58
39	1.00	240	920	245	1102	67.78	489.15
40	1.00	0	36	0	44	126.31	507.20
41	1.00	0	44	0	53	82.97	504.89
42	1.00	29	134	21	162	62.93	476.19
43	1.00	0	5	0	6	0.00	523.12
44	1.00	37	142	38	170	59.62	482.63
45	1.00	15	97	0	117	59.91	494.36
46	1.00	0	0	0	0	0.00	524.60
47	1.00	0	0	0	0	0.00	531.46
48	1.00	4	9	6	10	112.18	518.15
49	1.00	0	33	0	41	90.86	508.20
50	1.00	0	22	0	27	147.22	520.49
51	1.00	0	16	0	20	219.50	503.46
52	1.00	0	0	0	0	0.00	512.39
53	1.00	0	8	0	10	228.41	519.65
54	1.00	0	6	0	8	660.99	510.49
55	1.00	0	19	0	23	99.89	520.72
56	1.00	6	4	13	5	97.67	507.11
57	1.00	6	20	6	24	73.06	513.63
58	1.00	0	43	0	53	97.00	511.82
59	1.00	13	105	0	127	69.93	509.93
60	1.00	0	6	0	7	178.66	518.96
61	1.00	8	47	1	56	81.72	517.97
Missing vial 62.							
63	1.00	0	2	0	3	0.00	546.03
64	1.00	2070	3677	3755	4285	57.12	482.85

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 19.37 Date Processed: 2/5/2014 9:31:16 AM
14C Chi Square: 15.31 Date Processed: 2/5/2014 9:31:16 AM
3H E^2/B (1-18.6 keV): 385.50 Date Processed: 2/5/2014 9:31:16 AM
14C E^2/B (4-156 keV): 768.20 Date Processed: 2/5/2014 9:31:16 AM
3H Efficiency (0-18.6 keV): 63.79 Date Processed: 2/5/2014 9:31:16 AM
14C Efficiency (0-156 keV): 95.72 Date Processed: 2/5/2014 9:31:16 AM
IPA Background Date Processed: 2/5/2014 9:31:16 AM
3H Background CPM (0-18.6 keV): 10.57 Date Processed: 2/5/2014 9:31:16 AM
14C Background CPM (0-156 keV): 14.83 Date Processed: 2/5/2014 9:31:16 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 25.72 Date Processed: 2/7/2014 8:20:45 AM
14C Chi Square: 10.05 Date Processed: 2/7/2014 8:20:45 AM
3H E^2/B (1-18.6 keV): 386.11 Date Processed: 2/7/2014 8:20:45 AM
14C E^2/B (4-156 keV): 726.54 Date Processed: 2/7/2014 8:20:45 AM
3H Efficiency (0-18.6 keV): 63.93 Date Processed: 2/7/2014 8:20:45 AM
14C Efficiency (0-156 keV): 96.54 Date Processed: 2/7/2014 8:20:45 AM
IPA Background Date Processed: 2/7/2014 8:20:45 AM
3H Background CPM (0-18.6 keV): 10.70 Date Processed: 2/7/2014 8:20:45 AM
14C Background CPM (0-156 keV): 15.37 Date Processed: 2/7/2014 8:20:45 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040
Location: Room 166	Surveyors: Gordon Robb
Survey Unit: SU1-B2166	Shane Brungardt
	Survey Number: 020314-03
	Map ID: see attached

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys α (Loose)	α (Total)	β (Loose)	β (Total)	Radiation Surveys γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY

- ☐ PROCEDURE NO.
- ☑ SPECIAL FSS
- ☐ ROUTINE

Contamination	☐	By Shift ☐	Daily ☐		Weekly ☐		Monthly ☐	
Radiation	☐	By Shift ☐	Daily ☐		Weekly ☐		Monthly ☐	

COMMENTS: FSS of room 166.

Date: 2/3/2013	Time Start: 1400	Time Complete: 1600	Page 1 of ~~8~~ 9

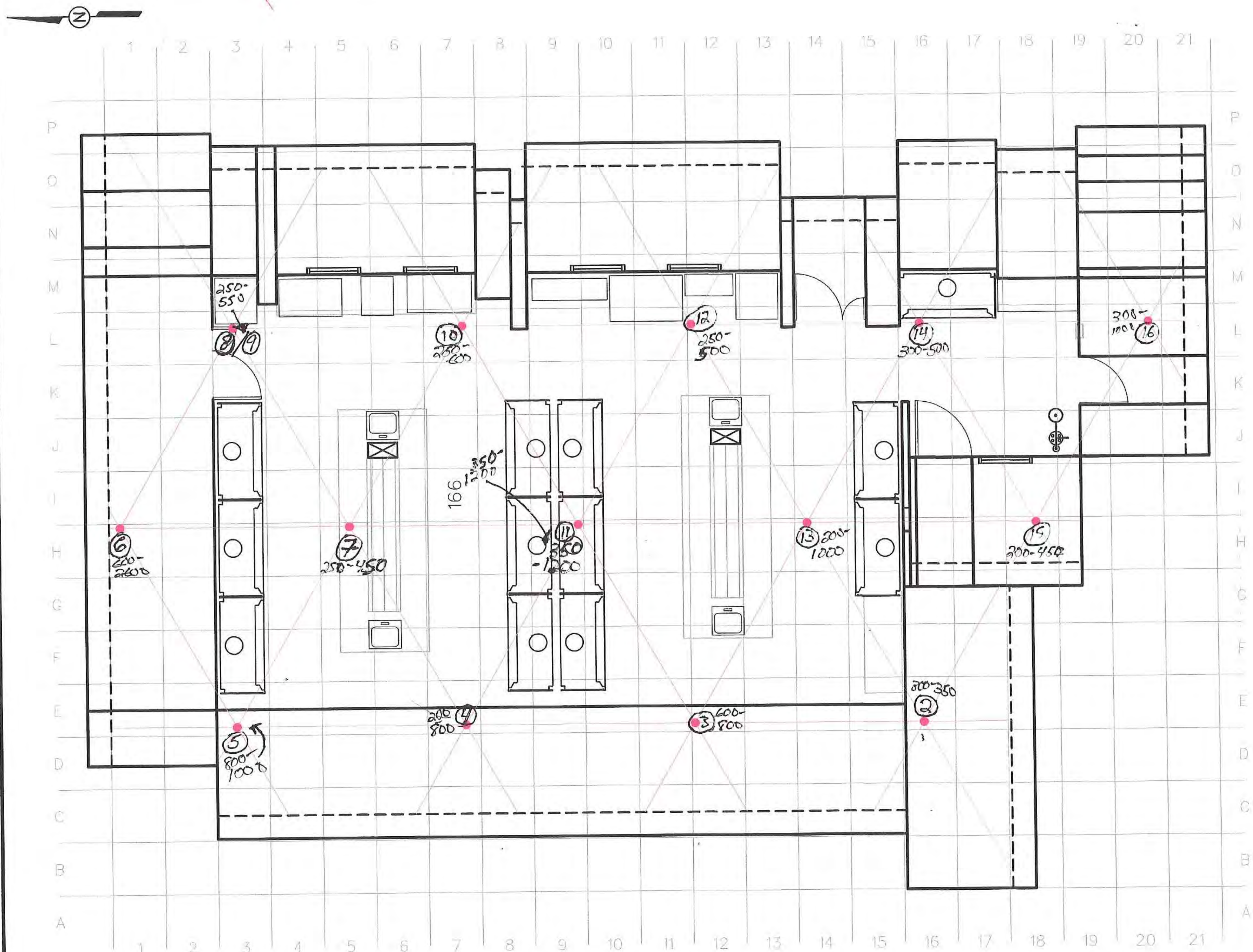
Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Drywall	E16
3					Drywall	E12
4					Drywall	E7
5					Drywall	E3
6					Drywall	H1
7					Concrete Floor (bare)	H5
8					Concrete Floor (bare)	L3
9					Concrete Floor (bare)	L3 - duplicate
10					Concrete Floor (bare)	L7
11					Concrete Floor (bare)	H9
12					Concrete Floor (bare)	L12
13					Concrete Floor (bare)	H14
14					Concrete Floor (bare)	L16
15					Drywall	H18
16					Glass	L20
17						
18						
19						
20						
21						
22						
23						
24						
25						

RCS REVIEW [signature] DATE 02/06/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
	LSC Background	1							
237279	E16	2	392	Drywall	216.1	175.9	126	0.095	1470
237279	E12	3	1062	Drywall	216.1	845.9	126	0.095	7067
237279	E7	4	819	Drywall	216.1	602.9	126	0.095	5037
237279	E3	5	1035	Drywall	216.1	818.9	126	0.095	6841
237279	H1	6	2260	Drywall	216.1	2043.9	126	0.095	17075
237279	H5	7	264	Concrete Floor (bare)	324.5	-60.5	126	0.095	-505
237279	L3	8	430	Concrete Floor (bare)	324.5	105.5	126	0.095	881
237279	L3 - duplicate	9	421	Concrete Floor (bare)	324.5	96.5	126	0.095	806
237279	L7	10	348	Concrete Floor (bare)	324.5	23.5	126	0.095	196
237279	H9	11	1222	Concrete Floor (bare)	324.5	897.5	126	0.095	7498
237279	L12	12	325	Concrete Floor (bare)	324.5	0.5	126	0.095	4
237279	H14	13	915	Concrete Floor (bare)	324.5	590.5	126	0.095	4933
237279	L16	14	365	Concrete Floor (bare)	324.5	40.5	126	0.095	338
237279	H18	15	1008	Drywall	216.1	791.9	126	0.095	6616
237279	L20	16	296	Glass	265.6	30.4	126	0.095	254

020314-03 Inst. 23601 4368



DW = Dry Wall
C = Concrete

LEGEND:

● SYSTEMATIC SAMPLE LOCATION

1) LSC BKG
Gross Static Counts
2) 392 DW
3) 1,062 DW
4) 819 DW
5) 1,035 DW
6) 2,260 DW
7) 264 C
8) 430 C
D 9) 421 C
10) 348 C
11) 1,222 C
12) 325 C
13) 915 C
14) 365 C
15) 1,008 DW
16) 296 Glass

NOTES:

1. WALL SURFACE AREA: 114 SQ. M.
   FLOOR SURFACE AREA: 115 SQ. M.
   TOTAL SURFACE AREA: 229 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.34 METERS.

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS
IN B2-166
SU1-B2166

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

SCALE IN METERS
0 2 4

optuit_opi_fssr_temp006.dgn sammccowley 1/10/2014 3:29:15 PM PDF_with_Levels.plt sei_textsub_only.tbl

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}^{\,d}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	17	1	64.15%	27
C-14	10	32	1	95.98%	23

Bias

$$relative \quad bias = \frac{measured \quad result \quad - e\,xp\,ected \quad result}{e\,xp\,ected \quad result}$$

	Spike	Result	Relative bias
H-3	4174	3634	-0.12937
C-14	4354	4388	0.007809

H-3 spike value =	4174	dpm
C-14 spike value=	4354	dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm) H-3			Smears (dpm) C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
8	9	430	421	0.0211516	37	0	2	8	33	1.22

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

Assay Definition-

Assay Description:
020314-03 SU1 B2166 SYSTEMATIC DUPE AND SPIKE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140206_1426\20140206_1426.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	10	28	0	0	66.83	541.04
Missing vial 2.							
3	1.00	0	27	0	33	96.41	495.66
Missing vial 4.							
5	1.00	2	0	6	0	0.00	548.83
6	1.00	2047	3761	3634	4388	58.74	489.50

Assay Definition-

Assay Description:
020314-03 B2166 SYSTEMATICS 501

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140203_1630\20140203_1630.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	17	32	0	0	67.36	540.26
2	1.00	15	1	37	0	0.00	514.14
3	1.00	4	8	8	9	77.91	504.68
4	1.00	3	8	5	10	8.91	513.01
5	1.00	12	2	29	1	13.04	526.57
6	1.00	18	39	29	46	48.96	526.61
7	1.00	9	9	20	10	39.93	499.43
8	1.00	16	8	37	8	5.94	492.11
9	1.00	9	22	14	26	51.44	483.60

10	1.00	1	2	3	2	12.12	517.74
11	1.00	7	11	13	13	71.19	522.60
12	1.00	4	9	7	11	49.08	466.94
13	1.00	6	12	10	13	51.32	520.06
14	1.00	3	1	8	1	0.00	507.72
15	1.00	10	17	18	19	60.38	517.56
16	1.00	0	8	0	10	192.58	534.45
Missing vial 17.							
18	1.00	0	0	0	0	0.00	546.39
19	1.00	2070	3679	3736	4286	58.46	486.48

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 24.89 Date Processed: 2/3/2014 9:09:48 AM
14C Chi Square: 13.81 Date Processed: 2/3/2014 9:09:48 AM
3H E^2/B (1-18.6 keV): 402.67 Date Processed: 2/3/2014 9:09:48 AM
14C E^2/B (4-156 keV): 745.01 Date Processed: 2/3/2014 9:09:48 AM
3H Efficiency (0-18.6 keV): 64.15 Date Processed: 2/3/2014 9:09:48 AM
14C Efficiency (0-156 keV): 95.98 Date Processed: 2/3/2014 9:09:48 AM
IPA Background Date Processed: 2/3/2014 9:09:48 AM
3H Background CPM (0-18.6 keV): 10.28 Date Processed: 2/3/2014 9:09:48 AM
14C Background CPM (0-156 keV): 14.93 Date Processed: 2/3/2014 9:09:48 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 18.26 Date Processed: 2/6/2014 8:23:48 AM
14C Chi Square: 18.33 Date Processed: 2/6/2014 8:23:48 AM
3H E^2/B (1-18.6 keV): 388.97 Date Processed: 2/6/2014 8:23:48 AM
14C E^2/B (4-156 keV): 738.11 Date Processed: 2/6/2014 8:23:48 AM
3H Efficiency (0-18.6 keV): 63.86 Date Processed: 2/6/2014 8:23:48 AM
14C Efficiency (0-156 keV): 96.31 Date Processed: 2/6/2014 8:23:48 AM
IPA Background Date Processed: 2/6/2014 8:23:48 AM
3H Background CPM (0-18.6 keV): 10.65 Date Processed: 2/6/2014 8:23:48 AM
14C Background CPM (0-156 keV): 15.22 Date Processed: 2/6/2014 8:23:48 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040	Date: 2/3/2014	Time Start: 14:00	Time Complete: 14:45	Page 1 of 5
Location: RM 166	Surveyors: Gordon Robb, Shane Brungardt				
Survey Unit: SU1-B2166	Survey Number: 020314-02				
	Map ID: see attached				

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys α (Loose)	α (Total)	β (Loose)	β (Total)	Radiation Surveys γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY
- ☐ PROCEDURE NO.
- ☑ SPECIAL: Characterization
- ☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Survey of Areas in Survey Unit 1-B2166 Post Decontamination Effort. See previous survey 012914-01.

Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ / Beta cpm ☐ / Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Concrete Floor (bare	Floor G3
3					Concrete Floor (bare	Floor H8
4					Concrete Floor (bare	Floor I8
5					Concrete Floor (bare	Floor I10
6						
7						
8						
9						
10						
11						
12						
13						
14						
15					N/A	
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

RCS REVIEW DATE 02/07/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

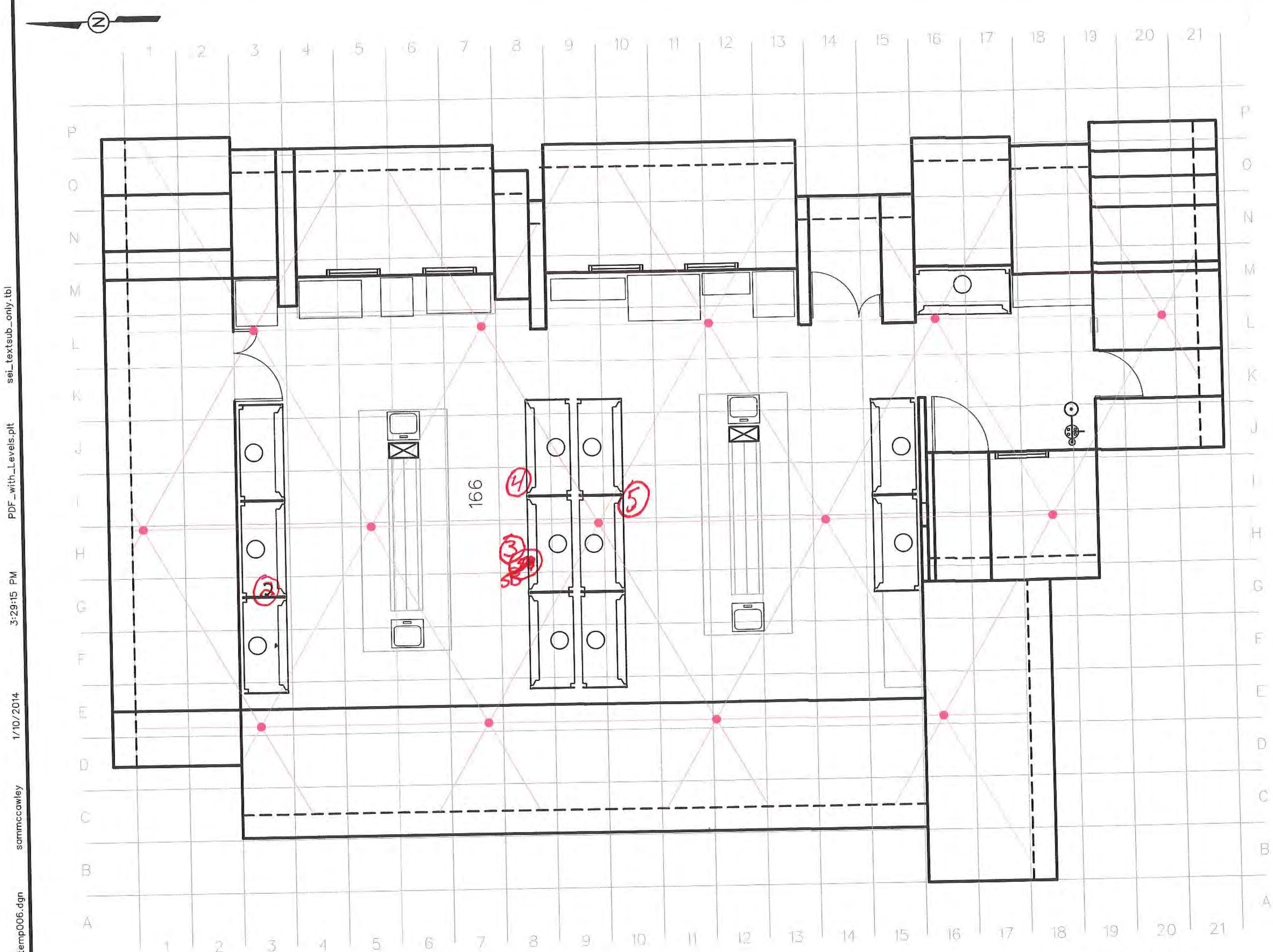
Page 2 of 5

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
	LSC Background	1							
237279	Floor G3	2	485	Concrete Floor (bare)	324.5	160.5	126	0.095	1341
237279	Floor H8	3	1000	Concrete Floor (bare)	324.5	675.5	126	0.095	5643
237279	Floor I8	4	3079	Concrete Floor (bare)	324.5	2754.5	126	0.095	23012
237279	Floor I10	5	932	Concrete Floor (bare)	324.5	607.5	126	0.095	5075

N/A

Survey 020314-02

Post DeCon of Areas Identified in Survey ~~0203~~ 012914-01



LEGEND:

- SYSTEMATIC SAMPLE LOCATION

Instr. 2360/4368
1) LSC BKG
Gross static Counts
2) 485 Cell G-3 #39/40
3) 1,000 cell H-8 #29
4) 3,079 cell I-8 #23
5) 932 cell I-10 #20

NOTES:

1. WALL SURFACE AREA: 114 SQ. M.
   FLOOR SURFACE AREA: 115 SQ. M.
   TOTAL SURFACE AREA: 229 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.34 METERS.

SCALE IN METERS
0 2 4

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS
IN B2-166
SU1-B2166

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

CBI Shaw Environmental & Infrastructure, Inc. (A CB&I Company)

aptuit_api_fssr_temp006.dgn sommccawley 1/10/2014 3:29:15 PM PDF_with_Levels.plt sei_textsub_only.tbl

Pg 4 of 5

Assay Definition-

Assay Description:
020314-02 SU1 166 DECON

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140203_1514\20140203_1514.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	21	31	0	0	58.47	537.32
2	1.00	0	4	0	5	90.89	519.60
3	1.00	0	7	0	9	27.75	482.79
4	1.00	14	58	12	70	59.88	477.37
5	1.00	0	21	0	26	82.20	505.79

Missing vial 6.
Missing vial 7.
Missing vial 8.
Missing vial 9.

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 24.89 Date Processed: 2/3/2014 9:09:48 AM
14C Chi Square: 13.81 Date Processed: 2/3/2014 9:09:48 AM
3H E^2/B (1-18.6 keV): 402.67 Date Processed: 2/3/2014 9:09:48 AM
14C E^2/B (4-156 keV): 745.01 Date Processed: 2/3/2014 9:09:48 AM
3H Efficiency (0-18.6 keV): 64.15 Date Processed: 2/3/2014 9:09:48 AM
14C Efficiency (0-156 keV): 95.98 Date Processed: 2/3/2014 9:09:48 AM
IPA Background Date Processed: 2/3/2014 9:09:48 AM
3H Background CPM (0-18.6 keV): 10.28 Date Processed: 2/3/2014 9:09:48 AM
14C Background CPM (0-156 keV): 14.93 Date Processed: 2/3/2014 9:09:48 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040
Location: Room 166 Walls	Surveyors: Gordon Robb
Survey Unit: SU1-B2166	Shane Brungardt
	Survey Number: 013014-01
	Map ID: see attached

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys				Radiation Surveys
	α (Loose)	α (Total)	β (Loose)	β (Total)	γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY

- ☐ PROCEDURE NO.
- ☑ SPECIAL: Characterization
- ☐ ROUTINE

Contamination	☐ By Shift	☐ Daily	☐ Weekly	☐ Monthly	☐
Radiation	☐ By Shift	☐ Daily	☐ Weekly	☐ Monthly	☐

COMMENTS: Characterization of walls in room 166

Date: 1/30/2014	Time Start: 0900	Time Complete: 1600	Page 1 of ~~10~~ 11

Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ / Beta cpm ☐ / Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Drywall	L 20/21
3					Drywall	H17
4					Drywall	N18
5					Drywall	E17
6					Drywall	C17
7					Drywall	B17
8					Drywall	D14
9					Drywall	E13
10					Drywall	E12
11					Drywall	E11
12					Drywall	E10
13					Metal	D9
14					Drywall	D8
15					Metal	D7
16					Glass	D5
17					Metal	C4
18					Setup/Lab Floor (resin)	D3
19					Drywall	F1
20					Drywall	H1
21					Drywall	I2
22					Drywall	J2
23					Metal	L2
24					Drywall	N3
25					Drywall	N3 - duplicate

RCS REVIEW ______ DATE 02/07/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

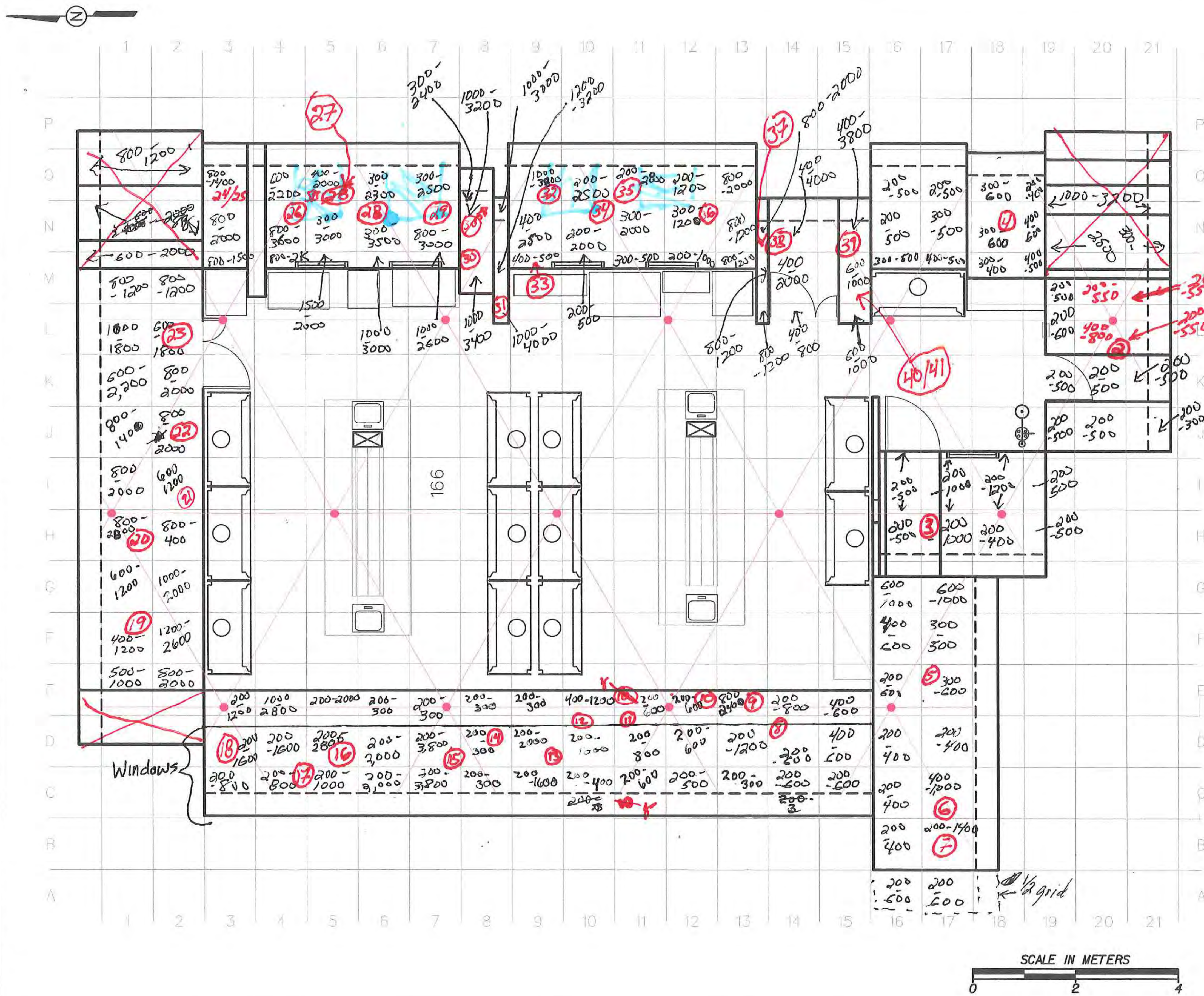
Contamination/Radiation Survey Report (Continuation Sheet)	Project Number: 144040	Date: 1/30/2014	Page 2 of ~~10~~ 11
RCS Review: N	Location: Room 166 Walls	COMMENTS: N/A	
Date: 02/07/14	Survey Number: 013014-01		
	Map ID: see attached		

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
26	N/A	N/A	SADS	SADS	Drywall	N4
27					Glass	O5
28					Drywall	N6
29					Drywall	N7
30					Drywall	M8
31					Drywall	L8
32					Drywall	O9
33					Drywall	M9
34					Drywall	N10
35					Drywall	O11
36					Drywall	N12
37					Drywall	N13
38					Metal	N14
39					Metal	N15
40					Drywall	M15
41					Drywall	M15- duplicate
42						
43						
44						
45						
46						
47						
48						
49						
50						

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☐	Item or Location
51	N/A	N/A				
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						
75						

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
	LSC Background	1							
237279	L 20/21	2	1024	Drywall	216.1	807.9	126	0.095	6749
237279	H17	3	1020	Drywall	216.1	803.9	126	0.095	6716
237279	N18	4	564	Drywall	216.1	347.9	126	0.095	2906
237279	E17	5	463	Drywall	216.1	246.9	126	0.095	2063
237279	C17	6	1080	Drywall	216.1	863.9	126	0.095	7217
237279	B17	7	1156	Drywall	216.1	939.9	126	0.095	7852
237279	D14	8	509	Drywall	216.1	292.9	126	0.095	2447
237279	E13	9	2994	Drywall	216.1	2777.9	126	0.095	23207
237279	E12	10	954	Drywall	216.1	737.9	126	0.095	6165
237279	E11	11	646	Drywall	216.1	429.9	126	0.095	3591
237279	E10	12	1059	Drywall	216.1	842.9	126	0.095	7042
237279	D9	13	2172	Metal	208.2	1963.8	126	0.095	16406
237279	D8	14	282	Drywall	216.1	65.9	126	0.095	551
237279	D7	15	3974	Metal	208.2	3765.8	126	0.095	31460
237279	D5	16	246	Glass	265.6	-19.6	126	0.095	-164
237279	C4	17	1277	Metal	208.2	1068.8	126	0.095	8929
237279	D3	18	371	Setup/Lab Floor (resin)	230	141	126	0.095	1178
237279	F1	19	991	Drywall	216.1	774.9	126	0.095	6474
237279	H1	20	2854	Drywall	216.1	2637.9	126	0.095	22038
237279	I2	21	881	Drywall	216.1	664.9	126	0.095	5555
237279	J2	22	2175	Drywall	216.1	1958.9	126	0.095	16365
237279	L2	23	949	Metal	208.2	740.8	126	0.095	6189
237279	N3	24	1196	Drywall	216.1	979.9	126	0.095	8186
237279	N3 - duplicate	25	1113	Drywall	216.1	896.9	126	0.095	7493
237279	N4	26	3889	Drywall	216.1	3672.9	126	0.095	30684
237279	O5	27	211	Glass	265.6	-54.6	126	0.095	-456
237279	N6	28	3420	Drywall	216.1	3203.9	126	0.095	26766
237279	N7	29	2158	Drywall	216.1	1941.9	126	0.095	16223
237279	M8	30	2810	Drywall	216.1	2593.9	126	0.095	21670
237279	L8	31	4331	Drywall	216.1	4114.9	126	0.095	34377
237279	O9	32	3812	Drywall	216.1	3595.9	126	0.095	30041
237279	M9	33	512	Drywall	216.1	295.9	126	0.095	2472

237279	N10	34	2138	Drywall	216.1	1921.9	126	0.095	16056
237279	O11	35	3106	Drywall	216.1	2889.9	126	0.095	24143
237279	N12	36	1445	Drywall	216.1	1228.9	126	0.095	10266
237279	N13	37	1273	Drywall	216.1	1056.9	126	0.095	8830
237279	N14	38	3488	Metal	208.2	3279.8	126	0.095	27400
237279	N15	39	3450	Metal	208.2	3241.8	126	0.095	27083
237279	M15	40	798	Drywall	216.1	581.9	126	0.095	4861
237279	M15- duplicate	41	814	Drywall	216.1	597.9	126	0.095	4995



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

1) LSC BKG
Gross Static Counts
2) 1,024
3) 1,020
4) 564
5) 463
6) 1,080
7) 1,156
8) 509
9) 2,994
10) 954
11) 646
12) 1059
13) 2172 metal
14) 282
15) 3,974 Metal Window Frame
16) 2416 Glass
17) Metal Frame 1,277
18) 371 Wood laminate shelf
19) 991
20) 2,854
21) 881
22) 2,175
23) 949 - Metal Door
24) 1,196
D 25) 1,113
26) 3,889
27) 211 Glass
28) 3,420
29) 2,158
30) 2,810
31) 4,331
32) 3,812
33) 512
34) 2,138
35) 3,106
36) 1,445
37) 1,273
38) 3,488 Metal Door
39) 3,450 Frame Metal Door
40) 798
D 41) 814

NOTES:

1. WALL SURFACE AREA: 114 SQ. M.
   FLOOR SURFACE AREA: 115 SQ. M.
   TOTAL SURFACE AREA: 229 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.34 METERS.

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS
IN B2-166
SU1-B2166

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}^{\,d}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	13	1	63.82%	24
C-14	10	26	1	95.90%	21

Bias

$$relative\ \ bias = \frac{measured\ \ result\ - expected\ \ result}{expected\ \ result}$$

	Spike	Result	Relative bias
H-3	4174	3606	-0.13608
C-14	4354	4364	0.002297

H-3 spike value =	4174	dpm
C-14 spike value=	4354	dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm)					
					H-3			C-14		
Original	**Duplicate**	**Original**	**Duplicate**	**RPD**	**Original**	**Duplicate**	**RPD**	**Original**	**Duplicate**	**RPD**
24	25	1196	1113	0.0718926	3	13	1.25	16	14	0.13
40	41	798	814	0.0198511	0	17	2	85	54	0.45

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where:

RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

A green cell indicates that the result is less than the MDC. The RPD is not relevant when the result is less than the MDC.

Assay Definition-

Assay Description:
013014-01 SU1-B2166 CHEACTERIZATION PART 2

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140207_0850\20140207_0850.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	9	28	0	0	73.93	544.20
Missing vial 2.							
3	1.00	8	12	13	14	68.97	541.70
Missing vial 4.							
5	1.00	14	45	17	54	68.08	532.03
Missing vial 6.							
7	1.00	0	6	0	8	153.21	557.42
8	1.00	2037	3740	3606	4364	58.01	491.94

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 13.70 Date Processed: 1/31/2014 8:19:39 AM
14C Chi Square: 15.89 Date Processed: 1/31/2014 8:19:39 AM
3H E^2/B (1-18.6 keV): 394.72 Date Processed: 1/31/2014 8:19:39 AM
14C E^2/B (4-156 keV): 708.47 Date Processed: 1/31/2014 8:19:39 AM
3H Efficiency (0-18.6 keV): 63.82 Date Processed: 1/31/2014 8:19:39 AM
14C Efficiency (0-156 keV): 95.90 Date Processed: 1/31/2014 8:19:39 AM
IPA Background Date Processed: 1/31/2014 8:19:39 AM
3H Background CPM (0-18.6 keV): 10.42 Date Processed: 1/31/2014 8:19:39 AM
14C Background CPM (0-156 keV): 15.42 Date Processed: 1/31/2014 8:19:39 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Assay Definition-

Assay Description:
013114-01 RM 166 WALL CHARACTRERIZATION

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140131_1532\20140131_1532.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	13	26	0	0	68.87	538.15
2	1.00	5	21	5	25	73.18	527.57
3	1.00	0	7	0	9	132.71	521.14
4	1.00	8	45	2	54	82.11	532.25
5	1.00	9	57	0	69	72.57	510.39
6	1.00	12	39	14	46	68.02	535.92
7	1.00	17	31	29	37	58.01	529.80
8	1.00	2	29	0	35	78.76	527.78
9	1.00	8	42	4	50	64.26	526.91

10	1.00	1	14	0	17	71.89	537.19
11	1.00	0	13	0	16	111.08	524.02
12	1.00	22	108	14	130	65.40	496.32
13	1.00	0	12	0	14	75.44	533.83
14	1.00	0	18	0	22	99.11	494.18
15	1.00	11	20	19	23	46.61	526.72
16	1.00	10	35	10	42	65.80	519.85
17	1.00	25	81	31	96	63.32	505.80
18	1.00	16	31	28	37	39.77	502.78
19	1.00	1	37	0	45	66.82	518.35
20	1.00	7	49	0	59	70.31	517.93
21	1.00	7	25	8	29	69.32	518.61
22	1.00	5	19	6	22	69.03	519.60
23	1.00	0	41	0	50	107.34	504.21
24	1.00	3	14	3	16	61.76	532.26
25	1.00	11	28	15	33	71.85	517.02
26	1.00	2	10	2	11	0.00	522.31
27	1.00	16	52	20	62	55.08	518.62
28	1.00	12	107	0	129	80.25	528.13
29	1.00	4	35	0	42	81.51	529.87
30	1.00	0	32	0	39	105.63	523.98
31	1.00	53	256	33	308	69.02	523.69
32	1.00	8	19	13	22	48.05	525.00
33	1.00	0	33	0	40	56.27	503.38
34	1.00	57	77	107	88	52.50	528.34
35	1.00	12	32	16	38	52.02	512.42
36	1.00	10	39	9	47	65.37	515.93
37	1.00	18	81	13	97	65.23	517.19
38	1.00	26	106	24	126	69.91	518.69
39	1.00	16	103	1	124	61.56	515.20
40	1.00	3	70	0	85	83.65	519.91
41	1.00	3	38	0	46	56.99	514.80
Missing vial 42.							
43	1.00	3	4	6	4	115.22	547.81
44	1.00	2056	3767	3651	4395	58.21	490.52

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 25.72 Date Processed: 2/7/2014 8:20:45 AM
14C Chi Square: 10.05 Date Processed: 2/7/2014 8:20:45 AM
3H E^2/B (1-18.6 keV): 386.11 Date Processed: 2/7/2014 8:20:45 AM
14C E^2/B (4-156 keV): 726.54 Date Processed: 2/7/2014 8:20:45 AM
3H Efficiency (0-18.6 keV): 63.93 Date Processed: 2/7/2014 8:20:45 AM
14C Efficiency (0-156 keV): 96.54 Date Processed: 2/7/2014 8:20:45 AM
IPA Background Date Processed: 2/7/2014 8:20:45 AM
3H Background CPM (0-18.6 keV): 10.70 Date Processed: 2/7/2014 8:20:45 AM
14C Background CPM (0-156 keV): 15.37 Date Processed: 2/7/2014 8:20:45 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040	Date: 1/29/2014	Time Start: 0900	Time Complete: 1600	Page 1 of ~~70~~ 8

Location:	Room 166 Floor
Survey Unit:	SU1-B2166
Surveyors:	
Survey Number:	012914-01
Map ID:	see attached

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys α (Loose)	Contamination Surveys α (Total)	Contamination Surveys β (Loose)	Contamination Surveys β (Total)	Radiation Surveys γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY
- ☐ PROCEDURE NO.
- ☑ SPECIAL: Characterization
- ☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Characterization survey of room 166. Floor monitor used for scans (2360 SN# 227437 /43-37 SN# PR216990 /Eff: 0.07 / MDC: 291 /Bkg: 617), handheld (43-68) used for statics.

Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Setup/Lab Floor	L18
3					Setup/Lab Floor	K19
4					Setup/Lab Floor	J17
5					Setup/Lab Floor	L16
6					Setup/Lab Floor	K15
7					Setup/Lab Floor	I15
8					Setup/Lab Floor	F15
9					Setup/Lab Floor	G14
10					Setup/Lab Floor	J14
11					Setup/Lab Floor	L14
12					Setup/Lab Floor	K13
13					Setup/Lab Floor	E13
14					Setup/Lab Floor	K12
15					Setup/Lab Floor	G12
16					Setup/Lab Floor	E12
17					Setup/Lab Floor	K11
18					Setup/Lab Floor	H11
19					Setup/Lab Floor	K10
20					Setup/Lab Floor	I10
21					Setup/Lab Floor	H10
22					Setup/Lab Floor	H9
23					Setup/Lab Floor	K9
24					Setup/Lab Floor	M9
25					Setup/Lab Floor	L8

RCS REVIEW [signature] DATE 02/07/14

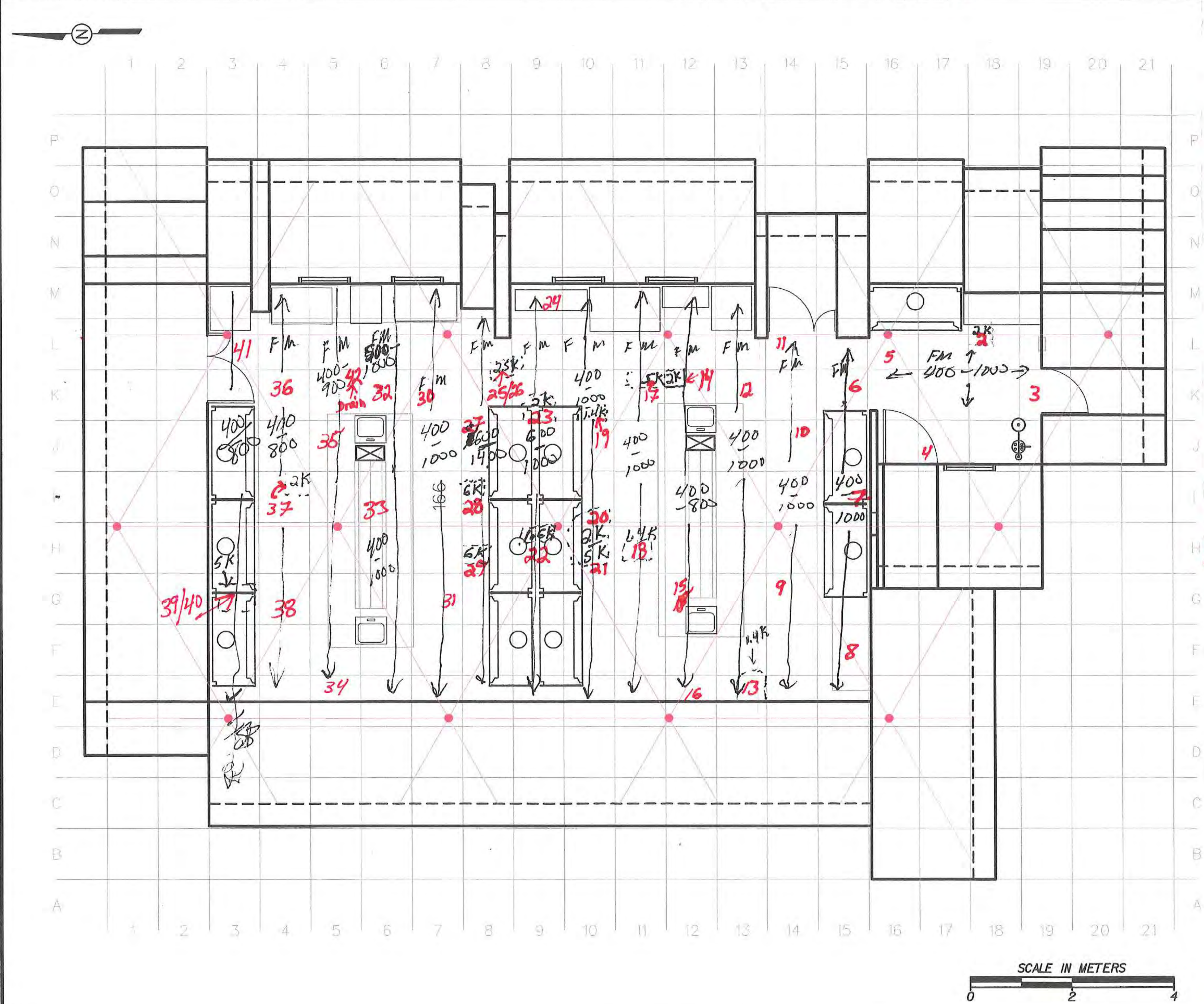
The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Contamination/Radiation Survey Report (Continuation Sheet)		Project Number: 144040	Date: 1/29/2014	Page 2 of 11
RCS Review:	Location: Room 166 Floor	COMMENTS: N/A		
Date: 02/07/14	Survey Number: 012914-01			
	Map ID: see attached			

	Alpha		Beta		Alpha cpm ☐			Alpha		Beta		Alpha cpm ☐	
	Loose	Total	Loose	Total	Beta cpm ☐	Item or Location		Loose	Total	Loose	Total	Beta cpm ☐	Item or Location
Item #	dpm/100cm²	dpm/100cm²	dpm/100cm²	dpm/100cm²	Material ☑		Item #	dpm/100cm²	dpm/100cm²	dpm/100cm²	dpm/100cm²	Material ☑	
26	N/A	N/A	SADS	SADS	Setup/Lab Floor	L8 (duplicate)	51	N/A	N/A				
27					Setup/Lab Floor	J8	52						
28					Setup/Lab Floor	I8	53						
29					Setup/Lab Floor	H8	54						
30					Setup/Lab Floor	K7	55						
31					Setup/Lab Floor	G7	56						
32					Setup/Lab Floor	K6	57						
33					Setup/Lab Floor	I6	58						
34					Setup/Lab Floor	E5	59						
35					Setup/Lab Floor	J5	60						
36					Setup/Lab Floor	K4	61						
37					Setup/Lab Floor	I4	62						
38					Setup/Lab Floor	G4	63						
39					Setup/Lab Floor	G3	64						
40					Setup/Lab Floor	G3 (duplicate)	65						
41					Setup/Lab Floor	L3	66						
42					Setup/Lab Floor	K5	67						
43							68						
44							69						
45							70						
46							71						
47							72						
48							73						
49							74						
50							75						

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
	LSC Background	1							
237279	L18	2	2235	Setup/Lab Floor	230	2005	126	0.095	16750
237279	K19	3	287	Setup/Lab Floor	230	57	126	0.095	476
237279	J17	4	335	Setup/Lab Floor	230	105	126	0.095	877
237279	L16	5	338	Setup/Lab Floor	230	108	126	0.095	902
237279	K15	6	272	Setup/Lab Floor	230	42	126	0.095	351
237279	I15	7	824	Setup/Lab Floor	230	594	126	0.095	4962
237279	F15	8	323	Setup/Lab Floor	230	93	126	0.095	777
237279	G14	9	303	Setup/Lab Floor	230	73	126	0.095	610
237279	J14	10	242	Setup/Lab Floor	230	12	126	0.095	100
237279	L14	11	322	Setup/Lab Floor	230	92	126	0.095	769
237279	K13	12	315	Setup/Lab Floor	230	85	126	0.095	710
237279	E13	13	1295	Setup/Lab Floor	230	1065	126	0.095	8897
237279	K12	14	3295	Setup/Lab Floor	230	3065	126	0.095	25606
237279	G12	15	256	Setup/Lab Floor	230	26	126	0.095	217
237279	E12	16	286	Setup/Lab Floor	230	56	126	0.095	468
237279	K11	17	3548	Setup/Lab Floor	230	3318	126	0.095	27719
237279	H11	18	1367	Setup/Lab Floor	230	1137	126	0.095	9499
237279	K10	19	2237	Setup/Lab Floor	230	2007	126	0.095	16767
237279	I10	20	5651	Setup/Lab Floor	230	5421	126	0.095	45288
237279	H10	21	1054	Setup/Lab Floor	230	824	126	0.095	6884
237279	H9	22	2371	Setup/Lab Floor	230	2141	126	0.095	17886
237279	K9	23	2027	Setup/Lab Floor	230	1797	126	0.095	15013
237279	M9	24	224	Setup/Lab Floor	230	-6	126	0.095	-50
237279	L8	25	3736	Setup/Lab Floor	230	3506	126	0.095	29290
237279	L8 (duplicate)	26	3734	Setup/Lab Floor	230	3504	126	0.095	29273
237279	J8	27	1314	Setup/Lab Floor	230	1084	126	0.095	9056
237279	I8	28	6852	Setup/Lab Floor	230	6622	126	0.095	55322
237279	H8	29	12176	Setup/Lab Floor	230	11946	126	0.095	99799
237279	K7	30	1061	Setup/Lab Floor	230	831	126	0.095	6942
237279	G7	31	421	Setup/Lab Floor	230	191	126	0.095	1596
237279	K6	32	439	Setup/Lab Floor	230	209	126	0.095	1746
237279	I6	33	289	Setup/Lab Floor	230	59	126	0.095	493

237279	E5	34	324	Setup/Lab Floor	230	94	126	0.095	785
237279	J5	35	307	Setup/Lab Floor	230	77	126	0.095	643
237279	K4	36	276	Setup/Lab Floor	230	46	126	0.095	384
237279	I4	37	4030	Setup/Lab Floor	230	3800	126	0.095	31746
237279	G4	38	288	Setup/Lab Floor	230	58	126	0.095	485
237279	G3	39	5793	Setup/Lab Floor	230	5563	126	0.095	46475
237279	G3 (duplicate)	40	5787	Setup/Lab Floor	230	5557	126	0.095	46424
237279	L3	41	360	Setup/Lab Floor	230	130	126	0.095	1086
237279	K5	42	796	Setup/Lab Floor	230	566	126	0.095	4728



LEGEND:

• SYSTEMATIC SAMPLE LOCATION

1) BKG LSC

~~27650~~ Gross Static Counts

2) 2,235
3) 287
4) 335
5) 338
6) 272
7) 824
8) 323
9) 303
10) 242
11) 322
12) 315
13) 1,295
14) 3,295
15) 256
16) 286
17) 3,648
18) 1,367
19) 2,237
20) 5,651
21) 1,054
22) 2,371
23) 2,027
24) 224
25) 3,736
D26) 3,734
27) 1,314
28) 6,852
29) 12,176
30) 1,061
31) 421
32) 439
33) 289
34) 324
35) 307
36) 276
37) 4,030
38) 288
39) 5,793
D40) 5,787
41) 360
42) 796

NOTES:

1. WALL SURFACE AREA: 114 SQ. M.
   FLOOR SURFACE AREA: 115 SQ. M.
   TOTAL SURFACE AREA: 229 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.34 METERS.

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS
IN B2-166
SU1-B2166

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

aptuit_api_fssr_temp006.dgn sammccawley 1/10/2014 3:29:15 PM PDF_with_Levels.plt sei_textsub_only.tbl

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}^{\,d}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	10	1	63.82%	22
C-14	10	30	1	95.90%	23

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

	Spike	Result	Relative bias (±0.2)
H-3	4174	3657	-0.123862
C-14	4354	4194	-0.036748

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm)					
					H-3			C-14		
Original	Duplicate	Original	Duplicate	RPD	Original	Duplicate	RPD	Original	Duplicate	RPD
25	26	3736	3734	0.000535	18	0	2	70	59	0.17
39	40	5793	5787	0.0010363	0	2	2	7	13	0.6

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

A green cell indicates that the result is less than the MDC. The RPD is not relevant when the result is less than the MDC.

Assay Definition-

Assay Description:
012914-01 SU1-B2166 CHEACTERIZATION PART 1

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140207_0917\20140207_0917.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	11	32	0	0	76.55	535.35
Missing vial 2.							
3	1.00	6	48	0	59	68.33	483.98
Missing vial 4.							
5	1.00	3	11	2	13	54.37	522.35
Missing vial 6.							
7	1.00	0	0	2	0	0.00	554.89
8	1.00	2036	3602	3657	4194	56.76	492.02

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 13.70 Date Processed: 1/31/2014 8:19:39 AM
14C Chi Square: 15.89 Date Processed: 1/31/2014 8:19:39 AM
3H E^2/B (1-18.6 keV): 394.72 Date Processed: 1/31/2014 8:19:39 AM
14C E^2/B (4-156 keV): 708.47 Date Processed: 1/31/2014 8:19:39 AM
3H Efficiency (0-18.6 keV): 63.82 Date Processed: 1/31/2014 8:19:39 AM
14C Efficiency (0-156 keV): 95.90 Date Processed: 1/31/2014 8:19:39 AM
IPA Background Date Processed: 1/31/2014 8:19:39 AM
3H Background CPM (0-18.6 keV): 10.42 Date Processed: 1/31/2014 8:19:39 AM
14C Background CPM (0-156 keV): 15.42 Date Processed: 1/31/2014 8:19:39 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Assay Definition-

Assay Description:
012914-01 RECOUNT

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140131_0914\20140131_0914.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	10	30	0	0	79.20	537.81
2	1.00	0	44	0	54	83.61	490.08
3	1.00	7	0	20	0	0.00	501.91
4	1.00	6	0	13	0	14.98	519.62
5	1.00	2	10	1	12	6.25	506.81
6	1.00	1	13	0	15	62.93	513.25
7	1.00	1	17	0	21	40.47	495.23
8	1.00	0	7	0	9	41.95	514.96
9	1.00	5	5	10	5	2.63	509.13

10	1.00	0	3	0	4	108.76	504.06
11	1.00	32	188	8	227	74.66	490.72
12	1.00	0	13	0	16	82.05	507.34
13	1.00	6	21	8	25	42.78	496.27
14	1.00	7	32	5	39	49.39	471.39
15	1.00	0	18	0	22	88.42	493.30
16	1.00	2	5	4	6	0.00	471.30
17	1.00	3	3	6	3	124.06	505.18
18	1.00	3	0	7	0	0.00	510.61
19	1.00	16	26	31	30	36.37	464.62
20	1.00	3	24	0	29	71.61	511.65
21	1.00	2	4	4	5	0.00	523.44
22	1.00	1	7	0	9	16.22	522.25
23	1.00	15	21	30	24	56.70	498.52
24	1.00	0	8	0	10	185.63	513.96
25	1.00	16	58	18	70	48.88	479.87
26	1.00	72	471	0	569	76.01	483.19
27	1.00	9	39	8	47	51.23	488.54
28	1.00	1	21	0	26	55.45	479.32
29	1.00	8	31	7	37	70.21	504.02
30	1.00	6	38	1	46	54.54	483.94
31	1.00	4	16	5	19	49.87	511.94
32	1.00	3	26	0	31	30.65	489.82
33	1.00	9	9	20	10	5.05	504.68
34	1.00	0	0	0	0	0.00	509.18
35	1.00	8	0	20	0	0.00	514.05
36	1.00	7	14	11	17	57.03	519.65
37	1.00	5	25	4	30	51.63	490.65
38	1.00	7	17	11	21	37.29	460.25
39	1.00	0	6	0	7	0.00	516.09
40	1.00	13	26	23	30	63.77	510.67
41	1.00	0	12	0	15	86.06	500.86
42	1.00	2	5	4	6	33.49	502.18
Missing vial 43.							
44	1.00	2	1	5	1	0.00	550.72
45	1.00	1963	3709	3445	4333	59.74	490.14

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 25.72 Date Processed: 2/7/2014 8:20:45 AM
14C Chi Square: 10.05 Date Processed: 2/7/2014 8:20:45 AM
3H E^2/B (1-18.6 keV): 386.11 Date Processed: 2/7/2014 8:20:45 AM
14C E^2/B (4-156 keV): 726.54 Date Processed: 2/7/2014 8:20:45 AM
3H Efficiency (0-18.6 keV): 63.93 Date Processed: 2/7/2014 8:20:45 AM
14C Efficiency (0-156 keV): 96.54 Date Processed: 2/7/2014 8:20:45 AM
IPA Background Date Processed: 2/7/2014 8:20:45 AM
3H Background CPM (0-18.6 keV): 10.70 Date Processed: 2/7/2014 8:20:45 AM
14C Background CPM (0-156 keV): 15.37 Date Processed: 2/7/2014 8:20:45 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040	Date: 2/10/2014	Time Start: 0800	Time Complete: 0945	Page 1 of 8 9
Location: NMR/Access-Egress Areas	Surveyors: Shane Brungardt, Gordon Robb				
Survey Unit: SU1-B2AE					
	Survey Number: 021014-01				
	Map ID: see attached				

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys				Radiation Surveys
	α (Loose)	α (Total)	β (Loose)	β (Total)	γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY

- ☐ PROCEDURE NO.
- ☑ SPECIAL Characterization
- ☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Characterization survey of NMR room and access/egress areas. Floor monitor used for floor scans (2360 SN# 227437 /43-37 SN# PR216990 /Eff: 0.07 / MDC: 291 /Bkg: 617), handheld (43-68) used for all other scans and all statics.

Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ / Beta cpm ☐ / Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Drywall	D4
3					Drywall	F3
4					Drywall	H4
5					Drywall	F5
6					Drywall	F4
7					Drywall	G6
8					Drywall	F7
9					Drywall	D6
10					Painted Concrete Block	B5
11					Painted Concrete Block	C3
12					Drywall	D1
13					Drywall	F2
14					Drywall	G1
15					Metal	I4
16					Glass	I4
17					Drywall	H5
18					Drywall	M9
19					Drywall	K11
20					Metal	I11
21					Metal	I11-DUP
22					Painted Concrete Block	G9
23					Drywall	I6
24					Metal	J7
25					Setup/Lab Floor (resin)	K8

RCS REVIEW [signature] DATE 02/11/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Contamination/Radiation Survey Report (Continuation Sheet)		Project Number: 144040	Date: 2/10/2014	Page 2 of ~~8~~ 9
RCS Review: [signature]	Location: NMR/Access-Egress Areas	COMMENTS:		
Date: 02/11/14	Survey Number: 021014-01			
	Map ID: see attached			

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
26	N/A	N/A	SADS	SADS	Setup/Lab Floor (resin)	I8
27					Setup/Lab Floor (resin)	I9
28					Setup/Lab Floor (resin)	J14
29					Setup/Lab Floor (resin)	I15
30					Setup/Lab Floor (resin)	I14
31					Painted Concrete Block	G15
32					Metal	I13
33					Drywall	I12
34					Drywall	K13
35					Metal	L15
36					Painted Concrete Block	I17
37					Painted Concrete Block	I17-DUP
38						
39						
40						
41						
42						
43						
44					N/A	
45						
46						
47						
48						
49						
50						

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☐	Item or Location
51	N/A	N/A				
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63					N/A	
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						
75						

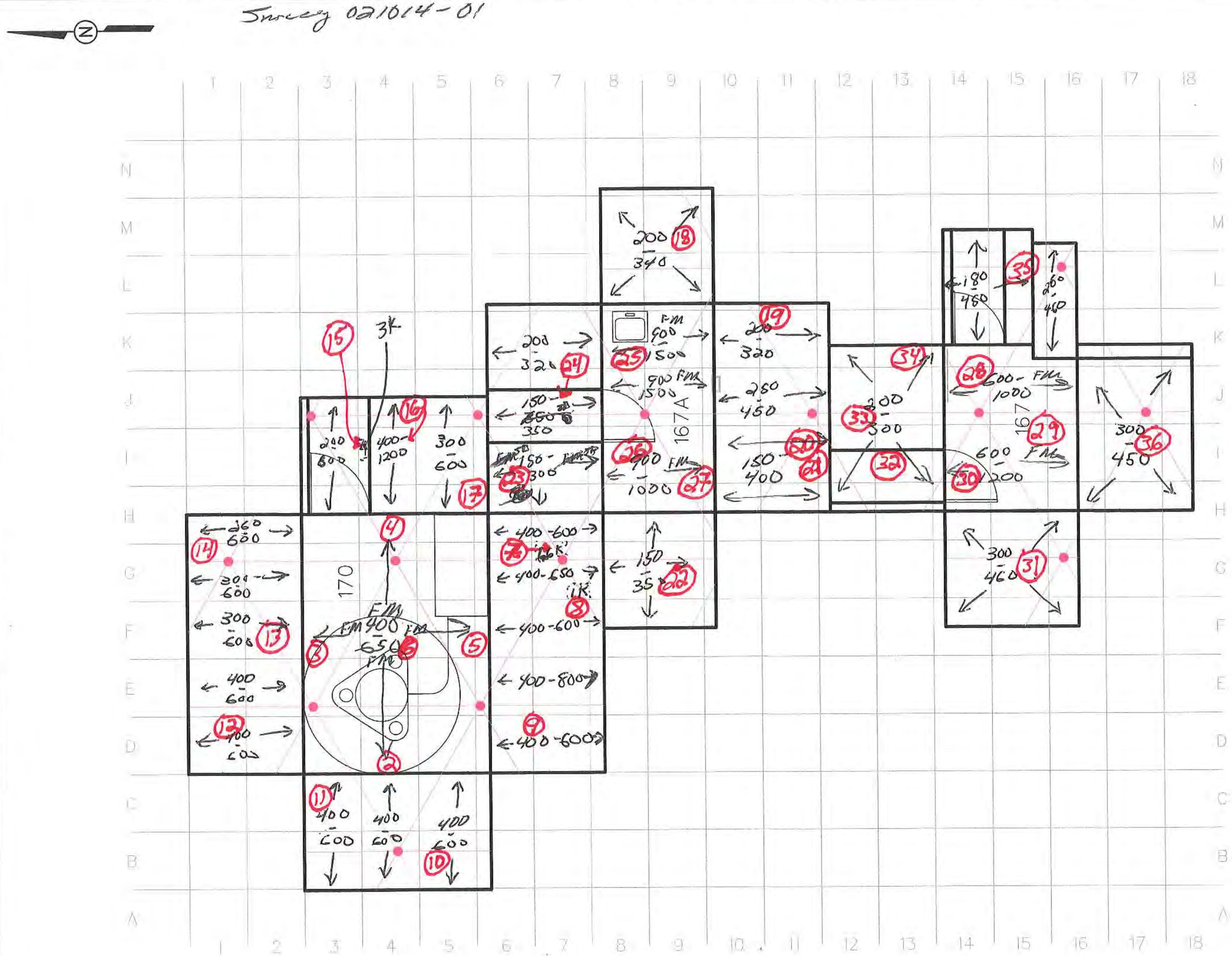
Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net $dpm/100cm^2$
	LSC Background	1							
237279	D4	2	263	Drywall	216.1	46.9	126	0.095	392
237279	F3	3	220	Drywall	216.1	3.9	126	0.095	33
237279	H4	4	237	Drywall	216.1	20.9	126	0.095	175
237279	F5	5	242	Drywall	216.1	25.9	126	0.095	216
237279	F4	6	256	Drywall	216.1	39.9	126	0.095	333
237279	G6	7	1643	Drywall	216.1	1426.9	126	0.095	11921
237279	F7	8	1172	Drywall	216.1	955.9	126	0.095	7986
237279	D6	9	487	Drywall	216.1	270.9	126	0.095	2263
237279	B5	10	428	Painted Concrete Block	286.6	141.4	126	0.095	1181
237279	C3	11	436	Painted Concrete Block	286.6	149.4	126	0.095	1248
237279	D1	12	385	Drywall	216.1	168.9	126	0.095	1411
237279	F2	13	370	Drywall	216.1	153.9	126	0.095	1286
237279	G1	14	442	Drywall	216.1	225.9	126	0.095	1887
237279	I4	15	1727	Metal	208.2	1518.8	126	0.095	12688
237279	I4	16	235	Glass	265.6	-30.6	126	0.095	-256
237279	H5	17	388	Drywall	216.1	171.9	126	0.095	1436
237279	M9	18	263	Drywall	216.1	46.9	126	0.095	392
237279	K11	19	246	Drywall	216.1	29.9	126	0.095	250
237279	I11	20	277	Metal	208.2	68.8	126	0.095	575
237279	I11-DUP	21	278	Metal	208.2	69.8	126	0.095	583
237279	G9	22	349	Painted Concrete Block	286.6	62.4	126	0.095	521
237279	I6	23	244	Drywall	216.1	27.9	126	0.095	233
237279	J7	24	265	Metal	208.2	56.8	126	0.095	475
237279	K8	25	594	Setup/Lab Floor (resin)	230	364	126	0.095	3041
237279	I8	26	553	Setup/Lab Floor (resin)	230	323	126	0.095	2698
237279	I9	27	364	Setup/Lab Floor (resin)	230	134	126	0.095	1119
237279	J14	28	485	Setup/Lab Floor (resin)	230	255	126	0.095	2130
237279	I15	29	513	Setup/Lab Floor (resin)	230	283	126	0.095	2364
237279	I14	30	473	Setup/Lab Floor (resin)	230	243	126	0.095	2030
237279	G15	31	370	Painted Concrete Block	286.6	83.4	126	0.095	697
237279	I13	32	315	Metal	208.2	106.8	126	0.095	892
237279	I12	33	231	Drywall	216.1	14.9	126	0.095	124
237279	K13	34	226	Drywall	216.1	9.9	126	0.095	83
237279	L15	35	239	Metal	208.2	30.8	126	0.095	257
237279	I17	36	370	Painted Concrete Block	286.6	83.4	126	0.095	697
237279	I17-DUP	37	370	Painted Concrete Block	286.6	83.4	126	0.095	697

Instrument 2360/4368
2360/4337 (F.M.)

C = concrete
DW = Dry Wall
PM = Painted Metal

PCB = Painted Concrete Block
G = Glass
LF = Linoleum Floor

Survey 021014-01



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

1) LSC Background Gross static counts
2) 263 - DW
3) 220 - DW
4) 237 - DW
5) 242 - DW
6) 256 - DW
7) 1643 - DW
8) 1172 - DW
9) 487 - DW
10) 428 - PCB
11) 436 - PCB
12) 385 - DW
13) 370 - DW
14) 442 - DW
15) 1727 - PM
16) 235 - G
17) 388 - DW
18) 263 - DW
19) 246 - DW
20) 277 - PM
D 21) 278 - PM
22) 349 - PCB
23) 244 - DW
24) 265 - PM
25) 594 - LF
26) 553 - LF
27) 364 - LF
28) 485 - LF
29) 513 - LF
30) 473 - LF
31) 370 - PCB
32) 315 - PM
33) 231 - DW
34) 226 - DW
35) 239 - PM
36) 370 - PCB
D 37) 370 - PCB

NOTES:

1. WALL SURFACE AREA: 75 SQ. M.
   FLOOR SURFACE AREA: 28 SQ. M.
   TOTAL SURFACE AREA: 103 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 2.91 METERS.

SCALE IN METERS
0 2 4

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS IN B2-167, B2-167A, B2-170 SU1-B2AE

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

CBI Shaw Environmental & Infrastructure, Inc. (A CB&I Company)

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b t_g (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	11	1	63.99%	23
C-14	10	30	1	96.17%	23

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

	Spike	Result	Relative bias
H-3	4174	3571	-0.14447
C-14	4354	4384	0.00689

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm) H-3			Smears (dpm) C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
20	21	277	278	0.0036036	11	0	2	21	22	0.0465116
36	37	370	370	0	0	4	2	1	0	2

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

Assay Definition-

Assay Description:
021014-01 SU1 NMR + CHARACTERIZTION BLANK SPIKE AND DUPE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140211_1018\20140211_
1018.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE	
1	10.00	12	29	0	0	72.87	533.37	
Missing vial 2.								
3	1.00	0	18	0	22	120.86	535.12	SAMPLE 20
Missing vial 4.								
5	1.00	0	0	4	0	0.00	535.77	SAMPLE 36
Missing vial 6.								
7	1.00	0	2	0	3	2544.73	550.29	
8	1.00	2016	3754	3571	4384	58.33	486.94	

Assay Definition-

Assay Description:
021014-01 SU1 NMR + CHARACTERIZTION

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140211_0826\20140211_0826.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	11	30	0	0	72.73	534.10
2	1.00	0	4	0	5	0.00	390.27
3	1.00	5	4	10	4	27.22	482.07
4	1.00	0	0	0	0	0.00	430.38
5	1.00	0	6	0	7	0.00	411.33
6	1.00	0	0	0	0	0.00	483.78
7	1.00	5	8	8	10	48.17	512.89
8	1.00	0	4	0	5	0.00	437.79
9	1.00	4	0	11	0	0.00	385.08

10	1.00	0	2	0	3	12.60	520.55
11	1.00	2	6	4	7	58.32	524.47
12	1.00	3	5	5	6	0.00	490.52
13	1.00	0	9	0	12	291.15	507.62
14	1.00	4	12	5	15	55.54	516.92
15	1.00	1	18	0	22	83.98	511.09
16	1.00	0	32	0	39	77.43	505.06
17	1.00	0	13	0	15	118.33	481.87
18	1.00	1	4	1	5	166.98	526.37
19	1.00	1	21	0	26	85.12	525.04
20	1.00	7	18	11	21	77.05	534.47
Missing vial 21.							
22	1.00	0	0	1	0	0.00	532.14
23	1.00	0	1	0	2	0.00	517.30
24	1.00	2	9	0	10	63.67	527.56
25	1.00	16	48	21	58	60.61	483.60
26	1.00	10	26	14	31	60.71	501.13
27	1.00	8	9	16	10	30.23	503.19
28	1.00	3	8	4	10	28.92	500.48
29	1.00	2	11	1	13	58.92	500.62
30	1.00	7	0	18	0	0.00	492.63
31	1.00	3	0	12	0	0.00	529.91
32	1.00	7	0	17	0	0.00	535.71
33	1.00	3	0	6	0	0.00	531.98
34	1.00	5	3	10	4	1.75	526.40
35	1.00	0	8	0	9	68.83	532.66
36	1.00	0	0	0	1	0.00	536.11
Missing vial 37.							
38	1.00	1	0	4	0	0.00	548.53
39	1.00	1916	3812	3300	4466	59.69	487.39

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 10.63 Date Processed: 2/11/2014 8:26:20 AM
14C Chi Square: 30.62 Date Processed: 2/11/2014 8:26:20 AM
3H E^2/B (1-18.6 keV): 385.91 Date Processed: 2/11/2014 8:26:20 AM
14C E^2/B (4-156 keV): 735.36 Date Processed: 2/11/2014 8:26:20 AM
3H Efficiency (0-18.6 keV): 63.98 Date Processed: 2/11/2014 8:26:20 AM
14C Efficiency (0-156 keV): 95.56 Date Processed: 2/11/2014 8:26:20 AM
IPA Background Date Processed: 2/11/2014 8:26:20 AM
3H Background CPM (0-18.6 keV): 10.67 Date Processed: 2/11/2014 8:26:20 AM
14C Background CPM (0-156 keV): 15.02 Date Processed: 2/11/2014 8:26:20 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040	Date: 2/10/2014	Time Start: 1000	Time Complete: 1700	Page 1 of ~~7~~ 8
Location: NMR/Access-Egress	Surveyors: Gordon Robb				
Survey Unit: SU1-B2AE	Shane Brungardt				
	Survey Number: 021014-02				
	Map ID: see attached				

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	α (Loose)	α (Total)	β (Loose)	β (Total)	γ
	Contamination Surveys				Radiation Surveys
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC ($dpm/100cm^2$)				615	
Background (cpm)				230	

REASON FOR SURVEY

☐ PROCEDURE NO.

☑ SPECIAL FSS

☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: FSS of NMR and Access/Egress Areas

Item #	Alpha Loose $dpm/100cm^2$	Alpha Total $dpm/100cm^2$	Beta Loose $dpm/100cm^2$	Beta Total $dpm/100cm^2$	Alpha cpm ☐ / Beta cpm ☐ / Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Painted Concrete Block	B4
3					Concrete Floor (bare)	E3
4					Concrete Floor (bare)	E6
5					Drywall	G7
6					Concrete Floor (bare)	G4
7					Drywall	G1
8					Metal	J3
9					Drywall	J6
10					Setup/Lab Floor (resin)	J8/9
11					Drywall	J11
12					Painted Concrete Block	L16
13					Painted Concrete Block	J17
14					Painted Concrete Block	G16
15					Setup/Lab Floor (resin)	J14
16					Setup/Lab Floor (resin)	J14-DUP
17						
18						
19						
20						
21						
22						
23						
24						
25						

RCS REVIEW DATE 02/11/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

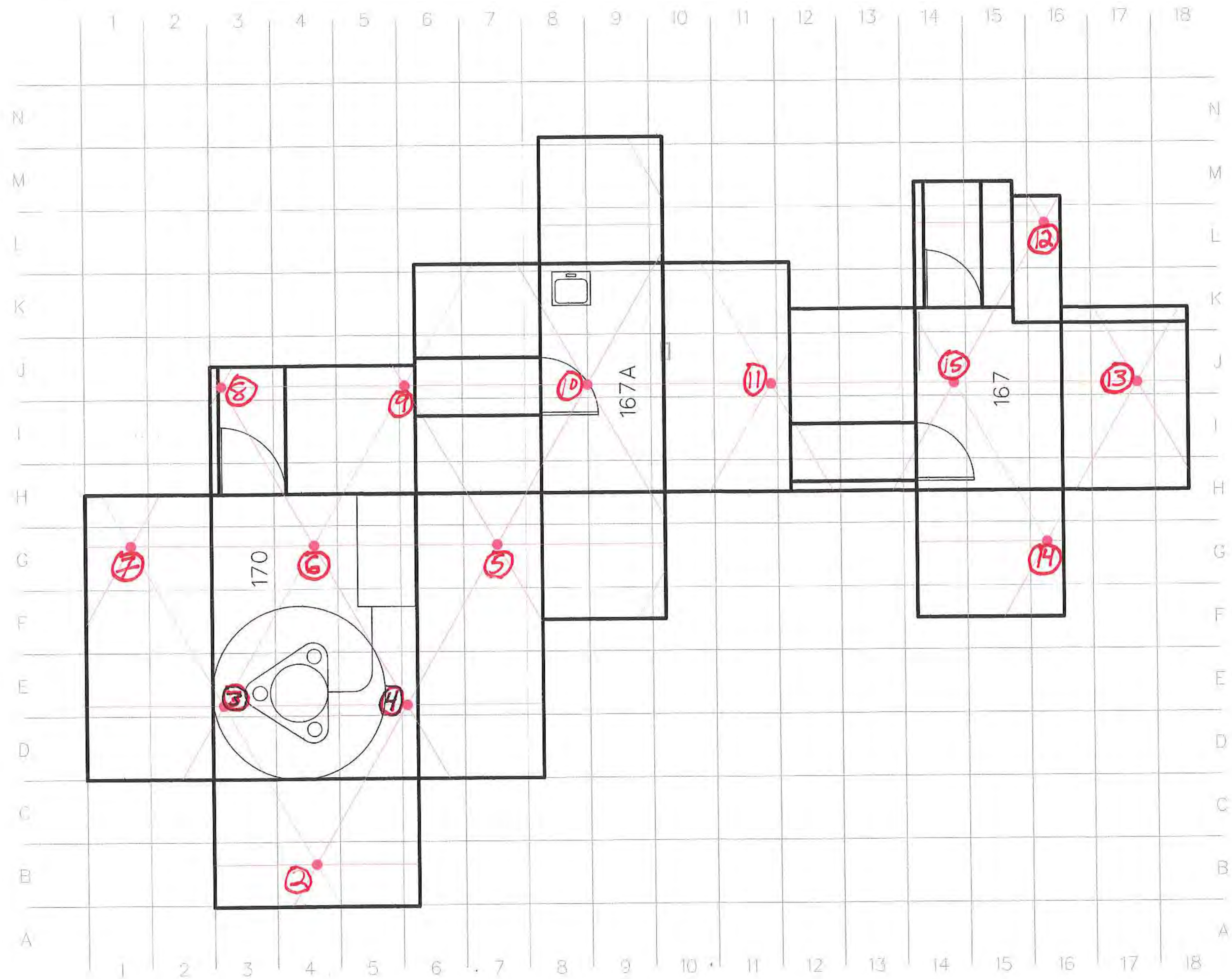
Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
	LSC Background	1							
237279	B4	2	451	Painted Concrete Block	286.6	164.4	126	0.095	1373
237279	E3	3	258	Concrete Floor (bare)	324.5	-66.5	126	0.095	-556
237279	E6	4	260	Concrete Floor (bare)	324.5	-64.5	126	0.095	-539
237279	G7	5	519	Drywall	216.1	302.9	126	0.095	2530
237279	G4	6	288	Concrete Floor (bare)	324.5	-36.5	126	0.095	-305
237279	G1	7	438	Drywall	216.1	221.9	126	0.095	1854
237279	J3	8	345	Metal	208.2	136.8	126	0.095	1143
237279	J6	9	404	Drywall	216.1	187.9	126	0.095	1570
237279	J8/9	10	510	Setup/Lab Floor (resin)	230	280	126	0.095	2339
237279	J11	11	218	Drywall	216.1	1.9	126	0.095	16
237279	L16	12	368	Painted Concrete Block	286.6	81.4	126	0.095	680
237279	J17	13	328	Painted Concrete Block	286.6	41.4	126	0.095	346
237279	G16	14	329	Painted Concrete Block	286.6	42.4	126	0.095	354
237279	J14	15	548	Setup/Lab Floor (resin)	230	318	126	0.095	2657
237279	J14-DUP	16	487	Setup/Lab Floor (resin)	230	257	126	0.095	2147

Inst: 2360/4368

Survey # 021014-02

DW = Dry Wall
PCB = Painted Concrete Block
CF = Concrete Floor

PM = Painted Metal
LM = Linoleum Floor



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

1) LSC Bkg
Gross Static Counts
2) 451 - PCB
3) 258 - CF
4) 260 - CF
5) 519 - DW
6) 288 - CF
7) 438 - DW
8) 345 - PM
9) 404 - DW
10) 510 - LF
11) 218 - DW
12) 368 - PCB
13) 328 - PCB
14) 329 - PCB
15) 548 - LF
16) 487 - LF

NOTES:

1. WALL SURFACE AREA: 75 SQ. M.
   FLOOR SURFACE AREA: 28 SQ. M.
   TOTAL SURFACE AREA: 103 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 2.91 METERS.

SCALE IN METERS
0 2 4

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS
IN B2-167, B2-167A, B2-170
SU1-B2AE

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

aptuit_api_fssr_temp005.dgn sammccowley 1/10/2014 3:28:07 PM PDF_with_Levels.plt sei_textsub_only.tbl

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)} \quad d$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	13	1	63.98%	24
C-14	10	29	1	95.56%	23

Bias

$$relative \quad bias = \frac{measured \quad result \quad - e\,xp\,ected \quad result}{e\,xp\,ected \quad result}$$

	Spike	Result	Relative bias
H-3	4174	3513	-0.15836
C-14	4354	4432	0.017915

H-3 spike value =	4174	dpm
C-14 spike value=	4354	dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm) H-3			Smears (dpm) C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
15	16	548	487	0.1178744	1	3	1	2	16	1.5555556

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\overline{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\overline{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

Assay Definition-

Assay Description:
021014-02 SU1 NMR + SYSTEMATIC BLANK SPIKE AND DUPE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140211_1328\20140211_1328.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE	
1	10.00	10	28	0	0	71.35	536.98	
Missing vial 2.								
3	1.00	3	14	3	16	63.37	499.38	SAMPLE 15
Missing vial 4.								
5	1.00	0	5	0	6	195.66	546.86	
6	1.00	1998	3792	3513	4432	59.76	487.08	

Assay Definition-

Assay Description:
021014-02 SU1 NMR + SYSTEMATIC ~~BLANK SPIKE AND DUPE~~

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140211_1045\20140211_1045.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	13	29	0	0	70.74	539.22
2	1.00	0	8	0	10	13.81	517.73
3	1.00	0	2	0	2	0.00	438.51
4	1.00	0	0	3	0	0.00	392.26
5	1.00	0	6	0	8	141.11	521.97
6	1.00	0	9	0	11	79.68	457.39
7	1.00	0	6	0	8	408.47	525.24
8	1.00	8	12	14	14	69.56	523.29
9	1.00	1	1	2	1	0.00	459.56

10	1.00	9	16	15	19	49.48	506.71
11	1.00	1	2	1	2	0.00	525.30
12	1.00	2	0	6	0	0.00	530.00
13	1.00	5	0	14	0	0.00	527.33
14	1.00	0	0	0	0	0.00	530.51
15	1.00	1	2	1	2	47.92	497.07
Missing vial 16.							
17	1.00	0	2	0	3	0.00	547.73
18	1.00	1945	3784	3398	4429	59.32	483.98

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 10.63 Date Processed: 2/11/2014 8:26:20 AM
14C Chi Square: 30.62 Date Processed: 2/11/2014 8:26:20 AM
3H E^2/B (1-18.6 keV): 385.91 Date Processed: 2/11/2014 8:26:20 AM
14C E^2/B (4-156 keV): 735.36 Date Processed: 2/11/2014 8:26:20 AM
3H Efficiency (0-18.6 keV): 63.98 Date Processed: 2/11/2014 8:26:20 AM
14C Efficiency (0-156 keV): 95.56 Date Processed: 2/11/2014 8:26:20 AM
IPA Background Date Processed: 2/11/2014 8:26:20 AM
3H Background CPM (0-18.6 keV): 10.67 Date Processed: 2/11/2014 8:26:20 AM
14C Background CPM (0-156 keV): 15.02 Date Processed: 2/11/2014 8:26:20 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

9

Contamination/Radiation Survey Report		Project Number: 144040	
Location:	Dock 5/API Commons	Surveyors:	Gordon Robb
Survey Unit:	SU3-B2		Shane Brungardt
		Survey Number:	021214-02
		Map ID:	see attached

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys				Radiation Surveys
	α (Loose)	α (Total)	β (Loose)	β (Total)	γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm²)				615	
Background (cpm)				230	

REASON FOR SURVEY
- ☐ PROCEDURE NO.
- ☑ SPECIAL FSS
- ☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: FSS of Dock 5 and API Commons. Floor monitor used for scans (2360 SN# 227437 /43-37 SN# PR216990 /Eff: 0.07 / MDC: 291 /Bkg: 617), handheld (43-68) used for statics.

Date: 2/12/2014 Time Start: 0900 Time Complete: 1200 Page 1 of 4

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Concrete Floor (bare)	F6
3					Concrete Floor (bare)	G3
4					Concrete Floor (bare)	B3
5					Tile	K28
6					Carpet	O27
7					Tile	K24
8					Carpet	M23
9					Carpet	N20
10					Tile	K17
11					Tile	J16
12					Carpet	M13
13					Carpet	O9
14					Tile	K7
15					Carpet	M5
16					Tile	K3
17					Tile	K3-Dup
18						
19						
20						
21						
22						
23						
24						
25						

RCS REVIEW DATE 02/14/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net $dpm/100cm^2$
	LSC Background	1							
237279	F6	2	313	Concrete Floor (bare)	324.5	-11.5	126	0.095	-96
237279	G3	3	331	Concrete Floor (bare)	324.5	6.5	126	0.095	54
237279	B3	4	290	Concrete Floor (bare)	324.5	-34.5	126	0.095	-288
237279	K28	5	282	Tile	225.5	56.5	126	0.095	472
237279	O27	6	236	Carpet	232.5	3.5	126	0.095	29
237279	K24	7	299	Tile	225.5	73.5	126	0.095	614
237279	M23	8	270	Carpet	232.5	37.5	126	0.095	313
237279	N20	9	259	Carpet	232.5	26.5	126	0.095	221
237279	K17	10	254	Tile	225.5	28.5	126	0.095	238
237279	J16	11	780	Tile	225.5	554.5	126	0.095	4632
237279	M13	12	274	Carpet	232.5	41.5	126	0.095	347
237279	O9	13	266	Carpet	232.5	33.5	126	0.095	280
237279	K7	14	198	Tile	225.5	-27.5	126	0.095	-230
237279	M5	15	263	Carpet	232.5	30.5	126	0.095	255
237279	K3	16	214	Tile	225.5	-11.5	126	0.095	-96
237279	K3-Dup	17	236	Tile	225.5	10.5	126	0.095	88

Survey # 021214 - 02
Instr. 2360/4337 (F.M.)
2360/4368

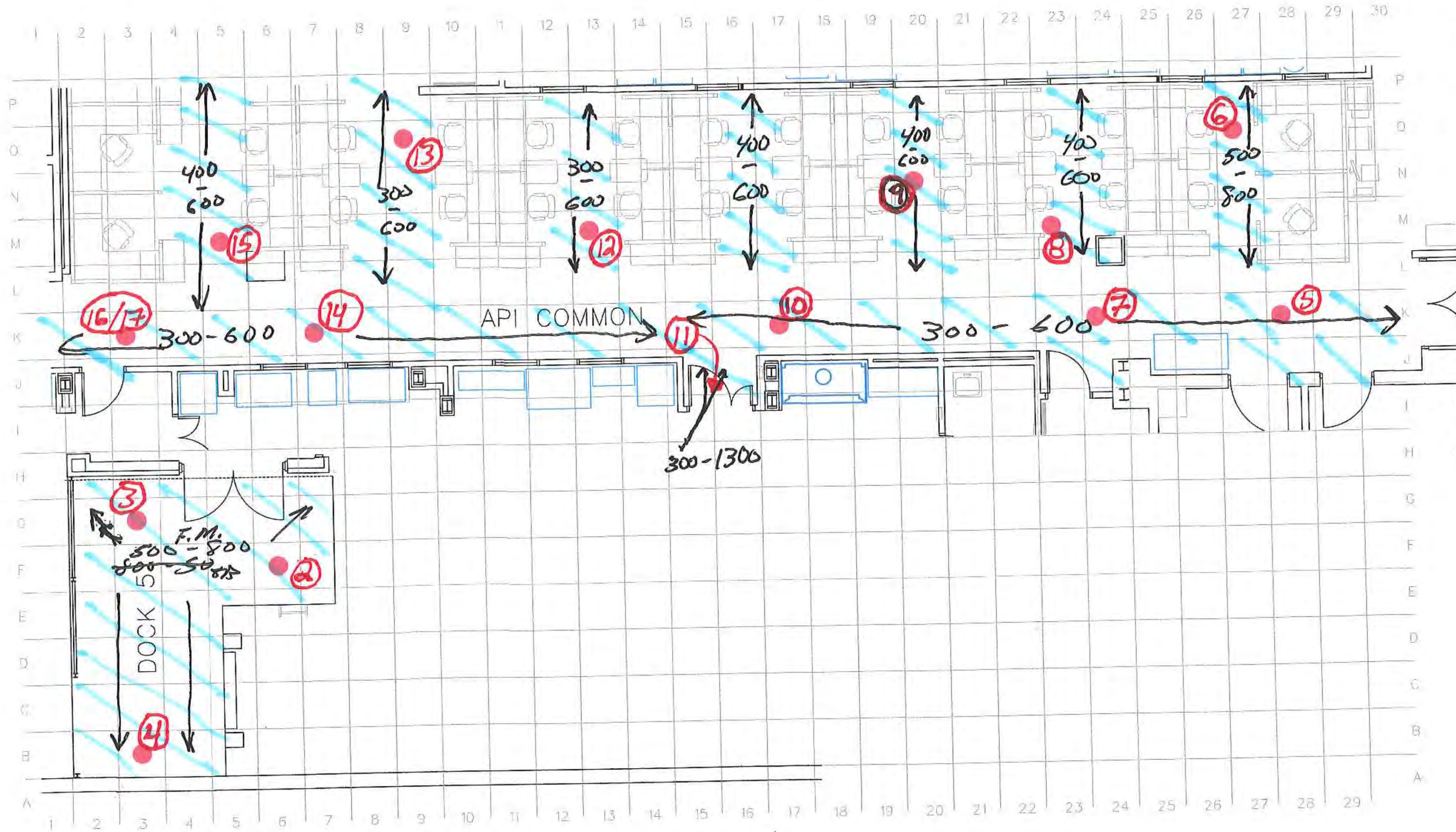
C = Concrete
LFT = Linoleum Floor Tile
CT = Carpet Tile

= Area Scanned with Floor Monitor

LEGEND:

● RANDOM SAMPLE LOCATION

1) BKG LSC
Gross Static Counts
2) 313 - C
3) 331 - C
4) 290 - C
5) 282 - LFT
6) 236 - CT
7) 299 - LFT
8) 270 - CT
9) 259 - CT
10) 254 - LFT
11) 780 - LFT
12) 274 - CT
13) 266 - CT
14) 198 - LFT
15) 263 - CT
16) 214 - LFT
17) 236 - LFT



SCALE IN METERS
0 3 6

FIGURE X-X
CLASS 3 SAMPLING LOCATIONS
IN B2 DOCK AND API COMMONS
SU3-B2

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	12	1	63.82%	23
C-14	10	31	1	96.32%	23

Bias

$$relative \quad bias = \frac{measured \quad result \; - expected \quad result}{expected \quad result}$$

	Spike	Result	Relative bias
H-3	4174	3611	-0.13488
C-14	4354	4440	0.019752

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm) H-3			Smears (dpm) C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
16	17	214	236	0.0977778	15	2	1.5294118	0	7	2

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

Assay Definition-

Assay Description:
021214-02 SU3 B2 COMMON SYSTEMATIC DUPE BLANK AND SPIKE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140214_1400\20140214_1400.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	10	32	0	0	77.01	529.87
Missing vial 2.							
3	1.00	2	6	2	7	0.00	464.95
Missing vial 4.							
5	1.00	6	0	15	0	0.00	546.44
6	1.00	2026	3798	3611	4440	58.98	480.06

Assay Definition-

Assay Description:
021214-02 SU3 B2 DOCK AND API COMMONS

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140212_1503\20140212_1503.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	12	31	0	0	70.80	535.28
2	1.00	0	0	0	0	0.00	498.44
3	1.00	0	2	0	2	0.00	444.76
4	1.00	0	0	0	0	0.00	513.63
5	1.00	2	0	5	0	660.86	507.89
6	1.00	1	0	2	0	0.00	513.53
7	1.00	0	6	0	7	7.55	496.48
8	1.00	0	6	0	8	209.69	525.40
9	1.00	2	0	7	0	0.00	510.34

10	1.00	0	10	0	12	80.08	484.38
11	1.00	5	32	0	39	63.95	492.94
12	1.00	0	0	1	0	0.00	498.24
13	1.00	6	0	16	0	0.00	510.94
14	1.00	0	0	0	0	0.00	495.87
15	1.00	0	0	0	0	0.00	503.47
16	1.00	5	0	15	0	0.00	471.27
Missing vial 17.							
Missing vial 18.							
19	1.00	5	0	12	0	0.00	546.51
20	1.00	1984	3819	3476	4468	59.47	485.28

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 13.05 Date Processed: 2/12/2014 8:11:07 AM
14C Chi Square: 24.43 Date Processed: 2/12/2014 8:11:07 AM
3H E^2/B (1-18.6 keV): 399.97 Date Processed: 2/12/2014 8:11:07 AM
14C E^2/B (4-156 keV): 748.78 Date Processed: 2/12/2014 8:11:07 AM
3H Efficiency (0-18.6 keV): 63.82 Date Processed: 2/12/2014 8:11:07 AM
14C Efficiency (0-156 keV): 96.32 Date Processed: 2/12/2014 8:11:07 AM
IPA Background Date Processed: 2/12/2014 8:11:07 AM
3H Background CPM (0-18.6 keV): 10.30 Date Processed: 2/12/2014 8:11:07 AM
14C Background CPM (0-156 keV): 14.85 Date Processed: 2/12/2014 8:11:07 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 11.84 Date Processed: 2/14/2014 9:29:21 AM
14C Chi Square: 23.73 Date Processed: 2/14/2014 9:29:21 AM
3H E^2/B (1-18.6 keV): 363.71 Date Processed: 2/14/2014 9:29:21 AM
14C E^2/B (4-156 keV): 694.29 Date Processed: 2/14/2014 9:29:21 AM
3H Efficiency (0-18.6 keV): 63.77 Date Processed: 2/14/2014 9:29:21 AM
14C Efficiency (0-156 keV): 96.64 Date Processed: 2/14/2014 9:29:21 AM
IPA Background Date Processed: 2/14/2014 9:29:21 AM
3H Background CPM (0-18.6 keV): 11.43 Date Processed: 2/14/2014 9:29:21 AM
14C Background CPM (0-156 keV): 16.52 Date Processed: 2/14/2014 9:29:21 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040
Location: GMP Overhead surfaces	Surveyors: Gordon Robb
Survey Unit: SU2-B2GMPO	Shane Brungardt
	Survey Number: 020714-03
	Map ID: see attached

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys				Radiation Surveys
	α (Loose)	α (Total)	β (Loose)	β (Total)	γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY
☐ PROCEDURE NO. ________
☑ SPECIAL FSS/Characterization
☐ ROUTINE
Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐
Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: FSS and Characterization survey of overhead surfaces in GMP.

Date: 2/7/2013 Time Start: 1330 Time Complete: 1500 Page 1 of ~~8~~ 11

Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Fire Retardant	V14
3					Fire Retardant	V9
4					Fire Retardant	E14
5					Fire Retardant	E24
6					Fire Retardant	E33
7					Drywall	C33
8					Drywall	R33
9					Drywall	L23
10					Drywall	E28
11					Drywall	B25
12					Drywall	R16
13					Drywall	O11
14					Drywall	E19
15					Drywall	B14
16					Drywall	E4
17					Drywall	B6
18					Drywall	K6
19					Drywall	R7
20					Drywall	V4
21					Drywall	V4 - dup
22					Drywall	Z7
23					Drywall	S8
24					Drywall	Y10
25					Drywall	S11

RCS REVIEW ________ DATE ________

Contamination/Radiation Survey Report (Continuation Sheet)	Project Number: 144040	Date: 2/7/2013	Page 2 of 11

RCS Review: ____________	Location: GMP Overhead surfaces
Date: ____________	Survey Number: 020714-03
	Map ID: see attached

COMMENTS:

	Alpha		Beta		Alpha cpm ☐	
	Loose	Total	Loose	Total	Beta cpm ☐	Item or Location
Item #	dpm/100cm²	dpm/100cm²	dpm/100cm²	dpm/100cm²	Material ☑	
26	N/A	N/A	SADS	SADS	Drywall	Z12
27					Metal	S13
28					Drywall	Y14
29					Drywall	S15
30					Drywall	Z16
31					Metal	V21
32					Drywall	U21
33					Metal	R24
34					Drywall	O20
35					Drywall	O28
36					Drywall	O28 - dup
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						

N/A

	Alpha		Beta		Alpha cpm ☐	
	Loose	Total	Loose	Total	Beta cpm ☐	Item or Location
Item #	dpm/100cm²	dpm/100cm²	dpm/100cm²	dpm/100cm²	Material ☐	
51	N/A	N/A				
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						
75						

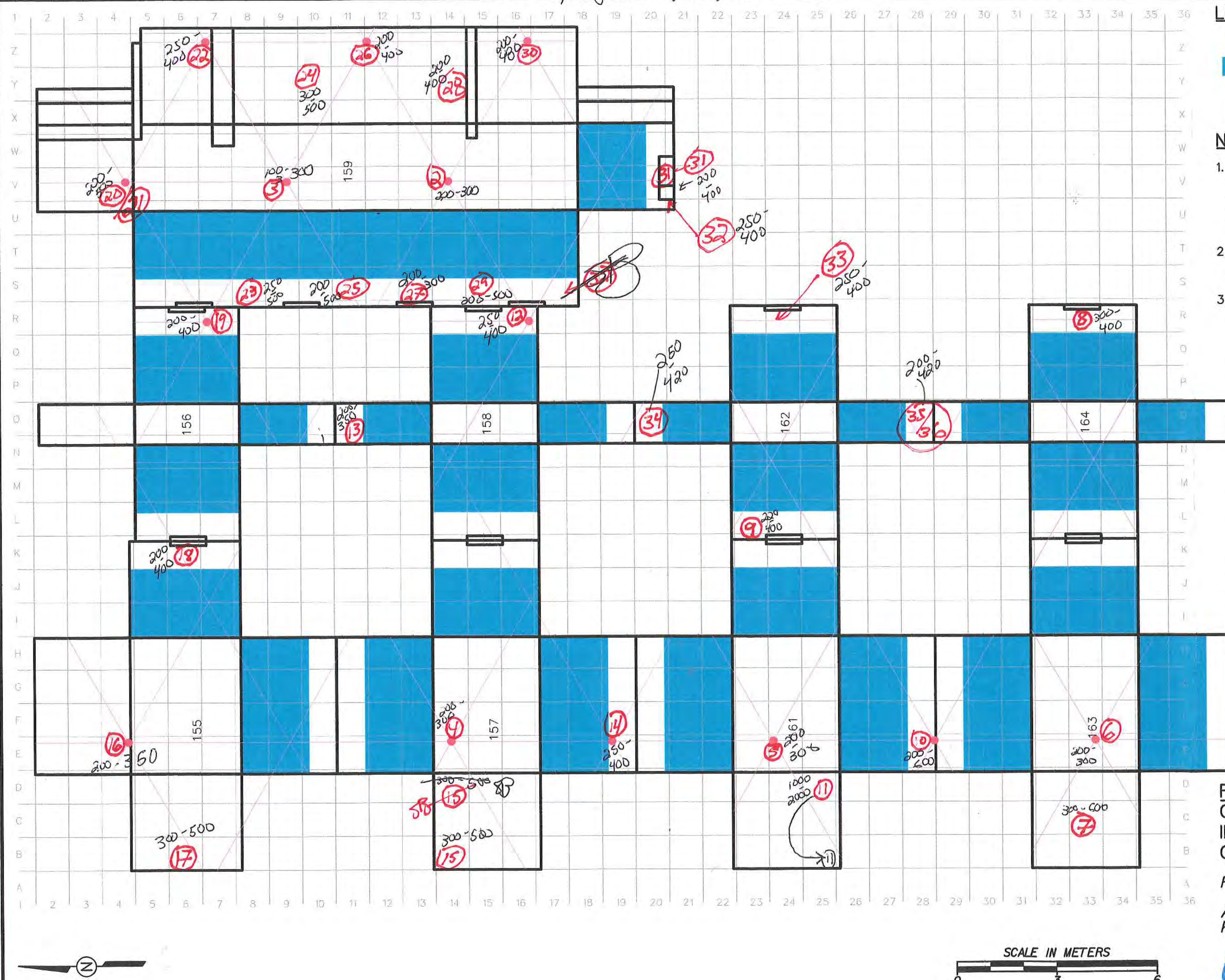
N/A

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
	LSC Background	1							
237279	V14	2	239	Fire Retardant	182.9	56.1	126	0.095	469
237279	V9	3	224	Fire Retardant	182.9	41.1	126	0.095	343
237279	E14	4	247	Fire Retardant	182.9	64.1	126	0.095	536
237279	E24	5	216	Fire Retardant	182.9	33.1	126	0.095	277
237279	E33	6	252	Fire Retardant	182.9	69.1	126	0.095	577
237279	C33	7	462	Drywall	216.1	245.9	126	0.095	2054
237279	R33	8	268	Drywall	216.1	51.9	126	0.095	434
237279	L23	9	298	Drywall	216.1	81.9	126	0.095	684
237279	E28	10	352	Drywall	216.1	135.9	126	0.095	1135
237279	B25	11	1779	Drywall	216.1	1562.9	126	0.095	13057
237279	R16	12	288	Drywall	216.1	71.9	126	0.095	601
237279	O11	13	284	Drywall	216.1	67.9	126	0.095	567
237279	E19	14	328	Drywall	216.1	111.9	126	0.095	935
237279	B14	15	287	Drywall	216.1	70.9	126	0.095	592
237279	E4	16	320	Drywall	216.1	103.9	126	0.095	868
237279	B6	17	400	Drywall	216.1	183.9	126	0.095	1536
237279	K6	18	252	Drywall	216.1	35.9	126	0.095	300
237279	R7	19	244	Drywall	216.1	27.9	126	0.095	233
237279	V4	20	346	Drywall	216.1	129.9	126	0.095	1085
237279	V4 - dup	21	329	Drywall	216.1	112.9	126	0.095	943
237279	Z7	22	293	Drywall	216.1	76.9	126	0.095	642
237279	S8	23	308	Drywall	216.1	91.9	126	0.095	768
237279	Y10	24	335	Drywall	216.1	118.9	126	0.095	993
237279	S11	25	289	Drywall	216.1	72.9	126	0.095	609
237279	Z12	26	350	Drywall	216.1	133.9	126	0.095	1119
237279	S13	27	284	Metal	208.2	75.8	126	0.095	633
237279	Y14	28	293	Drywall	216.1	76.9	126	0.095	642
237279	S15	29	355	Drywall	216.1	138.9	126	0.095	1160
237279	Z16	30	349	Drywall	216.1	132.9	126	0.095	1110
237279	V21	31	280	Metal	208.2	71.8	126	0.095	600
237279	U21	32	337	Drywall	216.1	120.9	126	0.095	1010
237279	R24	33	266	Metal	208.2	57.8	126	0.095	483

237279	O20	34	310	Drywall	216.1	93.9	126	0.095	784
237279	O28	35	294	Drywall	216.1	77.9	126	0.095	651
237279	O28 - dup	36	293	Drywall	216.1	76.9	126	0.095	642

N/A

Survey 020714-03 Instrument: 2360/4368
DW = Dry Wall
SCT = Spray Ceiling Texture
D = Duplicate PM = Painted Metal



LEGEND:

- SYSTEMATIC SAMPLE LOCATION
- INDICATES OPEN WALL SPACE ABOVE CEILING TILE

NOTES:

1. WALL SURFACE AREA: (ABOVE 2 M.) 181 SQ. M.

   CEILING SURFACE AREA: 102 SQ. M.

   TOTAL SURFACE AREA: 283 SQ. M.

2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 4.83 METERS.

3. CALCULATED AREA EXCLUDES OPEN WALL SPACE.

1) BKG 252
Gross Static Counts
2) 239 - SCT
3) 204 - SCT
4) 247 - SCT
5) 216 - SCT
6) 252 - SCT
7) 462 - DW
8) 268 - DW
9) 298 - DW
10) 352 - DW
11) 1779 - DW
12) 288 - DW
13) 284 - DW
14) 328 - DW
15) 287 - DW
16) 320 - DW
17) 400 - DW
18) 252 - DW
19) 244 - DW
20) 346 - DW
D 21) 329 - DW
22) 293 - DW
23) 308 - DW
24) 335 - DW
25) 289 - DW
26) 350 - DW
27) 284 - PM
28) 293 - DW
29) 355 - DW
30) 349 - DW
31) 280 - PM
32) 337 - DW
33) 266 - PM
34) 310 - DW
35) 294 - DW
D 36) 293 - DW

FIGURE X-X
CLASS 2 SAMPLING LOCATIONS IN B2-155 THROUGH B2-164 OVERHEAD SU2-B2GMPO

FINAL STATUS SURVEY

APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 3 6

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

aptuit_opi_fssr_temp011.dgn sammccawley 2/6/2014 9:43:41 AM PDF_with_Levels.plt sei_textsub_only.tbl

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	14	1	63.93%	25
C-14	10	31	1	96.54%	23

Bias

$$relative \quad bias = \frac{measured \quad result \quad - expected \quad result}{expected \quad result}$$

	Spike	Result	Relative bias
H-3	4174	3794	-0.09104
C-14	4354	4331	-0.00528

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm)					
					H-3			C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
20	21	346	329	0.0503704	11	6	0.5882353	22	28	0.24
35	36	294	293	0.0034072	6	2	1	0	16	2

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

7-8

Assay Definition-

Assay Description:
020714-03 SU2 B2 GMP SYSTEMATIC, BIASED DUPE, BLANK AND SPIKE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140210_0925\20140210_0925.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	9	31	0	0	78.19	538.33
Missing vial 2.							
3	1.00	6	24	6	28	64.56	497.18
Missing vial 4.							
5	1.00	3	14	2	16	62.84	516.45
Missing vial 6.							
7	1.00	0	0	0	0	0.00	552.63
8	1.00	2102	3718	3794	4331	58.10	488.10

Assay Definition-

Assay Description:
020714-03 SU2-B2GMP ABOVE 6'

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140207_1525\20140207_1525.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	14	31	0	0	67.54	535.14
2	1.00	0	9	0	11	90.19	487.98
3	1.00	0	18	0	22	164.63	472.19
4	1.00	0	0	0	0	0.00	493.64
5	1.00	1	11	0	14	30.77	514.37
6	1.00	7	2	15	1	0.00	508.32
7	1.00	1	9	0	10	106.07	520.52
8	1.00	2	7	2	8	0.00	505.44
9	1.00	2	0	6	0	177.02	517.29

10	1.00	0	21	0	26	108.24	488.39
11	1.00	6	31	4	37	58.20	500.07
12	1.00	7	35	4	43	72.52	489.94
13	1.00	2	22	0	27	61.09	484.17
14	1.00	4	19	3	22	27.99	474.91
15	1.00	4	21	3	25	43.30	469.35
16	1.00	10	36	12	44	42.57	445.03
17	1.00	0	9	0	11	117.38	515.09
18	1.00	1	15	0	19	35.89	480.86
19	1.00	0	22	0	27	93.82	502.04
20	1.00	7	18	11	22	56.19	490.57
Missing vial 21.							
22	1.00	10	61	2	74	76.91	483.93
23	1.00	4	10	7	12	72.73	509.11
24	1.00	7	47	0	57	58.76	472.14
25	1.00	0	8	0	10	126.05	508.93
26	1.00	14	47	17	56	51.74	488.23
27	1.00	2	0	6	0	0.00	498.38
28	1.00	6	29	5	35	64.98	504.34
29	1.00	0	8	0	9	0.00	519.97
30	1.00	9	57	1	69	64.46	485.88
31	1.00	4	0	10	0	0.00	508.26
32	1.00	0	0	0	0	0.00	504.48
33	1.00	0	5	0	7	182.51	512.81
34	1.00	0	12	0	15	61.05	499.62
35	1.00	3	0	6	0	0.00	508.66
Missing vial 36.							
37	1.00	0	1	1	1	438.17	549.00
38	1.00	2024	3752	3587	4381	59.49	488.23

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 25.72 Date Processed: 2/7/2014 8:20:45 AM
14C Chi Square: 10.05 Date Processed: 2/7/2014 8:20:45 AM
3H E^2/B (1-18.6 keV): 386.11 Date Processed: 2/7/2014 8:20:45 AM
14C E^2/B (4-156 keV): 726.54 Date Processed: 2/7/2014 8:20:45 AM
3H Efficiency (0-18.6 keV): 63.93 Date Processed: 2/7/2014 8:20:45 AM
14C Efficiency (0-156 keV): 96.54 Date Processed: 2/7/2014 8:20:45 AM
IPA Background Date Processed: 2/7/2014 8:20:45 AM
3H Background CPM (0-18.6 keV): 10.70 Date Processed: 2/7/2014 8:20:45 AM
14C Background CPM (0-156 keV): 15.37 Date Processed: 2/7/2014 8:20:45 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 24.28 Date Processed: 2/10/2014 9:25:34 AM
14C Chi Square: 15.64 Date Processed: 2/10/2014 9:25:34 AM
3H E^2/B (1-18.6 keV): 374.20 Date Processed: 2/10/2014 9:25:34 AM
14C E^2/B (4-156 keV): 696.30 Date Processed: 2/10/2014 9:25:34 AM
3H Efficiency (0-18.6 keV): 63.99 Date Processed: 2/10/2014 9:25:34 AM
14C Efficiency (0-156 keV): 96.17 Date Processed: 2/10/2014 9:25:34 AM
IPA Background Date Processed: 2/10/2014 9:25:34 AM
3H Background CPM (0-18.6 keV): 11.03 Date Processed: 2/10/2014 9:25:34 AM
14C Background CPM (0-156 keV): 15.52 Date Processed: 2/10/2014 9:25:34 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040
Location: GMP	Surveyors: Gordon Robb
Survey Unit: SU1-B2GMP	Shane Brungardt
	Survey Number: 020714-02
	Map ID: see attached

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys				Radiation Surveys
	α (Loose)	α (Total)	β (Loose)	β (Total)	γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY					
	☐ PROCEDURE NO.				
	☑ SPECIAL	FSS			
	☐ ROUTINE				
Contamination	☐ By Shift	☐ Daily	☐ Weekly	☐ Monthly	☐
Radiation	☐ By Shift	☐ Daily	☐ Weekly	☐ Monthly	☐

COMMENTS: FSS of GMP

Date: 2/7/2014	Time Start: 1200		Time Complete: 1300		Page 1 of 8
	Alpha		Beta		Alpha cpm ☐ / Beta cpm ☐ / Material ☑	Item or Location
Item #	Loose dpm/100cm^2	Total dpm/100cm^2	Loose dpm/100cm^2	Total dpm/100cm^2		
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Drywall	T16
3					Drywall	P13
4					Drywall	T10
5					Drywall	P8
6					Drywall	T5
7					Metal	K5
8					Drywall	G2
9					Drywall	B5
10					Drywall	G8
11					Concrete Floor (bare)	G13
12					Drywall	K21
13					Concrete Floor (bare)	G18
14					Drywall	B21
15					Drywall	K26
16					Drywall	G23
17					Drywall	G29
18					Drywall	B26
19					Drywall	B26 - dup
20						
21						
22			N/A			
23						
24						
25						

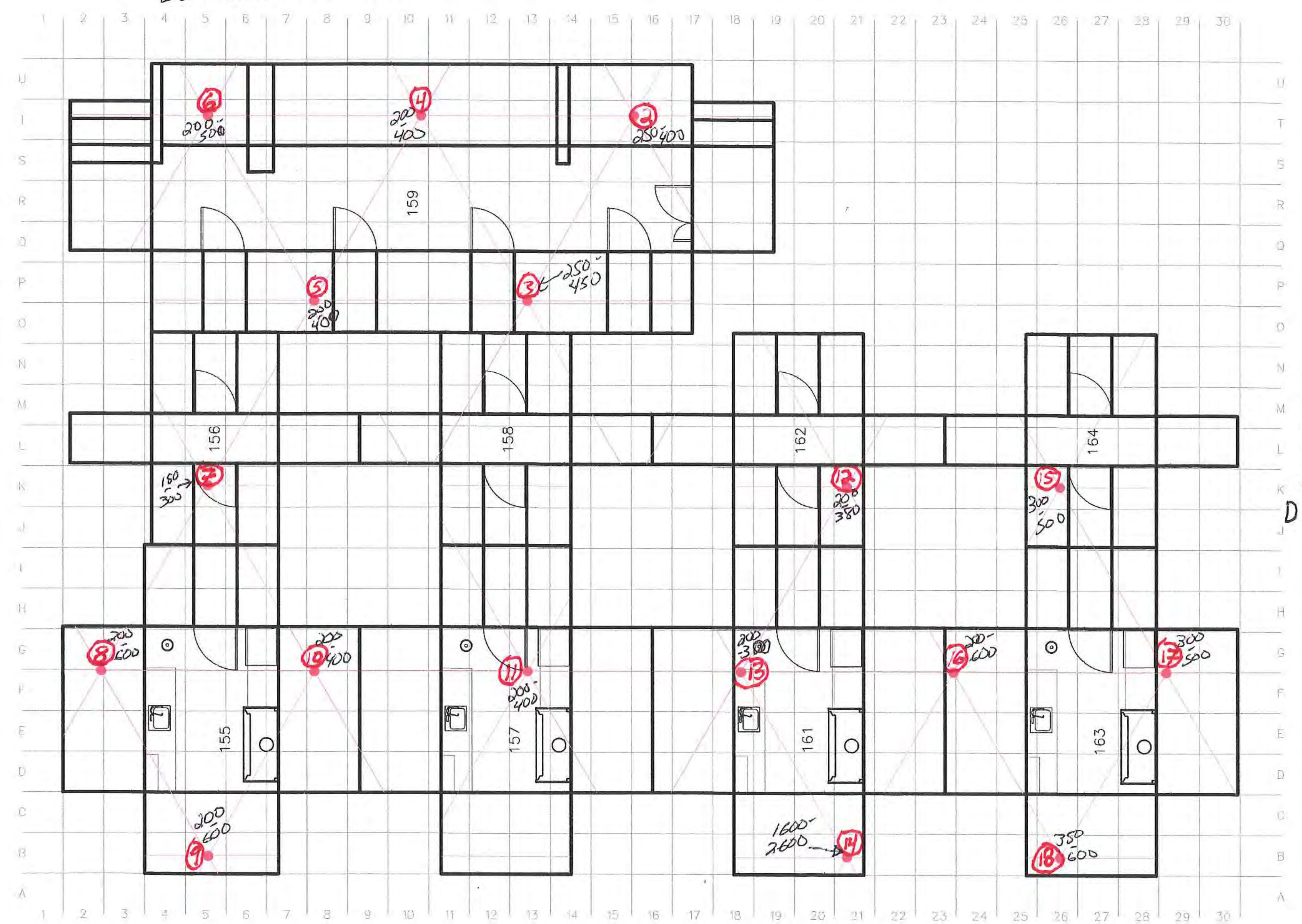
RCS REVIEW ______________________ DATE __________

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net $dpm/100cm^2$
	LSC Background	1							
237279	T16	2	354	Drywall	216.1	137.9	126	0.095	1152
237279	P13	3	363	Drywall	216.1	146.9	126	0.095	1227
237279	T10	4	251	Drywall	216.1	34.9	126	0.095	292
237279	P8	5	297	Drywall	216.1	80.9	126	0.095	676
237279	T5	6	304	Drywall	216.1	87.9	126	0.095	734
237279	K5	7	202	Metal	208.2	-6.2	126	0.095	-52
237279	G2	8	236	Drywall	216.1	19.9	126	0.095	166
237279	B5	9	462	Drywall	216.1	245.9	126	0.095	2054
237279	G8	10	249	Drywall	216.1	32.9	126	0.095	275
237279	G13	11	268	Concrete Floor (bare)	324.5	-56.5	126	0.095	-472
237279	K21	12	283	Drywall	216.1	66.9	126	0.095	559
237279	G18	13	295	Concrete Floor (bare)	324.5	-29.5	126	0.095	-246
237279	B21	14	1854	Drywall	216.1	1637.9	126	0.095	13683
237279	K26	15	439	Drywall	216.1	222.9	126	0.095	1862
237279	G23	16	571	Drywall	216.1	354.9	126	0.095	2965
237279	G29	17	331	Drywall	216.1	114.9	126	0.095	960
237279	B26	18	502	Drywall	216.1	285.9	126	0.095	2388
237279	B26 - dup	19	482	Drywall	216.1	265.9	126	0.095	2221

Survey 020714-02 SU1-B2GMP Systematics

Instrument 2360/4368
C: Concrete
DW = Dry Wall
~~PM = Painted Metal~~ SB
SS = Stainless Steel



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

1) BKG LSC
Gross Static Counts
2) 354-DW
3) 363-DW
4) 251-DW
5) 297-DW
6) 304-DW
7) 202-SS
8) 236-DW
9) 462-DW
10) 249-DW
11) 268-C
12) 283-DW
13) 295-C
14) 1854-DW
15) 439-DW
16) 571-DW
17) 331-DW
18) 502-DW
D 19) 482-DW

NOTES:

1. WALL SURFACE AREA: 232 SQ. M.
   FLOOR SURFACE AREA: 102 SQ. M.
   TOTAL SURFACE AREA: 334 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 5.25 METERS.

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS IN B2-155 THROUGH B2-164
SU1-B2GMP

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

SCALE IN METERS
0 3 6

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

aptuit_opi_fssr_temp003.dgn sammccowley 1/10/2014 3:26:48 PM PDF_with_Levels.plt sei_textsub_only.tbl

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}^{\,d}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	11	1	63.93%	23
C-14	10	32	1	96.54%	23

Bias

$$relative\quad bias = \frac{measured\quad result\quad - expected\quad result}{expected\quad result}$$

	Spike	Result	Relative bias
H-3	4174	3579	-0.14255
C-14	4354	4345	-0.00207

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm)					
					H-3			C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
18	19	502	482	0.0406504	0	0	0	0	17	2

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

5.f.X

Assay Definition-

Assay Description:
020714-02 SU1-B2GMP SYSTEMATIC DUPE AND SPIKE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140207_1338\20140207_1338.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	10	30	0	0	71.61	534.13
Missing vial 2.							
3	1.00	0	14	0	17	59.72	504.81
Missing vial 4.							
5	1.00	0	10	0	12	168.90	550.53
6	1.00	2011	3722	3579	4345	58.96	485.57

6 of 8
GB

Assay Definition-

Assay Description:
020714-02 SU1-B2GMP SYSTEMATIC DUPE AND SPIKE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140207_1400\20140207_1400.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	11	32	0	0	73.12	531.58
2	1.00	9	15	17	17	40.04	512.87
3	1.00	13	58	11	70	51.31	474.18
4	1.00	12	34	17	40	66.99	503.34
5	1.00	2	13	0	16	19.10	474.66
6	1.00	4	11	5	13	1.66	503.37
7	1.00	7	15	11	18	59.64	490.55
8	1.00	5	27	3	32	72.36	498.13
9	1.00	0	8	0	10	0.00	507.83

10	1.00	3	26	0	31	38.96	476.98
11	1.00	0	2	0	3	0.00	428.05
12	1.00	5	10	8	12	63.10	512.65
13	1.00	0	0	0	0	0.00	422.81
14	1.00	4	3	8	3	53.72	517.98
15	1.00	4	26	1	32	78.84	506.26
16	1.00	15	64	14	76	59.44	470.82
17	1.00	5	17	5	20	45.33	490.13
18	1.00	0	0	0	0	0.00	511.99
Missing vial 19.							
20	1.00	1	0	5	0	0.00	554.57
21	1.00	1998	3773	3513	4408	59.44	488.80

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 25.72 Date Processed: 2/7/2014 8:20:45 AM
14C Chi Square: 10.05 Date Processed: 2/7/2014 8:20:45 AM
3H E^2/B (1-18.6 keV): 386.11 Date Processed: 2/7/2014 8:20:45 AM
14C E^2/B (4-156 keV): 726.54 Date Processed: 2/7/2014 8:20:45 AM
3H Efficiency (0-18.6 keV): 63.93 Date Processed: 2/7/2014 8:20:45 AM
14C Efficiency (0-156 keV): 96.54 Date Processed: 2/7/2014 8:20:45 AM
IPA Background Date Processed: 2/7/2014 8:20:45 AM
3H Background CPM (0-18.6 keV): 10.70 Date Processed: 2/7/2014 8:20:45 AM
14C Background CPM (0-156 keV): 15.37 Date Processed: 2/7/2014 8:20:45 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040
Location: GMP	Surveyors: Gordon Robb, Shane Brungardt
Survey Unit: SU1-B2GMP	
	Survey Number: 020714-01
	Map ID: see attached

Date: 2/7/2014 Time Start: 0830 Time Complete: 1100 Page 1 of ~~9~~ 10

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys α (Loose)	α (Total)	β (Loose)	β (Total)	Radiation Surveys γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm²)				615	
Background (cpm)				230	

REASON FOR SURVEY
☐ PROCEDURE NO.
☑ SPECIAL Characterization
☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐
Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Characterization survey of GMP (floor statics only)

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Concrete Floor (bare)	Q15
3					Concrete Floor (bare)	R13
4					Concrete Floor (bare)	Q11
5					Concrete Floor (bare)	R9
6					Concrete Floor (bare)	S8
7					Concrete Floor (bare)	R5
8					Concrete Floor (bare)	S4
9					Concrete Floor (bare)	Q7
10					Concrete Floor (bare)	S10
11					Concrete Floor (bare)	Q14
12					Concrete Floor (bare)	S15
13					Concrete Floor (bare)	R17
14					Concrete Floor (bare)	L26
15					Concrete Floor (bare)	G28
16					Concrete Floor (bare)	G27
17					Concrete Floor (bare)	D27
18					Concrete Floor (bare)	F26
19					Concrete Floor (bare)	G25
20					Concrete Floor (bare)	L20
21					Concrete Floor (bare)	L20 - dup
22					Concrete Floor (bare)	F20
23					Concrete Floor (bare)	D20
24					Concrete Floor (bare)	E20
25					Concrete Floor (bare)	D18

RCS REVIEW [signature] DATE 02/07/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Contamination/Radiation Survey Report (Continuation Sheet)	Project Number: 144040	Date: 2/7/2014	Page 2 of ~~8~~ 10
RCS Review: [signature]	Location: GMP	COMMENTS:	
Date: 02/07/14	Survey Number: 020714-01		
	Map ID: see attached		

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
26	N/A	N/A	SADS	SADS	Concrete Floor (bare)	G19
27					Concrete Floor (bare)	L11
28					Concrete Floor (bare)	D12
29					Concrete Floor (bare)	E12
30					Concrete Floor (bare)	F11
31					Concrete Floor (bare)	G13
32					Concrete Floor (bare)	L6
33					Concrete Floor (bare)	D6
34					Concrete Floor (bare)	D4
35					Concrete Floor (bare)	G5
36					Concrete Floor (bare)	G5 - dup
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						

N/A

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☐	Item or Location
51	N/A	N/A				
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						
75						

N/A

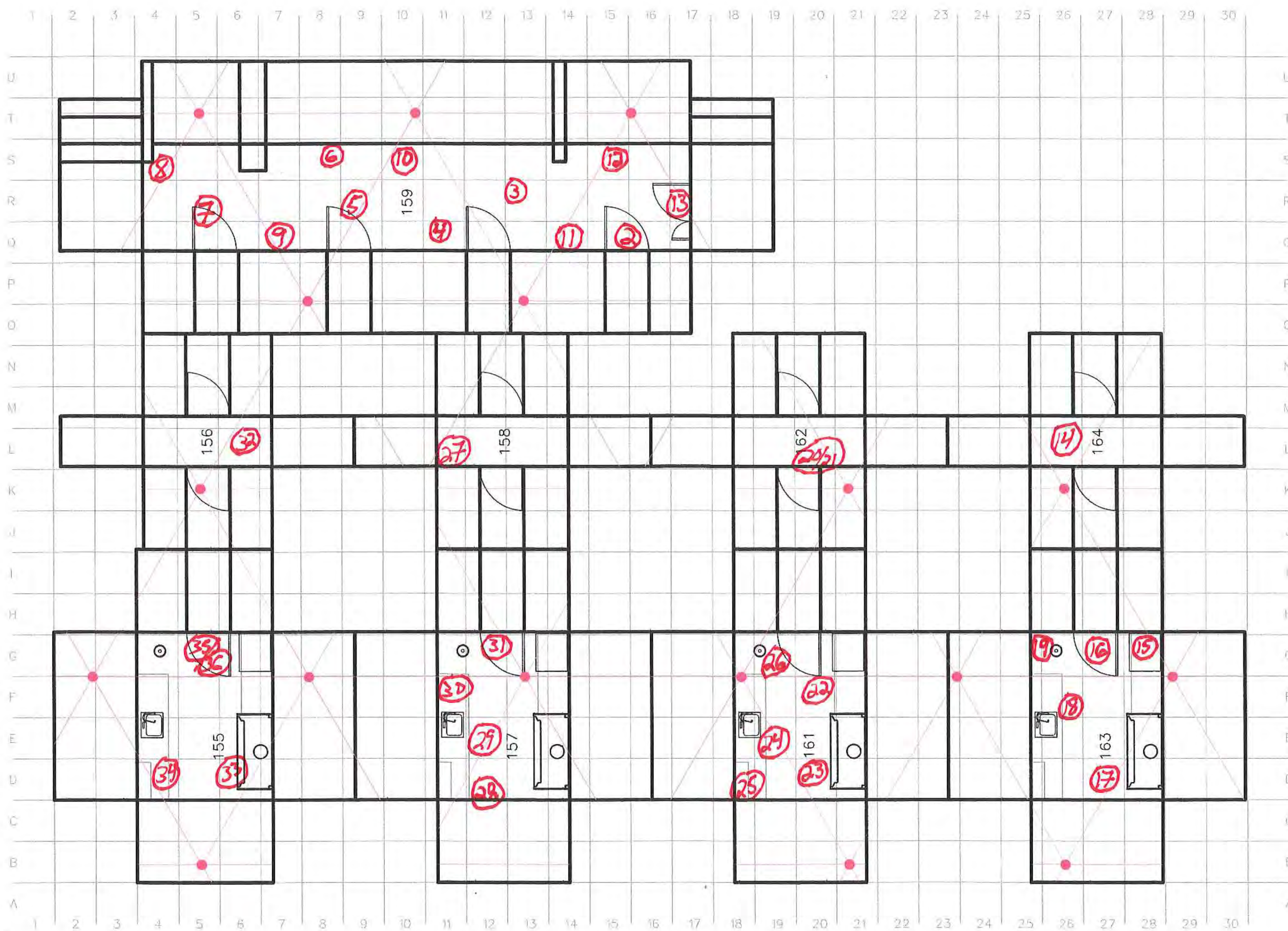
Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
	LSC Background	1							
237279	Q15	2	1789	Concrete Floor (bare)	324.5	1464.5	126	0.095	12235
237279	R13	3	238	Concrete Floor (bare)	324.5	-86.5	126	0.095	-723
237279	Q11	4	290	Concrete Floor (bare)	324.5	-34.5	126	0.095	-288
237279	R9	5	288	Concrete Floor (bare)	324.5	-36.5	126	0.095	-305
237279	S8	6	2003	Concrete Floor (bare)	324.5	1678.5	126	0.095	14023
237279	R5	7	236	Concrete Floor (bare)	324.5	-88.5	126	0.095	-739
237279	S4	8	224	Concrete Floor (bare)	324.5	-100.5	126	0.095	-840
237279	Q7	9	291	Concrete Floor (bare)	324.5	-33.5	126	0.095	-280
237279	S10	10	308	Concrete Floor (bare)	324.5	-16.5	126	0.095	-138
237279	Q14	11	253	Concrete Floor (bare)	324.5	-71.5	126	0.095	-597
237279	S15	12	244	Concrete Floor (bare)	324.5	-80.5	126	0.095	-673
237279	R17	13	269	Concrete Floor (bare)	324.5	-55.5	126	0.095	-464
237279	L26	14	252	Concrete Floor (bare)	324.5	-72.5	126	0.095	-606
237279	G28	15	284	Concrete Floor (bare)	324.5	-40.5	126	0.095	-338
237279	G27	16	423	Concrete Floor (bare)	324.5	98.5	126	0.095	823
237279	D27	17	297	Concrete Floor (bare)	324.5	-27.5	126	0.095	-230
237279	F26	18	272	Concrete Floor (bare)	324.5	-52.5	126	0.095	-439
237279	G25	19	273	Concrete Floor (bare)	324.5	-51.5	126	0.095	-430
237279	L20	20	256	Concrete Floor (bare)	324.5	-68.5	126	0.095	-572
237279	L20 - dup	21	240	Concrete Floor (bare)	324.5	-84.5	126	0.095	-706
237279	F20	22	256	Concrete Floor (bare)	324.5	-68.5	126	0.095	-572
237279	D20	23	348	Concrete Floor (bare)	324.5	23.5	126	0.095	196
237279	E20	24	290	Concrete Floor (bare)	324.5	-34.5	126	0.095	-288
237279	D18	25	274	Concrete Floor (bare)	324.5	-50.5	126	0.095	-422
237279	G19	26	283	Concrete Floor (bare)	324.5	-41.5	126	0.095	-347
237279	L11	27	255	Concrete Floor (bare)	324.5	-69.5	126	0.095	-581
237279	D12	28	2332	Concrete Floor (bare)	324.5	2007.5	126	0.095	16771
237279	E12	29	297	Concrete Floor (bare)	324.5	-27.5	126	0.095	-230
237279	F11	30	295	Concrete Floor (bare)	324.5	-29.5	126	0.095	-246
237279	G13	31	251	Concrete Floor (bare)	324.5	-73.5	126	0.095	-614
237279	L6	32	274	Concrete Floor (bare)	324.5	-50.5	126	0.095	-422
237279	D6	33	292	Concrete Floor (bare)	324.5	-32.5	126	0.095	-272

237279	D4	34	288	Concrete Floor (bare)	324.5	-36.5	126	0.095	-305
237279	G5	35	299	Concrete Floor (bare)	324.5	-25.5	126	0.095	-213
237279	G5 - dup	36	313	Concrete Floor (bare)	324.5	-11.5	126	0.095	-96
				N/A					

Survey # 020714-01 SU1-B2GMP Characterization Part 2 (Floors)(Concrete)

Instrument - 2360/4368

D = Duplicate



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

1) LSC BKG

Gross Static Counts

2) 1789
3) 238
4) 290
5) 288
6) 2003
7) 236
8) 224
9) 291
10) 308
11) 253
12) 244
13) 269
14) 252
15) 284
16) 423
17) 297
18) 272
19) 273
20) 256
D 21) 240
22) 256
23) 348
24) 290
25) 274
26) 283
27) 255
28) 2332
29) 297
30) 295
31) 251
32) 274
33) 292
34) 288
35) 299
D 36) 313

NOTES:

1. WALL SURFACE AREA: 232 SQ. M.
   FLOOR SURFACE AREA: 102 SQ. M.
   TOTAL SURFACE AREA: 334 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 5.25 METERS.

SCALE IN METERS

0 3 6

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS IN B2-155 THROUGH B2-164 SU1-B2GMP

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

aptuit_api_fssr_temp003.dgn sammccowley 1/10/2014 3:26:48 PM PDF_with_Levels.plt sei_textsub_only.tbl

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	11	1	63.93%	23
C-14	10	31	1	96.54%	23

Bias

$$relative \quad bias = \frac{measured \quad result \quad - expected \quad result}{expected \quad result}$$

	Spike	Result	Relative bias
H-3	4174	3567	-0.14542
C-14	4354	4290	-0.0147

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm) H-3			Smears (dpm) C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
20	21	256	240	0.0645161	0	0	0	0	5	2
35	36	299	313	0.0457516	6	3	0.6666667	20	17	0.1621622

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

Assay Definition-

Assay Description:
020714-01 SU1-B2GMP CHARACTERIZATION SPIKE AND DUPE PART 2

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140207_1041\20140207_1041.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	12	31	0	0	75.62	534.29
Missing vial 2.							
3	1.00	0	4	0	5	0.00	402.71
Missing vial 4.							
5	1.00	3	14	3	17	12.64	429.72
Missing vial 6.							
7	1.00	7	10	12	11	32.34	552.26
8	1.00	2001	3676	3567	4290	57.81	486.60

B of 9
65

Assay Definition-

Assay Description:
020714-01 SU1-B2GMP CHARACTERIZATION PART 2

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140207_1107\20140207_1107.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	11	31	0	0	67.62	535.78
2	1.00	0	8	0	9	95.46	499.91
3	1.00	0	0	0	0	0.00	460.48
4	1.00	5	8	9	10	48.50	454.45
5	1.00	0	8	0	10	67.85	450.75
6	1.00	1	6	0	7	51.13	448.29
7	1.00	0	6	0	7	0.00	432.24
8	1.00	0	2	0	3	0.00	474.61
9	1.00	0	7	0	9	0.00	448.98

10	1.00	7	8	15	9	21.08	465.73
11	1.00	0	0	0	0	0.00	452.17
12	1.00	1	4	0	5	9.72	464.61
13	1.00	0	4	0	6	0.00	465.80
14	1.00	0	6	0	8	22.01	466.68
15	1.00	5	9	8	11	37.83	482.06
16	1.00	0	16	0	20	68.28	487.03
17	1.00	2	10	2	12	66.41	483.17
18	1.00	2	10	0	12	9.32	446.89
19	1.00	16	20	38	23	21.67	390.74
20	1.00	0	0	0	0	0.00	398.19
Missing vial 21.							
22	1.00	0	2	0	3	0.00	426.20
23	1.00	3	4	5	5	0.00	487.37
24	1.00	0	10	0	12	63.36	469.88
25	1.00	11	8	24	9	26.82	464.49
26	1.00	2	5	2	6	0.00	429.19
27	1.00	0	13	0	16	76.95	435.66
28	1.00	107	427	106	513	61.61	479.41
29	1.00	1	22	0	27	44.22	433.60
30	1.00	0	21	0	26	50.98	429.61
31	1.00	1	5	0	6	0.00	408.00
32	1.00	0	9	0	11	35.01	455.16
33	1.00	5	12	9	15	43.39	432.82
34	1.00	7	0	17	0	0.00	473.79
35	1.00	5	17	6	20	80.91	428.10

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 25.72 Date Processed: 2/7/2014 8:20:45 AM
14C Chi Square: 10.05 Date Processed: 2/7/2014 8:20:45 AM
3H E^2/B (1-18.6 keV): 386.11 Date Processed: 2/7/2014 8:20:45 AM
14C E^2/B (4-156 keV): 726.54 Date Processed: 2/7/2014 8:20:45 AM
3H Efficiency (0-18.6 keV): 63.93 Date Processed: 2/7/2014 8:20:45 AM
14C Efficiency (0-156 keV): 96.54 Date Processed: 2/7/2014 8:20:45 AM
IPA Background Date Processed: 2/7/2014 8:20:45 AM
3H Background CPM (0-18.6 keV): 10.70 Date Processed: 2/7/2014 8:20:45 AM
14C Background CPM (0-156 keV): 15.37 Date Processed: 2/7/2014 8:20:45 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040	Date: 2/6/2014	Time Start: 0900	Time Complete: 1500	Page 1 of ~~8~~ 14
Location: GMP	Surveyors: Gordon Robb				
Survey Unit: SU1-B2GMP	Shane Brungardt				
	Survey Number: 020614-01				
	Map ID: see attached				

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys				Radiation Surveys
	α (Loose)	α (Total)	β (Loose)	β (Total)	γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY

☐ PROCEDURE NO. ____

☑ SPECIAL Characterization

☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Characterization survey of GMP. Floor monitor used for floor scans (2360 SN# 227437 /43-37 SN# PR216990 /Eff: 0.07 / MDC: 291 /Bkg: 617), handheld (43-68) used for all other scans and all statics.

Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Drywall	S18
3					Metal	Q18
4					Drywall	U15
5					Drywall	T16
6					Glass	U12
7					Drywall	T11
8					Drywall	U10
9					Drywall	T8
10					Drywall	U7
11					Drywall	U6
12					Drywall	T5
13					Drywall	Q2
14					Drywall	S3
15					Drywall	P16
16					Drywall	P15
17					Drywall	P13
18					Metal	P12
19					Drywall	O10
20					Glass	O9
21					Glass	O9 - duplicate
22					Metal	P9
23					Drywall	O7
24					Drywall	P5
25					Metal	J5

RCS REVIEW [signature] DATE 02/08/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Contamination/Radiation Survey Report (Continuation Sheet)	Project Number: 144040	Date: 2/6/2014	Page 2 of ~~13~~ 14
RCS Review:	Location: GMP	COMMENTS:	
Date: 02/08/14	Survey Number: 020614-01		
	Map ID: see attached		

Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ Beta cpm ☐ Material ☐	Item or Location
26	N/A	N/A	SADS	SADS	Metal	N5
27					Drywall	M6
28					Drywall	L7
29					Drywall	L2
30					Drywall	G3
31					Glass	G2
32					Drywall	D2
33					Drywall	B4
34					Drywall	B6
35					Drywall	D8
36					Drywall	F7
37					Drywall	G9
38					Metal	I5
39					Metal	J12
40					Drywall	N13
41					Drywall	N13 - duplicate
42					Drywall	L15
43					Drywall	J13
44					Drywall	L10
45					Drywall	G10
46					Metal	I12
47					Glass	F9
48					Drywall	D9
49					Drywall	B13
50					Drywall	D15

Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
51	N/A	N/A	SADS	SADS	Drywall	E16
52					Metal	N20
53					Drywall	K19
54					Drywall	L17
55					Drywall	L22
56					Drywall	H19
57					Drywall	I21
58					Drywall	E22
59					Drywall	D22
60					Drywall	B20
61					Drywall	B20 - duplicate
62					Drywall	B19
63					Drywall	E17
64					Glass	F16
65					Drywall	K26
66					Drywall	L24
67					Drywall	N26
68					Drywall	L30
69					Drywall	I26
70					Drywall	H28
71					Drywall	F29
72					Drywall	D29
73					Drywall	C28
74					Drywall	B26
75					Drywall	D24

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
	LSC Background	1							
237279	S18	2	298	Drywall	216.1	81.9	126	0.095	684
237279	Q18	3	1397	Metal	208.2	1188.8	126	0.095	9931
237279	U15	4	418	Drywall	216.1	201.9	126	0.095	1687
237279	T16	5	303	Drywall	216.1	86.9	126	0.095	726
237279	U12	6	224	Glass	265.6	-41.6	126	0.095	-348
237279	T11	7	288	Drywall	216.1	71.9	126	0.095	601
237279	U10	8	1987	Drywall	216.1	1770.9	126	0.095	14794
237279	T8	9	304	Drywall	216.1	87.9	126	0.095	734
237279	U7	10	269	Drywall	216.1	52.9	126	0.095	442
237279	U6	11	253	Drywall	216.1	36.9	126	0.095	308
237279	T5	12	308	Drywall	216.1	91.9	126	0.095	768
237279	Q2	13	307	Drywall	216.1	90.9	126	0.095	759
237279	S3	14	322	Drywall	216.1	105.9	126	0.095	885
237279	P16	15	309	Drywall	216.1	92.9	126	0.095	776
237279	P15	16	1064	Drywall	216.1	847.9	126	0.095	7084
237279	P13	17	299	Drywall	216.1	82.9	126	0.095	693
237279	P12	18	267	Metal	208.2	58.8	126	0.095	491
237279	O10	19	312	Drywall	216.1	95.9	126	0.095	801
237279	O9	20	212	Glass	265.6	-53.6	126	0.095	-448
237279	O9 - duplicate	21	232	Glass	265.6	-33.6	126	0.095	-281
237279	P9	22	256	Metal	208.2	47.8	126	0.095	399
237279	O7	23	313	Drywall	216.1	96.9	126	0.095	810
237279	P5	24	290	Drywall	216.1	73.9	126	0.095	617
237279	J5	25	1478	Metal	208.2	1269.8	126	0.095	10608
237279	N5	26	996	Metal	208.2	787.8	126	0.095	6581
237279	M6	27	2354	Drywall	216.1	2137.9	126	0.095	17860
237279	L7	28	274	Drywall	216.1	57.9	126	0.095	484
237279	L2	29	262	Drywall	216.1	45.9	126	0.095	383
237279	G3	30	2833	Drywall	216.1	2616.9	126	0.095	21862
237279	G2	31	272	Glass	265.6	6.4	126	0.095	53
237279	D2	32	1448	Drywall	216.1	1231.9	126	0.095	10292
237279	B4	33	402	Drywall	216.1	185.9	126	0.095	1553

237279	B6	34	341	Drywall	216.1	124.9	126	0.095	1043
237279	D8	35	275	Drywall	216.1	58.9	126	0.095	492
237279	F7	36	304	Drywall	216.1	87.9	126	0.095	734
237279	G9	37	336	Drywall	216.1	119.9	126	0.095	1002
237279	I5	38	405	Metal	208.2	196.8	126	0.095	1644
237279	J12	39	955	Metal	208.2	746.8	126	0.095	6239
237279	N13	40	627	Drywall	216.1	410.9	126	0.095	3433
237279	N13 - duplicate	41	656	Drywall	216.1	439.9	126	0.095	3675
237279	L15	42	256	Drywall	216.1	39.9	126	0.095	333
237279	J13	43	332	Drywall	216.1	115.9	126	0.095	968
237279	L10	44	314	Drywall	216.1	97.9	126	0.095	818
237279	G10	45	368	Drywall	216.1	151.9	126	0.095	1269
237279	I12	46	304	Metal	208.2	95.8	126	0.095	800
237279	F9	47	298	Glass	265.6	32.4	126	0.095	271
237279	D9	48	371	Drywall	216.1	154.9	126	0.095	1294
237279	B13	49	263	Drywall	216.1	46.9	126	0.095	392
237279	D15	50	320	Drywall	216.1	103.9	126	0.095	868
237279	E16	51	352	Drywall	216.1	135.9	126	0.095	1135
237279	N20	52	565	Metal	208.2	356.8	126	0.095	2981
237279	K19	53	911	Drywall	216.1	694.9	126	0.095	5805
237279	L17	54	310	Drywall	216.1	93.9	126	0.095	784
237279	L22	55	364	Drywall	216.1	147.9	126	0.095	1236
237279	H19	56	1112	Drywall	216.1	895.9	126	0.095	7485
237279	I21	57	699	Drywall	216.1	482.9	126	0.095	4034
237279	E22	58	270	Drywall	216.1	53.9	126	0.095	450
237279	D22	59	1138	Drywall	216.1	921.9	126	0.095	7702
237279	B20	60	2794	Drywall	216.1	2577.9	126	0.095	21536
237279	B20 - duplicate	61	2783	Drywall	216.1	2566.9	126	0.095	21444
237279	B19	62	712	Drywall	216.1	495.9	126	0.095	4143
237279	E17	63	736	Drywall	216.1	519.9	126	0.095	4343
237279	F16	64	241	Glass	265.6	-24.6	126	0.095	-206
237279	K26	65	1042	Drywall	216.1	825.9	126	0.095	6900
237279	L24	66	428	Drywall	216.1	211.9	126	0.095	1770
237279	N26	67	1742	Drywall	216.1	1525.9	126	0.095	12748
237279	L30	68	344	Drywall	216.1	127.9	126	0.095	1069

237279	I26	69	700	Drywall	216.1	483.9	126	0.095	4043
237279	H28	70	555	Drywall	216.1	338.9	126	0.095	2831
237279	F29	71	2317	Drywall	216.1	2100.9	126	0.095	17551
237279	D29	72	1227	Drywall	216.1	1010.9	126	0.095	8445
237279	C28	73	606	Drywall	216.1	389.9	126	0.095	3257
237279	B26	74	542	Drywall	216.1	325.9	126	0.095	2723
237279	D24	75	515	Drywall	216.1	298.9	126	0.095	2497
237279	F24	76	1055	Drywall	216.1	838.9	126	0.095	7008

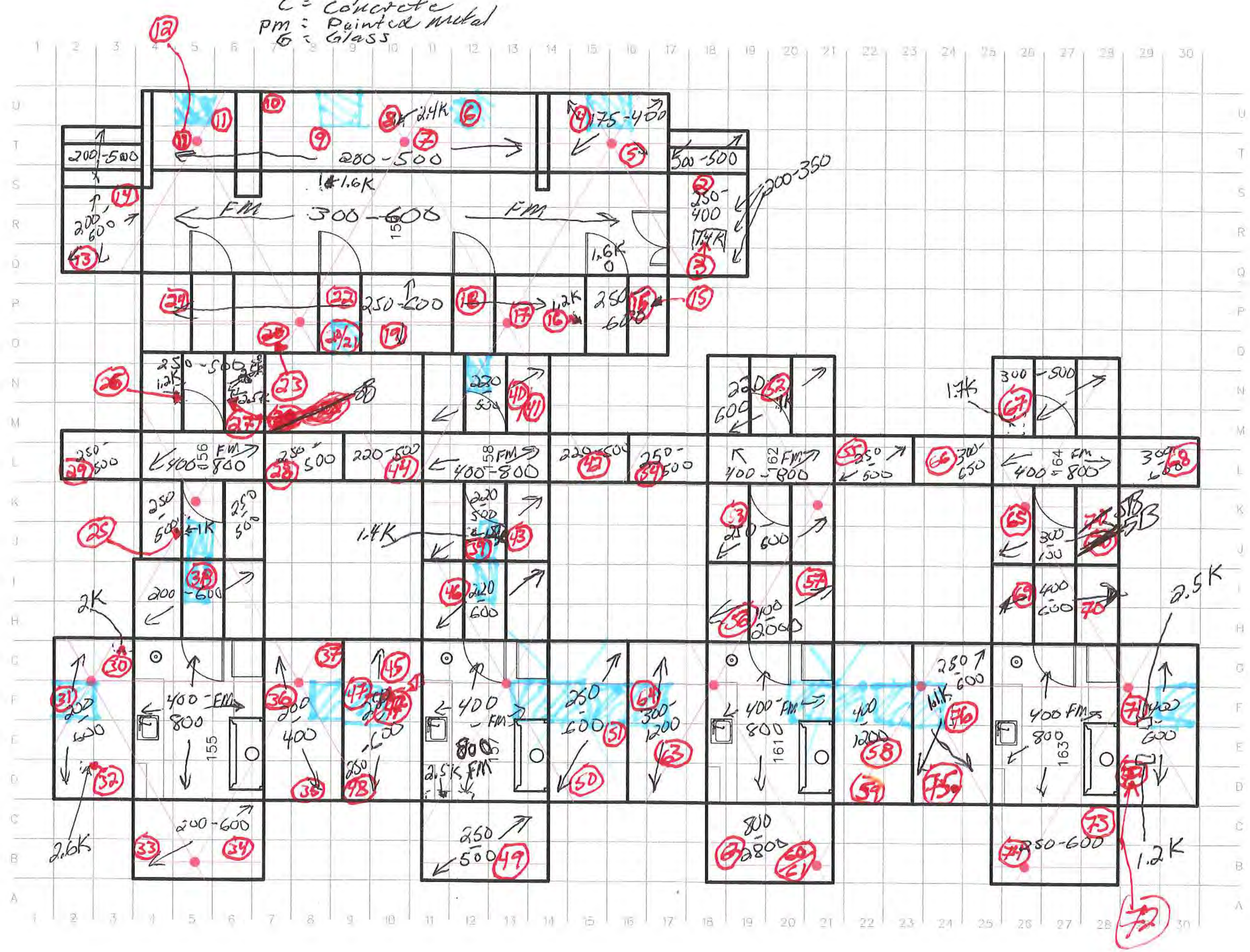
NA

Survey 020614-01 GMP Characterization Part 1

Instruments 2360/4368 Hand held
2360/4337 Floor Monitor

DW: Dry Wall
C = Concrete
PM: Painted Metal
G = Glass

D: Duplicate Static



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

1) LSC BRG

Gross Static Counts (2360/4368)

2) 298 DW
3) 1397 PM
4) 418 DW
5) 303 DW
6) 224 G
7) 288 DW
8) 1987 DW
9) 304 DW
10) 269 DW
11) 253 DW
12) 308 DW
13) 307 DW
14) 322 DW
15) 309 DW
16) 1064 DW
17) 299 DW
18) 267 PM
19) 312 DW
20) 212 G
D 21) 232 G
22) 256 PM
23) 313 DW
24) 290 DW
25) ~~996~~ 519 PM 1478
26) 996 PM
27) 2354 DW
28) 274 DW
29) 262 DW
30) 2833 DW
31) 272 G
32) 1448 DW
33) 402 DW
34) 341 DW
35) 275 DW
36) 304 DW
37) 336 DW
38) 405 PM
39) 955 pm
D 40) 627 DW
D 41) 656 DW
42) 256 DW
43) 332 DW
44) 314 DW
45) 368 DW
46) 304 PM
47) 298 G
48) 371 DW
49) 263 DW
50) 329 DW
51) 352 DW
52) 565 PM
53) 911 DW
54) 310 DW
55) 364 DW
56) 1112 DW
57) 699 DW
58) 270 DW
59) 1138 DW
60) 2794 DW
D 61) 2783 DW
62) 712 DW
63) 736 DW
64) 241 G
65) 1042 DW
66) 428 DW
67) 1742 DW
68) 354 DW
69) 700 DW
70) 555 DW
71) 2317 DW
72) 1227 DW
73) 606 DW
74) 542 DW
75) 515 DW
76) 1055 DW

NOTES:

1. WALL SURFACE AREA: 232 SQ. M.
   FLOOR SURFACE AREA: 102 SQ. M.
   TOTAL SURFACE AREA: 334 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 5.25 METERS.

SCALE IN METERS
0 3 6

FIGURE X-X
CLASS 1 SAMPLING LOCATIONS
IN B2-155 THROUGH B2-164
SU1-B2GMP

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}^{d}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	12	1	63.86%	23
C-14	10	31	1	96.31%	23

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

	Spike	Result	Relative bias
H-3	4174	3405	-0.18424
C-14	4354	4396	0.009646

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm) H-3			Smears (dpm) C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
20	21	212	232	0.0900901	10	0	2	12	40	1.0769231
40	41	627	656	0.0452065	49	22	0.7605634	285	296	0.0378657
60	61	2794	2783	0.0039448	2	0	2	49	38	0.2528736

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

Assay Definition-

Assay Description:
020614-01 SU1-B2GMP CHARACTERIZATION PART 1 DUPE AND SPIKE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140207_1309\20140207_1309.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	10	29	0	0	76.17	537.48
Missing vial 2.							
3	1.00	1	33	0	40	63.35	517.96
Missing vial 4.							
5	1.00	47	246	22	296	71.23	506.61
Missing vial 6.							
7	1.00	3	31	0	38	96.63	525.94
Missing vial 8.							
9	1.00	1	1	2	2	0.00	552.64

9-8-13/14

10	1.00	1951	3758	3405	4396	59.08	487.89

Assay Definition-

Assay Description:
020614-01 SU1-B2GMP CHEACTERIZATION PART 1

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140206_1617\20140206_1617.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	12	31	0	0	75.26	534.34
2	1.00	6	16	8	19	73.18	519.46
3	1.00	7	52	0	63	52.46	479.95
4	1.00	5	33	0	40	66.99	516.50
5	1.00	15	16	31	18	7.60	490.87
6	1.00	17	14	35	16	30.47	512.87
7	1.00	12	14	24	16	43.05	519.10
8	1.00	6	7	12	8	18.22	521.05
9	1.00	15	35	24	41	59.26	495.86

10	1.00	7	23	8	28	66.17	505.97
11	1.00	7	5	14	6	0.00	505.25
12	1.00	12	14	22	16	50.01	509.83
13	1.00	4	20	3	24	31.77	487.90
14	1.00	5	17	6	20	62.82	505.39
15	1.00	4	43	0	52	65.59	519.18
16	1.00	3	74	0	91	69.63	501.20
17	1.00	11	20	20	23	39.12	482.65
18	1.00	13	59	10	70	63.67	497.30
19	1.00	3	20	1	25	62.13	508.70
20	1.00	6	10	10	12	29.70	517.05
Missing vial 21.							
22	1.00	5	31	2	38	57.98	501.71
23	1.00	4	13	5	15	67.75	494.78
24	1.00	8	22	10	26	52.97	505.06
25	1.00	21	70	26	83	53.31	499.28
26	1.00	34	145	29	174	65.08	514.01
27	1.00	5	12	8	14	22.15	512.91
28	1.00	0	16	0	19	83.27	495.75
29	1.00	5	15	7	18	68.62	493.51
30	1.00	13	11	26	13	43.41	514.19
31	1.00	3	9	4	11	46.69	529.00
32	1.00	3	29	0	36	49.96	480.02
33	1.00	6	1	13	1	0.00	525.10
34	1.00	0	0	2	0	0.00	517.33
35	1.00	9	11	19	13	47.81	500.54
36	1.00	1	0	4	0	0.00	495.47
37	1.00	2	0	8	0	0.00	495.43
38	1.00	10	46	8	56	48.93	508.12
39	1.00	16	61	15	73	68.49	515.00
40	1.00	57	237	49	285	62.38	498.82
Missing vial 41.							
42	1.00	7	56	0	68	70.07	487.64
43	1.00	17	65	16	78	68.74	508.48
44	1.00	4	17	4	20	35.20	498.40
45	1.00	22	74	27	89	57.69	497.93
46	1.00	11	35	14	41	52.86	495.64
47	1.00	8	70	0	85	67.01	513.25
48	1.00	9	55	1	66	62.92	506.14
49	1.00	11	56	7	68	56.18	495.99
50	1.00	1	16	0	19	35.37	489.20
51	1.00	0	18	0	22	85.69	498.16
52	1.00	14	38	20	45	69.51	501.20
53	1.00	5	26	3	31	97.16	512.30
54	1.00	7	7	15	7	8.95	502.55
55	1.00	4	0	11	0	0.00	499.74
56	1.00	4	8	7	9	16.06	525.99
57	1.00	5	15	7	17	65.17	495.57
58	1.00	7	5	15	5	0.00	483.59
59	1.00	1	7	1	8	23.29	501.15
60	1.00	7	41	2	49	85.97	522.60
Missing vial 61.							
62	1.00	7	4	14	4	0.00	518.25
63	1.00	2	10	2	11	23.29	504.72
64	1.00	14	54	13	65	73.43	514.22
65	1.00	15	91	1	110	67.72	516.30
66	1.00	0	13	0	16	102.14	503.60
67	1.00	1	23	0	28	82.80	509.23
68	1.00	57	393	0	475	77.14	512.73
69	1.00	36	134	38	160	55.06	493.43
70	1.00	6	28	5	33	45.42	500.96
71	1.00	237	1131	157	1360	62.02	492.16
72	1.00	205	1009	128	1215	65.31	480.52

73	1.00	14	69	9	83	73.53	509.49
74	1.00	6	31	4	37	68.98	490.76
75	1.00	6	29	4	35	75.97	513.47
76	1.00	0	19	0	24	87.48	515.37
Missing vial 77.							
78	1.00	0	0	0	0	0.00	548.17
79	1.00	1982	3734	3498	4364	58.62	486.16

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 18.26 Date Processed: 2/6/2014 8:23:48 AM
14C Chi Square: 18.33 Date Processed: 2/6/2014 8:23:48 AM
3H E^2/B (1-18.6 keV): 388.97 Date Processed: 2/6/2014 8:23:48 AM
14C E^2/B (4-156 keV): 738.11 Date Processed: 2/6/2014 8:23:48 AM
3H Efficiency (0-18.6 keV): 63.86 Date Processed: 2/6/2014 8:23:48 AM
14C Efficiency (0-156 keV): 96.31 Date Processed: 2/6/2014 8:23:48 AM
IPA Background Date Processed: 2/6/2014 8:23:48 AM
3H Background CPM (0-18.6 keV): 10.65 Date Processed: 2/6/2014 8:23:48 AM
14C Background CPM (0-156 keV): 15.22 Date Processed: 2/6/2014 8:23:48 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 25.72 Date Processed: 2/7/2014 8:20:45 AM
14C Chi Square: 10.05 Date Processed: 2/7/2014 8:20:45 AM
3H E^2/B (1-18.6 keV): 386.11 Date Processed: 2/7/2014 8:20:45 AM
14C E^2/B (4-156 keV): 726.54 Date Processed: 2/7/2014 8:20:45 AM
3H Efficiency (0-18.6 keV): 63.93 Date Processed: 2/7/2014 8:20:45 AM
14C Efficiency (0-156 keV): 96.54 Date Processed: 2/7/2014 8:20:45 AM
IPA Background Date Processed: 2/7/2014 8:20:45 AM
3H Background CPM (0-18.6 keV): 10.70 Date Processed: 2/7/2014 8:20:45 AM
14C Background CPM (0-156 keV): 15.37 Date Processed: 2/7/2014 8:20:45 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040	Date: 2/13/2014	Time Start: 13:00	Time Complete: 14:00	Page 1 of 6

Location:	Room 103A and 112	Surveyors:	Gordon Robb
Survey Unit:	SU2-B2		Shane Brungardt
		Survey Number:	021314-01
		Map ID:	see attached
ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS	
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.	

Instrument Information	Contamination Surveys α (Loose)	α (Total)	β (Loose)	β (Total)	Radiation Surveys γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY
- ☐ PROCEDURE NO.
- ☑ SPECIAL Post-Decon
- ☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Post Decon survery of .areas in B2-103A and 112 identified in previous survey 021114-01

Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Drywall	E 7/8
3					Painted Concrete Floor	H5
4					Painted Concrete Floor	D5
5					Painted Concrete Floor	D6
6					Setup/Lab Floor (resin)	Painted Brick G8
7					Setup/Lab Floor (resin)	K10
8					Setup/Lab Floor (resin)	L9
9					Setup/Lab Floor (resin)	L10
10					Concrete Floor (bare)	M9
11					Concrete Floor (bare)	M10
12					Concrete Floor (bare)	M11
13					Concrete Floor (bare)	M10
14					Concrete Floor (bare)	M9
15					Concrete Floor (bare)	M9
16					Setup/Lab Floor (resin)	N8
17					Setup/Lab Floor (resin)	Concrete Block J11
18					Setup/Lab Floor (resin)	Concrete Blo ck I12
19						
20						
21						
22					N/A	
23						
24						
25						

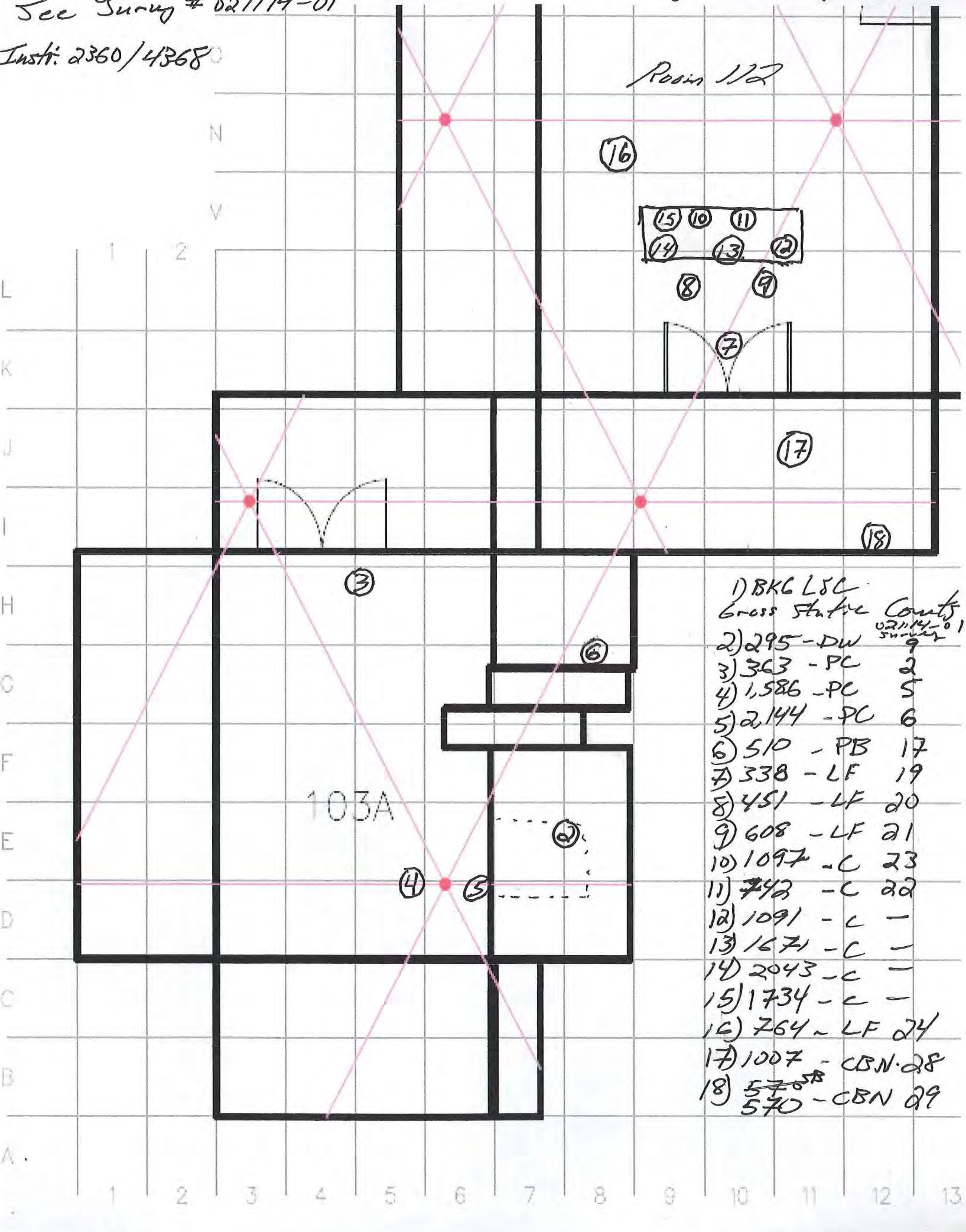
RCS REVIEW [signature] DATE 02/13/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Survey # 021314-01 SU2-B2 Post Decon Survey

See Survey # 021114-01

Inst: 2360/4368



1) BKG LSC
Gross Static Counts | 021114-01 Survey

2) 295 - DW 9
3) 363 - PC 2
4) 1,586 - PC 5
5) 2,144 - PC 6
6) 510 - PB 17
7) 338 - LF 19
8) 451 - LF 20
9) 608 - LF 21
10) 1097 - C 23
11) ~~742~~ - C 22
12) 1091 - C —
13) 1671 - C —
14) 2043 - C —
15) 1734 - C —
16) 764 - LF 24
17) 1007 - CBN 28
18) ~~570~~ 558 570 - CBN 29

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
	LSC Background	1							
237279	E 7/8	2	295	Drywall	216.1	78.9	126	0.095	659
237279	H5	3	363	Painted Concrete Floor	301.5	61.5	126	0.095	514
237279	D5	4	1586	Painted Concrete Floor	301.5	1284.5	126	0.095	10731
237279	D6	5	2144	Painted Concrete Floor	301.5	1842.5	126	0.095	15393
237279	Painted Brick G8	6	510	Setup/Lab Floor (resin)	230	280	126	0.095	2339
237279	K10	7	338	Setup/Lab Floor (resin)	230	108	126	0.095	902
237279	L9	8	451	Setup/Lab Floor (resin)	230	221	126	0.095	1846
237279	L10	9	608	Setup/Lab Floor (resin)	230	378	126	0.095	3158
237279	M9	10	1097	Concrete Floor (bare)	324.5	772.5	126	0.095	6454
237279	M10	11	742	Concrete Floor (bare)	324.5	417.5	126	0.095	3488
237279	M11	12	1091	Concrete Floor (bare)	324.5	766.5	126	0.095	6404
237279	M10	13	1671	Concrete Floor (bare)	324.5	1346.5	126	0.095	11249
237279	M9	14	2043	Concrete Floor (bare)	324.5	1718.5	126	0.095	14357
237279	M9	15	1734	Concrete Floor (bare)	324.5	1409.5	126	0.095	11775
237279	N8	16	764	Setup/Lab Floor (resin)	230	534	126	0.095	4461
237279	Concrete Block J1	17	1007	Setup/Lab Floor (resin)	230	777	126	0.095	6491
237279	Concrete Blo ck I1	18	570	Setup/Lab Floor (resin)	230	340	126	0.095	2840

Assay Definition-

Assay Description:
021314-01 POST DECON SU2-B2 SURVEY 021114-01

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140213_1427\20140213_1427.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	13	43	0	0	69.19	458.37
2	1.00	2	0	7	0	0.00	436.19
3	1.00	0	15	0	18	65.15	447.25
4	1.00	6	16	9	19	41.33	443.10
5	1.00	1	1	2	1	0.00	448.23
6	1.00	3	1	8	1	0.00	451.82
7	1.00	0	21	0	26	25.40	433.18
8	1.00	2	14	0	17	29.29	429.88
9	1.00	2	44	0	54	46.20	423.22

5 of 6

10	1.00	3	20	0	24	35.25	436.91
11	1.00	10	8	24	8	0.00	434.00
12	1.00	19	74	22	90	51.65	440.11
13	1.00	1	24	0	30	63.93	434.58
14	1.00	6	55	0	68	60.50	438.51
15	1.00	0	8	0	11	0.00	431.22
16	1.00	8	7	19	8	38.80	436.94
17	1.00	2	28	0	34	66.48	443.96
18	1.00	6	11	12	13	65.33	453.18

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 19.48 Date Processed: 2/13/2014 8:13:20 AM
14C Chi Square: 18.22 Date Processed: 2/13/2014 8:13:20 AM
3H E^2/B (1-18.6 keV): 378.15 Date Processed: 2/13/2014 8:13:20 AM
14C E^2/B (4-156 keV): 719.27 Date Processed: 2/13/2014 8:13:20 AM
3H Efficiency (0-18.6 keV): 63.92 Date Processed: 2/13/2014 8:13:20 AM
14C Efficiency (0-156 keV): 95.93 Date Processed: 2/13/2014 8:13:20 AM
IPA Background Date Processed: 2/13/2014 8:13:20 AM
3H Background CPM (0-18.6 keV): 10.88 Date Processed: 2/13/2014 8:13:20 AM
14C Background CPM (0-156 keV): 15.47 Date Processed: 2/13/2014 8:13:20 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040
Location: HEPA Room	Surveyors: Gordon Robb, Shane Brungardt
Survey Unit: SU2-B2	
	Survey Number: 021114-01
	Map ID: see attached

Date: 2/11/2014 Time Start: 0900 Time Complete: 1500 Page 1 of 70

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys α (Loose)	α (Total)	β (Loose)	β (Total)	Radiation Surveys γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY

- ☐ PROCEDURE NO.
- ☑ SPECIAL Characterization
- ☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Characterization of HEPA room. Floor monitor used for scans (2360 SN# 227437 /43-37 SN# PR216990 /Eff: 0.07 / MDC: 291 /Bkg: 617), handheld (43-68) used for statics.

Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Painted Concrete Floor	H4
3					Painted Concrete Floor	H3
4					Metal	G3
5					Painted Concrete Floor	D5
6					Painted Concrete Floor	D6
7					Painted Concrete Floor	E4
8					Painted Concrete Floor	H5
9					Drywall	E7
10					Painted Concrete Block	J5
11					Painted Concrete Block	G1
12					Metal	J4
13					Painted Concrete Block	F1
14					Painted Concrete Block	D2
15					Painted Concrete Block	B4
16					Drywall	D8
17					Painted Concrete Block	G8
18					Painted Concrete Block	G8-Dup
19					Setup/Lab Floor (resin)	K10
20					Setup/Lab Floor (resin)	L9
21					Setup/Lab Floor (resin)	L11
22					Concrete Floor (bare)	M10
23					Concrete Floor (bare)	M10
24					Setup/Lab Floor (resin)	N9
25					Setup/Lab Floor (resin)	P12

RCS REVIEW DATE 02/12/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Contamination/Radiation Survey Report (Continuation Sheet)		Project Number: 144040	Date: 2/11/2014	Page 2 of ~~10~~ 11
RCS Review: [signature]	Location: HEPA Room	COMMENTS: N/A		
Date: 02/12/14	Survey Number: 021114-01			
	Map ID: see attached			

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
26	N/A	N/A	SADS	SADS	Setup/Lab Floor (resin)	K12
27					Setup/Lab Floor (resin)	K8
28					Painted Concrete Block	J11
29					Painted Concrete Block	I12
30					Metal	J10
31					Painted Concrete Block	L6
32					Painted Concrete Block	O6
33					Metal	P14
34					Painted Concrete Block	L14
35					Painted Concrete Block	N14
36					Setup/Lab Floor (resin)	N10
37					Setup/Lab Floor (resin)	M12
38					Setup/Lab Floor (resin)	M12-Dup
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						

Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ Beta cpm ☐ Material ☐	Item or Location
51	N/A	N/A				
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						
75						

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net $dpm/100cm^2$
	LSC Background	1							
237279	H4	2	12627	Painted Concrete Floor	301.5	12326	126	0.095	102970
237279	H3	3	2158	Painted Concrete Floor	301.5	1856.5	126	0.095	15510
237279	G3	4	3178	Metal	208.2	2969.8	126	0.095	24810
237279	D5	5	5661	Painted Concrete Floor	301.5	5359.5	126	0.095	44774
237279	D6	6	3559	Painted Concrete Floor	301.5	3257.5	126	0.095	27214
237279	E4	7	408	Painted Concrete Floor	301.5	106.5	126	0.095	890
237279	H5	8	670	Painted Concrete Floor	301.5	368.5	126	0.095	3079
237279	E7	9	6334	Drywall	216.1	6117.9	126	0.095	51110
237279	J5	10	1488	Painted Concrete Block	286.6	1201.4	126	0.095	10037
237279	G1	11	1189	Painted Concrete Block	286.6	902.4	126	0.095	7539
237279	J4	12	419	Metal	208.2	210.8	126	0.095	1761
237279	F1	13	491	Painted Concrete Block	286.6	204.4	126	0.095	1708
237279	D2	14	579	Painted Concrete Block	286.6	292.4	126	0.095	2443
237279	B4	15	470	Painted Concrete Block	286.6	183.4	126	0.095	1532
237279	D8	16	421	Drywall	216.1	204.9	126	0.095	1712
237279	G8	17	1268	Painted Concrete Block	286.6	981.4	126	0.095	8199
237279	G8-Dup	18	1386	Painted Concrete Block	286.6	1099.4	126	0.095	9185
237279	K10	19	10712	Setup/Lab Floor (resin)	230	10482	126	0.095	87569
237279	L9	20	8643	Setup/Lab Floor (resin)	230	8413	126	0.095	70284
237279	L11	21	6771	Setup/Lab Floor (resin)	230	6541	126	0.095	54645
237279	M10	22	15754	Concrete Floor (bare)	324.5	15430	126	0.095	128901
237279	M10	23	16258	Concrete Floor (bare)	324.5	15934	126	0.095	133112
237279	N9	24	5304	Setup/Lab Floor (resin)	230	5074	126	0.095	42389
237279	P12	25	280	Setup/Lab Floor (resin)	230	50	126	0.095	418
237279	K12	26	394	Setup/Lab Floor (resin)	230	164	126	0.095	1370
237279	K8	27	331	Setup/Lab Floor (resin)	230	101	126	0.095	844
237279	J11	28	3116	Painted Concrete Block	286.6	2829.4	126	0.095	23637
237279	I12	29	2626	Painted Concrete Block	286.6	2339.4	126	0.095	19544
237279	J10	30	251	Metal	208.2	42.8	126	0.095	358
237279	L6	31	492	Painted Concrete Block	286.6	205.4	126	0.095	1716
237279	O6	32	418	Painted Concrete Block	286.6	131.4	126	0.095	1098
237279	P14	33	261	Metal	208.2	52.8	126	0.095	441

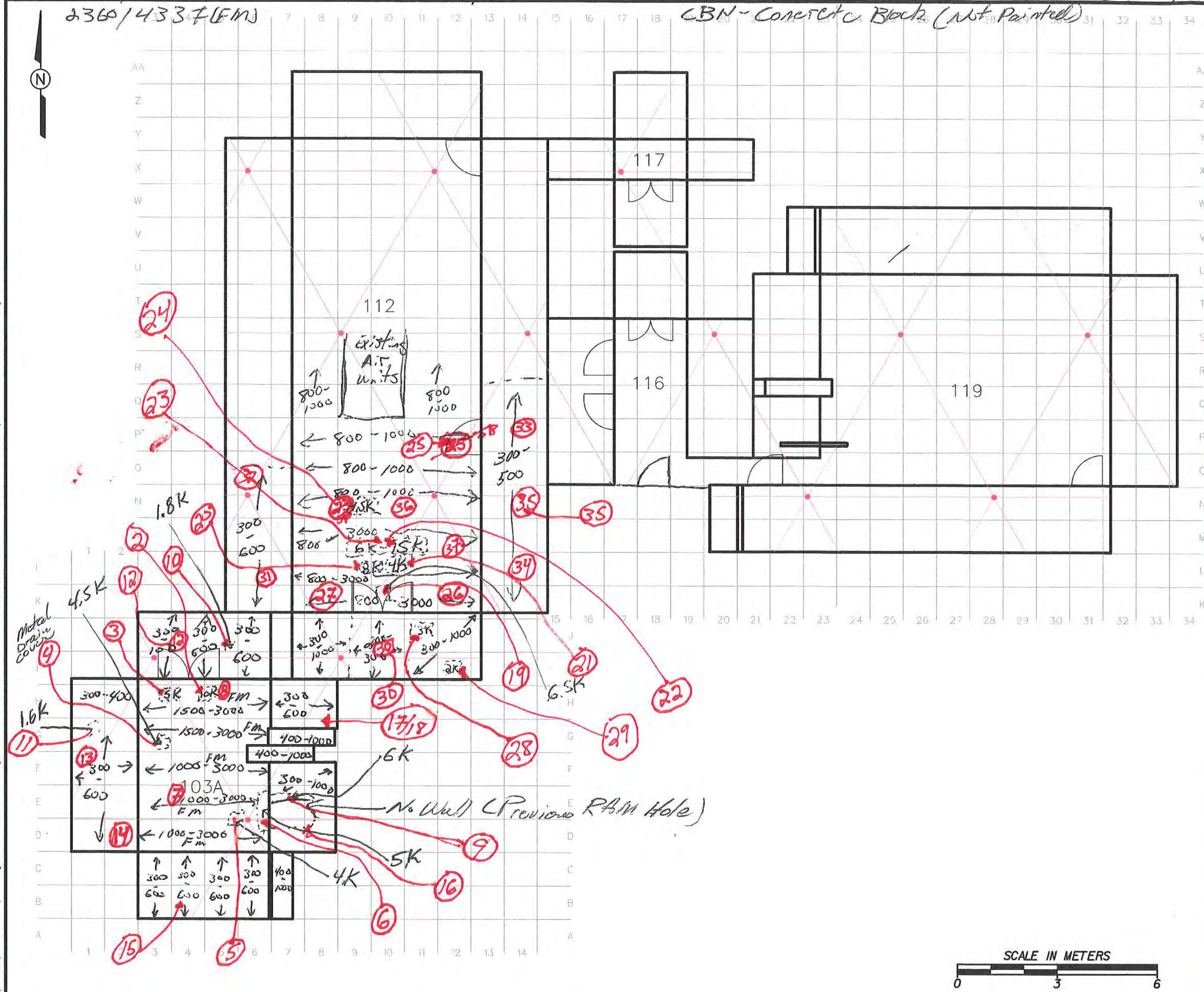
237279	L14	34	391	Painted Concrete Block	286.6	104.4	126	0.095	872
237279	N14	35	355	Painted Concrete Block	286.6	68.4	126	0.095	571
237279	N10	36	423	Setup/Lab Floor (resin)	230	193	126	0.095	1612
237279	M12	37	375	Setup/Lab Floor (resin)	230	145	126	0.095	1211
237279	M12-Dup	38	341	Setup/Lab Floor (resin)	230	111	126	0.095	927

M

Inst. 2360/4368
2360/4337 (FM)
Survey # 021114-01

PC = Concrete (painted)
DW = DW
LF = lab floor
CB - Concrete Brick (Painted) PCB
PB - Painted Brick
PM - Painted Metal
CBN - Concrete Block (Not Painted)
m = metal
C = Concrete (not painted)

SU2-B2 Part 1



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

1) LSC DKG
gross static counts

2) 12,627 - PC
3) 2,158 - PC
4) 3,178 - M
5) 5,661 - PC
6) 3,559 - PC
7) 408 - PC
8) 670 - PC
9) 6,334 - DW
10) 1,488 - CB
11) 1,189 - CB
12) 419 - PM
13) 491 - CB
14) 579 - CB
15) 470 - CB
16) 421 - DW
17) 1268 - PB
D 18) 1,386 - PB
19) 10,712 - LF
20) 8,643 - LF
21) 6,771 - LF
22) 15,754 - C
23) 16,258 - C
24) 5,304 - LF
25) 280 - LF
26) 394 - LF
27) 331 - LF
28) 376 - CBN
29) 2626 - CBN
30) 251 - PM
31) 492 - CB
32) 418 - CB
33) 261 - PM
34) 391 - CB
35) 355 - CB
36) 423 - LF
37) 375 - LF
D 38) 341 - LF

NOTES:

1. WALL SURFACE AREA: 211 SQ. M.
   FLOOR SURFACE AREA: 170 SQ. M.
   TOTAL SURFACE AREA: 381 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 5.61 METERS.

FIGURE X-X
CLASS 2 SAMPLING LOCATIONS
IN B2-103A, B2-112, B2-116, B2-117,
AND B2-119
SU2-B2

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc.
(A CB&I Company)

aptuit_api_fssr_temp007.dgn sammccawley 1/10/2014 3:30:32 PM PDF_with_Levels.plt sei_textsub_only.tbl

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	11	1	63.82%	23
C-14	10	33	1	96.32%	24

Bias

$$relative\ bias = \frac{measured\ result - expected\ result}{expected\ result}$$

	Spike	Result	Relative bias
H-3	4174	3663	-0.12242
C-14	4354	4392	0.008728

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm)					
					H-3			C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
17	18	1268	1386	0.0889224	98	0	2	2060	2181	0.057062
37	38	375	341	0.0949721	28	32	0.1333333	99	87	0.1290323

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

Assay Definition-

Assay Description:
021114-01 SU2-B2 CHARACTERIZATION PART 1 DUPE AND SPIKE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140212_0818\20140212_0818.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE	
1	10.00	11	32	0	0	66.22	521.93	
Missing vial 2.								
3	1.00	244	1794	0	2181	73.89	456.21	SAMPLE 17
Missing vial 4.								
5	1.00	24	72	32	87	55.74	464.31	SAMPLE 37
Missing vial 6.								
7	1.00	2	0	7	0	2416.33	550.38	
8	1.00	2058	3765	3663	4392	58.30	488.90	

Assay Definition-

Assay Description:
021114-01 SU2-B2 CHARACTERIZATION PART 1

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140211_1558\20140211_1558.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	11	33	0	0	73.31	517.48
2	1.00	8	34	8	41	44.51	446.89
3	1.00	19	39	36	46	27.97	439.45
4	1.00	5	39	0	47	37.35	423.49
5	1.00	8	23	12	28	48.45	475.57
6	1.00	9	26	14	32	18.17	457.97
7	1.00	1	0	1	0	0.00	471.64
8	1.00	2	20	0	24	42.86	467.86
9	1.00	730	3056	679	3678	56.63	462.38

10	1.00	12	80	0	97	54.43	466.79
11	1.00	75	221	114	265	39.48	418.37
12	1.00	10	25	17	29	45.00	455.66
13	1.00	13	25	25	30	16.82	409.58
14	1.00	13	73	5	88	61.57	446.82
15	1.00	2	0	6	0	0.00	476.41
16	1.00	58	239	54	287	56.43	474.07
17	1.00	295	1700	98	2060	63.15	454.48
Missing vial 18.							
19	1.00	899	1998	1723	2368	37.59	399.46
20	1.00	576	2054	750	2475	47.90	411.38
21	1.00	647	2001	921	2394	48.10	439.07
22	1.00	38	220	10	266	67.51	491.63
23	1.00	65	222	79	266	45.47	464.31
24	1.00	16	95	4	114	63.25	492.56
25	1.00	0	14	0	17	69.68	471.52
26	1.00	7	27	7	32	35.34	466.30
27	1.00	16	57	20	69	34.84	454.43
28	1.00	102	492	67	592	60.81	481.23
29	1.00	194	806	176	967	60.21	486.10
30	1.00	5	6	10	7	40.82	531.75
31	1.00	75	318	64	382	63.98	492.56
32	1.00	12	37	15	44	71.49	511.94
33	1.00	8	2	17	2	4.95	517.18
34	1.00	19	56	26	67	47.29	503.93
35	1.00	7	8	15	9	0.00	467.31
36	1.00	0	14	0	17	61.78	497.79
37	1.00	23	83	28	99	50.64	460.65
Missing vial 38.							
39	1.00	10	0	26	0	0.00	548.03
40	1.00	2020	3627	3638	4229	57.89	485.27

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 10.63 Date Processed: 2/11/2014 8:26:20 AM
14C Chi Square: 30.62 Date Processed: 2/11/2014 8:26:20 AM
3H E^2/B (1-18.6 keV): 385.91 Date Processed: 2/11/2014 8:26:20 AM
14C E^2/B (4-156 keV): 735.36 Date Processed: 2/11/2014 8:26:20 AM
3H Efficiency (0-18.6 keV): 63.98 Date Processed: 2/11/2014 8:26:20 AM
14C Efficiency (0-156 keV): 95.56 Date Processed: 2/11/2014 8:26:20 AM
IPA Background Date Processed: 2/11/2014 8:26:20 AM
3H Background CPM (0-18.6 keV): 10.67 Date Processed: 2/11/2014 8:26:20 AM
14C Background CPM (0-156 keV): 15.02 Date Processed: 2/11/2014 8:26:20 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 13.05 Date Processed: 2/12/2014 8:11:07 AM
14C Chi Square: 24.43 Date Processed: 2/12/2014 8:11:07 AM
3H E^2/B (1-18.6 keV): 399.97 Date Processed: 2/12/2014 8:11:07 AM
14C E^2/B (4-156 keV): 748.78 Date Processed: 2/12/2014 8:11:07 AM
3H Efficiency (0-18.6 keV): 63.82 Date Processed: 2/12/2014 8:11:07 AM
14C Efficiency (0-156 keV): 96.32 Date Processed: 2/12/2014 8:11:07 AM
IPA Background Date Processed: 2/12/2014 8:11:07 AM
3H Background CPM (0-18.6 keV): 10.30 Date Processed: 2/12/2014 8:11:07 AM
14C Background CPM (0-156 keV): 14.85 Date Processed: 2/12/2014 8:11:07 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040	Date: 2/12/2014	Time Start: 0900	Time Complete: 1100	Page 1 of ~~7~~ 8
Location: HEPA Room	Surveyors: Gordon Robb, Shane Brungardt				
Survey Unit: SU2-B2	Survey Number: 021214-01				
	Map ID: see attached				

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys α (Loose)	α (Total)	β (Loose)	β (Total)	Radiation Surveys γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm²)				615	
Background (cpm)				230	

REASON FOR SURVEY

- ☐ PROCEDURE NO.
- ☑ SPECIAL Characterization
- ☐ ROUTINE

Contamination ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

Radiation ☐ By Shift ☐ Daily ☐ Weekly ☐ Monthly ☐

COMMENTS: Characterization of HEPA room. Floor monitor used for scans (2360 SN# 227437 /43-37 SN# PR216990 /Eff: 0.07 / MDC: 291 /Bkg: 617), handheld (43-68) used for statics.

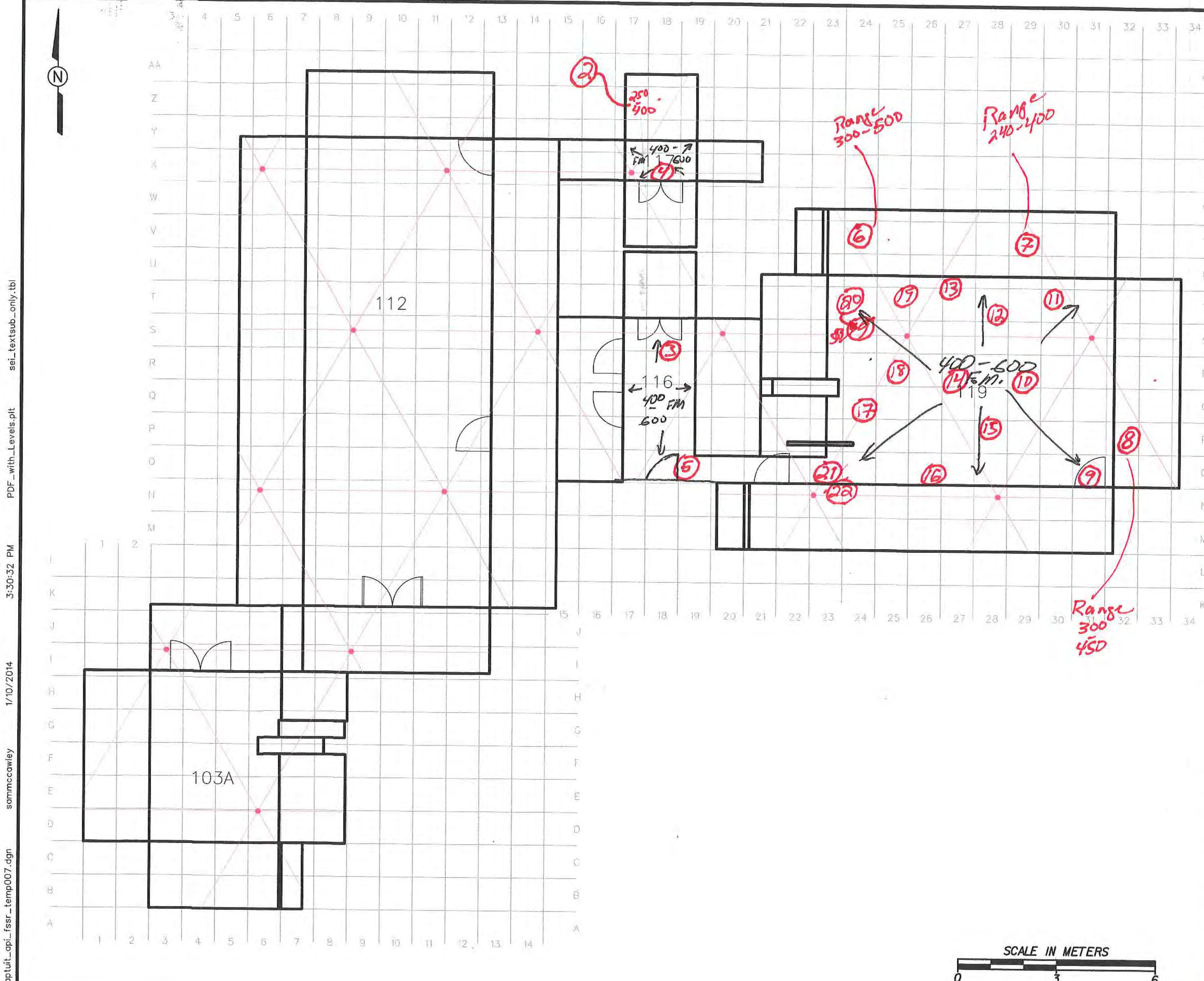
Item #	Alpha Loose dpm/100cm²	Alpha Total dpm/100cm²	Beta Loose dpm/100cm²	Beta Total dpm/100cm²	Alpha cpm ☐ / Beta cpm ☐ / Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Painted Concrete Block	Z17
3					Setup/Lab Floor (resin)	S18
4					Setup/Lab Floor (resin)	X18
5					Setup/Lab Floor (resin)	O19
6					Painted Concrete Block	V24
7					Painted Concrete Block	V29
8					Painted Concrete Block	P32
9					Setup/Lab Floor (resin)	O31
10					Setup/Lab Floor (resin)	R29
11					Setup/Lab Floor (resin)	T30
12					Setup/Lab Floor (resin)	T28
13					Setup/Lab Floor (resin)	U27
14					Setup/Lab Floor (resin)	R27
15					Setup/Lab Floor (resin)	P28
16					Setup/Lab Floor (resin)	O26
17					Setup/Lab Floor (resin)	O24
18					Setup/Lab Floor (resin)	R25
19					Setup/Lab Floor (resin)	T25
20					Setup/Lab Floor (resin)	T24
21					Setup/Lab Floor (resin)	O23
22					Setup/Lab Floor (resin)	O23-Dup
23						
24						
25						

RCS REVIEW DATE 02/12/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net dpm/100cm^2
	LSC Background	1							
237279	Z17	2	347	Painted Concrete Block	286.6	60.4	126	0.095	505
237279	S18	3	274	Setup/Lab Floor (resin)	230	44	126	0.095	368
237279	X18	4	306	Setup/Lab Floor (resin)	230	76	126	0.095	635
237279	O19	5	274	Setup/Lab Floor (resin)	230	44	126	0.095	368
237279	V24	6	336	Painted Concrete Block	286.6	49.4	126	0.095	413
237279	V29	7	297	Painted Concrete Block	286.6	10.4	126	0.095	87
237279	P32	8	344	Painted Concrete Block	286.6	57.4	126	0.095	480
237279	O31	9	278	Setup/Lab Floor (resin)	230	48	126	0.095	401
237279	R29	10	253	Setup/Lab Floor (resin)	230	23	126	0.095	192
237279	T30	11	283	Setup/Lab Floor (resin)	230	53	126	0.095	443
237279	T28	12	230	Setup/Lab Floor (resin)	230	0	126	0.095	0
237279	U27	13	296	Setup/Lab Floor (resin)	230	66	126	0.095	551
237279	R27	14	253	Setup/Lab Floor (resin)	230	23	126	0.095	192
237279	P28	15	248	Setup/Lab Floor (resin)	230	18	126	0.095	150
237279	O26	16	273	Setup/Lab Floor (resin)	230	43	126	0.095	359
237279	O24	17	230	Setup/Lab Floor (resin)	230	0	126	0.095	0
237279	R25	18	254	Setup/Lab Floor (resin)	230	24	126	0.095	201
237279	T25	19	245	Setup/Lab Floor (resin)	230	15	126	0.095	125
237279	T24	20	275	Setup/Lab Floor (resin)	230	45	126	0.095	376
237279	O23	21	275	Setup/Lab Floor (resin)	230	45	126	0.095	376
237279	O23-Dup	22	264	Setup/Lab Floor (resin)	230	34	126	0.095	284

Survey # 021214-01 Part 2 Instr. - 2360/4337 (FM) 2360/4368 LF = Lab Floor PCB: Painted Concrete Block



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

1) LSC BKG
2) Gross Static Counts
2) 347 - PCB
3) 274 - LF
4) 306 - LF
5) 274 - LF
6) 336 - PCB
7) 297 - PCB
8) 344 - PCB
9) 278 - LF
10) 253 - LF
11) 283 - LF
12) 230 - LF
13) 296 - LF
14) 253 - LF
15) 248 - LF
16) 273 - LF
17) 230 - LF
18) 254 - LF
19) 245 - LF
20) 275 - LF
21) 275 - LF
D22) 264 - LF

NOTES:

1. WALL SURFACE AREA: 211 SQ. M.
   FLOOR SURFACE AREA: 170 SQ. M.
   TOTAL SURFACE AREA: 381 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 5.61 METERS.

SCALE IN METERS 0 3 6

FIGURE X-X
CLASS 2 SAMPLING LOCATIONS IN B2-103A, B2-112, B2-116, B2-117, AND B2-119 SU2-B2

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc. (A CB&I Company)

aptuit_api_fssr_temp007.dgn sammccawley 1/10/2014 3:30:32 PM PDF_with_Levels.plt sei_textsub_only.tbl

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\, (1 + \frac{t_g}{t_b})}^{\,d}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	8	1	63.82%	20
C-14	10	29	1	96.32%	22

Bias

$$relative \quad bias = \frac{measured \quad result - expected \quad result}{expected \quad result}$$

	Spike	Result	Relative bias
H-3	4174	3605	-0.13632
C-14	4354	4281	-0.01677

H-3 spike value = 4174 dpm

C-14 spike value= 4354 dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm)					
					H-3			C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
21	22	275	264	0.0408163	1	2	0.6666667	18	2	1.6

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

Assay Definition-

Assay Description:
021214-01 SU2-B2116/117/119 CHARACTERIZATION DUPE, BLAND AND SPIKE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140212_1254\20140212_1254.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE	
1	10.00	10	30	0	0	71.17	545.35	
Missing vial 2.								
3	1.00	1	2	2	2	11.41	460.02	SAMPLE 21
Missing vial 4.								
Missing vial 5.								
6	1.00	5	0	15	0	0.00	553.91	
7	1.00	2016	3670	3605	4281	57.89	486.79	

Assay Definition-

Assay Description:
021214-01 SU2-B2116/117/119 CHARACTERIZATION

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140212_1028\20140212_1028.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	8	29	0	0	76.87	549.42
2	1.00	0	6	0	8	0.00	500.44
3	1.00	1	0	3	0	0.00	519.69
4	1.00	4	5	8	6	97.58	515.42
5	1.00	1	8	0	9	82.34	509.12
6	1.00	5	7	9	8	49.76	527.27
7	1.00	5	2	11	2	34.33	518.21
8	1.00	3	0	8	0	0.00	526.14
9	1.00	1	2	1	2	50.75	496.74

10	1.00	0	1	0	1	0.00	504.56
11	1.00	3	5	5	6	0.00	492.20
12	1.00	10	0	28	0	0.00	508.24
13	1.00	1	4	0	5	104.52	504.15
14	1.00	1	1	1	1	42.32	507.00
15	1.00	8	5	17	5	24.66	503.66
16	1.00	4	0	11	0	0.00	495.81
17	1.00	9	0	23	0	0.00	481.90
18	1.00	0	0	1	0	0.00	496.52
19	1.00	2	5	2	6	54.58	495.57
20	1.00	2	5	2	6	3.66	499.04
21	1.00	3	15	1	18	49.76	472.44
Missing vial 22.							
Missing vial 23.							
24	1.00	5	3	10	3	43.13	549.45
25	1.00	1984	3596	3552	4194	58.17	487.16

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 13.05 Date Processed: 2/12/2014 8:11:07 AM
14C Chi Square: 24.43 Date Processed: 2/12/2014 8:11:07 AM
3H E^2/B (1-18.6 keV): 399.97 Date Processed: 2/12/2014 8:11:07 AM
14C E^2/B (4-156 keV): 748.78 Date Processed: 2/12/2014 8:11:07 AM
3H Efficiency (0-18.6 keV): 63.82 Date Processed: 2/12/2014 8:11:07 AM
14C Efficiency (0-156 keV): 96.32 Date Processed: 2/12/2014 8:11:07 AM
IPA Background Date Processed: 2/12/2014 8:11:07 AM
3H Background CPM (0-18.6 keV): 10.30 Date Processed: 2/12/2014 8:11:07 AM
14C Background CPM (0-156 keV): 14.85 Date Processed: 2/12/2014 8:11:07 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

Contamination/Radiation Survey Report	Project Number: 144040	Date: 2/13/2014	Time Start: 1200	Time Complete: 1400	Page 1 of ~~7~~ 8 9

Location: HEPA Room	Surveyors: Gordon Robb
Survey Unit: SU2-B2	Shane Brungardt
	Survey Number: 021314-02
	Map ID: see attached

ACCEPTABLE SURFACE CONTAMINATION LEVELS	Type of Levels: DCGL	ACCEPTABLE SCAN LIMITS
C-14: 370,000 dpm/100cm2 (Total) H-3/C-14: 37,000 dpm/100cm2 (Removable)		Less than twice material background.

Instrument Information	Contamination Surveys				Radiation Surveys
	α (Loose)	α (Total)	β (Loose)	β (Total)	γ
Instrument Type	N/A	N/A	Perkin Elmer TriCarb 2900TR	2360	N/A
Instrument Serial No.			061925	237279	
Probe Type			N/A	43-68	
Probe Serial No.			N/A	PR190298	
Source Type			SADS	C-14	
Source Serial No.				E1-821	
Source Strength (dpm)				40608	
Efficiency				0.095	
MDC (dpm/100cm^2)				615	
Background (cpm)				230	

REASON FOR SURVEY	☐	PROCEDURE NO.					
	☑	SPECIAL	FSS				
	☐	ROUTINE					
Contamination	☐	By Shift ☐	Daily ☐	Weekly ☐	Monthly ☐		
Radiation	☐	By Shift ☐	Daily ☐	Weekly ☐	Monthly ☐		

COMMENTS: FSS of HEPA Room

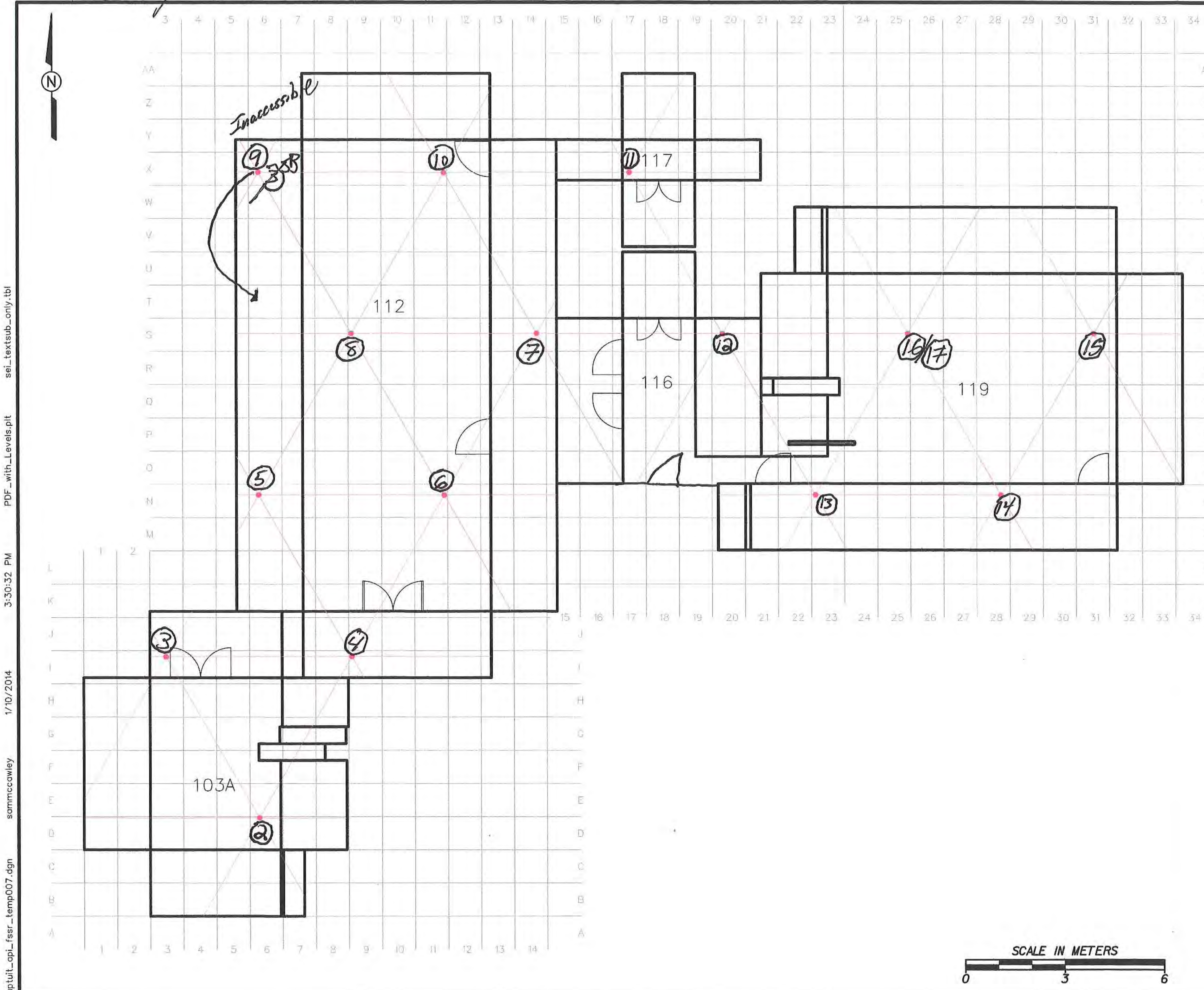
Item #	Alpha Loose dpm/100cm^2	Alpha Total dpm/100cm^2	Beta Loose dpm/100cm^2	Beta Total dpm/100cm^2	Alpha cpm ☐ Beta cpm ☐ Material ☑	Item or Location
1	N/A	N/A	SADS	N/A	N/A	LSC Background
2				SADS	Painted Concrete Floor	D6
3					Painted Concrete Block	I3
4					Painted Concrete Block	I9
5					Painted Concrete Block	N6
6					Setup/Lab Floor (resin)	N11
7					Painted Concrete Block	S14
8					Setup/Lab Floor (resin)	S9
9					Painted Concrete Block	T6 (moved from X6, inaccessible)
10					Setup/Lab Floor (resin)	X11
11					Setup/Lab Floor (resin)	X17
12					Painted Concrete Block	S20
13					Painted Concrete Block	N23
14					Painted Concrete Block	N28
15					Setup/Lab Floor (resin)	S31
16					Setup/Lab Floor (resin)	S25
17					Setup/Lab Floor (resin)	S25-Dup
18						
19						
20						
21						
22						
23						
24						
25						

RCS REVIEW [signature] DATE 02/14/14

The knowing and willful recording of false, fictitious, or fraudulent statements or entries on this document may be punishable as a felony under federal statutes.

Instrument Serial Number	Description	Sample Location	Gross cpm	Material	Background	Net cpm	Probe Area (cm^2)	Efficiency	Net $dpm/100cm^2$
	LSC Background	1							
237279	D6	2	801	Painted Concrete Floor	301.5	499.5	126	0.095	4173
237279	I3	3	704	Painted Concrete Block	286.6	417.4	126	0.095	3487
237279	I9	4	371	Painted Concrete Block	286.6	84.4	126	0.095	705
237279	N6	5	340	Painted Concrete Block	286.6	53.4	126	0.095	446
237279	N11	6	310	Setup/Lab Floor (resin)	230	80	126	0.095	668
237279	S14	7	274	Painted Concrete Block	286.6	-12.6	126	0.095	-105
237279	S9	8	292	Setup/Lab Floor (resin)	230	62	126	0.095	518
237279	ed from X6, inac	9	342	Painted Concrete Block	286.6	55.4	126	0.095	463
237279	X11	10	331	Setup/Lab Floor (resin)	230	101	126	0.095	844
237279	X17	11	288	Setup/Lab Floor (resin)	230	58	126	0.095	485
237279	S20	12	337	Painted Concrete Block	286.6	50.4	126	0.095	421
237279	N23	13	393	Painted Concrete Block	286.6	106.4	126	0.095	889
237279	N28	14	336	Painted Concrete Block	286.6	49.4	126	0.095	413
237279	S31	15	244	Setup/Lab Floor (resin)	230	14	126	0.095	117
237279	S25	16	263	Setup/Lab Floor (resin)	230	33	126	0.095	276
237279	S25-Dup	17	251	Setup/Lab Floor (resin)	230	21	126	0.095	175

Survey #021314-02 Instrument 2360/4368



LEGEND:

● SYSTEMATIC SAMPLE LOCATION

1) LSC BKG
Gross Static Counts
2) 801 - Painted Concrete
3) 704 - Painted Brick
4) 371 - Painted Concrete Block
5) 340 - Painted Concrete Block
6) 310 - LF (Lab Floor)
7) 274 - Painted Concrete Block
8) 292 - Lab Floor
9) 342 - Painted Concrete Block
10) 331 - Lab Floor
11) 288 - Lab Floor
12) 337 - Painted Concrete Block
13) 393 - Painted Concrete Block
14) 336 - Painted Concrete Block
15) 244 - Lab Floor
16) 263 - Lab Floor
17) 251 - Lab Floor

NOTES:

1. WALL SURFACE AREA: 211 SQ. M.
   FLOOR SURFACE AREA: 170 SQ. M.
   TOTAL SURFACE AREA: 381 SQ. M.
2. THE LENGTH OF EACH LEG OF THE TRIANGULAR SAMPLING GRID IS 5.61 METERS.

FIGURE X-X
CLASS 2 SAMPLING LOCATIONS IN B2-103A, B2-112, B2-116, B2-117, AND B2-119
SU2-B2

FINAL STATUS SURVEY REPORT

APTUIT, LLC
KANSAS CITY, MISSOURI

Shaw Environmental & Infrastructure, Inc. (A CB&I Company)

aptuit_api_fssr_temp007.dgn sammccawley 1/10/2014 3:30:32 PM PDF_with_Levels.plt sei_textsub_only.tbl

LSC MDC

$$\frac{3 + 3.29\sqrt{R_b\, t_g\,(1 + \frac{t_g}{t_b})}^{\,d}}{(Efficiency)(t_g)}$$

	Bkg ct time (min)	Bkg ct rate (cpm)	Sample ct time (min)	Efficiency (%)	MDC (dpm)
H-3	10	13	1	63.92%	24
C-14	10	49	1	95.93%	28

Bias

$$relative \quad bias = \frac{measured \quad result \; - e\,xp\,ected \quad result}{e\,xp\,ected \quad result}$$

	Spike	Result	Relative bias
H-3	4174	3516	-0.15764
C-14	4354	4344	-0.0023

H-3 spike value =	4174	dpm
C-14 spike value=	4354	dpm

Relative Percent Difference (RPD)

Location ID		Statics (cpm)			Smears (dpm)					
					H-3			C-14		
Original	Duplicate	Original	Duplicate	RPD (<0.2)	Original	Duplicate	RPD (<0.3)	Original	Duplicate	RPD (<0.3)
16	17	263	251	0.0466926	0	0	0	0	6	2

The RPD is derived as follows:

$$RPD = \frac{|x_1 - x_2|}{\bar{x}}$$

where: RPD = Relative range between the two observed values (X1 and X2)

$\bar{x}$ = Arithmetic mean of the two samples.

The RPD is not relevant when the result is less than the MDC.

The RPD exceeds the limit.

Assay Definition-

Assay Description:
021314-02 SU2 B2 SYSTEMATIC DUPE BLANK AND SPIKE

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140214_1310\20140214_1310.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	12	47	0	0	65.59	449.82
Missing vial 2.							
3	1.00	0	5	0	6	0.00	428.85
Missing vial 4.							
5	1.00	0	0	0	0	0.00	545.84
6	1.00	1985	3718	3516	4344	58.97	485.38

Assay Definition-

Assay Description:
021314-02 SU2-B2 SYSTEMATICS

Assay Type: DPM (Dual)
Report Name: WIPE TEST
Output Data Path: C:\Documents and Settings\QuantaSmart\Desktop\D&D
Raw Results Path: C:\Packard\Tricarb\Results\CLINDT\WIPES\20140213_1538\20140213_1538.results
Comma-Delimited File Name: C:\Documents and Settings\QuantaSmart\Desktop\D&D\WIPE TEST.txt
Assay File Name: C:\Packard\TriCarb\Assays\WIPES.lsa

Count Conditions-

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

Background Subtract: On - 1st Vial
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL	Bkg Subtract
A	0.0	12.0	1st Vial
B	12.0	156.0	1st Vial
C	0.0	0.0	1st Vial

Count Corrections-

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

Half Life-

Half Life Correction: Off

Regions	Half Life	Units	Reference Date	Reference Time
A				
B				
C				

Cycle 1 Results

S#	Count Time	CPMA	CPMB	DPM1	DPM2	SIS	tSIE
1	10.00	13	49	0	0	67.06	446.06
2	1.00	0	0	3	0	0.00	419.72
3	1.00	7	7	15	8	17.74	436.87
4	1.00	27	98	33	118	48.81	428.74
5	1.00	2	10	0	13	43.49	427.55
6	1.00	6	17	9	21	32.47	408.38
7	1.00	2	22	0	27	56.46	408.61
8	1.00	4	23	0	29	28.45	405.65
9	1.00	5	0	13	0	0.00	426.34

10	1.00	1	19	0	23	24.42	372.42
11	1.00	2	0	7	0	0.00	437.78
12	1.00	3	0	12	0	0.00	451.83
13	1.00	0	0	3	0	0.00	448.87
14	1.00	0	3	0	4	0.00	446.37
15	1.00	0	9	0	11	13.87	416.75
16	1.00	0	0	0	0	0.00	428.99
Missing vial 17.							
18	1.00	0	0	0	0	0.00	472.24
19	1.00	1896	3589	3788	4215	49.42	414.26

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 19.48 Date Processed: 2/13/2014 8:13:20 AM
14C Chi Square: 18.22 Date Processed: 2/13/2014 8:13:20 AM
3H E^2/B (1-18.6 keV): 378.15 Date Processed: 2/13/2014 8:13:20 AM
14C E^2/B (4-156 keV): 719.27 Date Processed: 2/13/2014 8:13:20 AM
3H Efficiency (0-18.6 keV): 63.92 Date Processed: 2/13/2014 8:13:20 AM
14C Efficiency (0-156 keV): 95.93 Date Processed: 2/13/2014 8:13:20 AM
IPA Background Date Processed: 2/13/2014 8:13:20 AM
3H Background CPM (0-18.6 keV): 10.88 Date Processed: 2/13/2014 8:13:20 AM
14C Background CPM (0-156 keV): 15.47 Date Processed: 2/13/2014 8:13:20 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

SNC Protocol

Calibration Information
Software Version IC: 2.12
Software Version EC: 2.03
Instrument Model: Tri-Carb 2900TR
Instrument Serial Number: 061925
3H Chi Square: 11.84 Date Processed: 2/14/2014 9:29:21 AM
14C Chi Square: 23.73 Date Processed: 2/14/2014 9:29:21 AM
3H E^2/B (1-18.6 keV): 363.71 Date Processed: 2/14/2014 9:29:21 AM
14C E^2/B (4-156 keV): 694.29 Date Processed: 2/14/2014 9:29:21 AM
3H Efficiency (0-18.6 keV): 63.77 Date Processed: 2/14/2014 9:29:21 AM
14C Efficiency (0-156 keV): 96.64 Date Processed: 2/14/2014 9:29:21 AM
IPA Background Date Processed: 2/14/2014 9:29:21 AM
3H Background CPM (0-18.6 keV): 11.43 Date Processed: 2/14/2014 9:29:21 AM
14C Background CPM (0-156 keV): 16.52 Date Processed: 2/14/2014 9:29:21 AM
3H Calibration DPM: 271800
3H Reference Date: 7/29/2011
14C Calibration DPM: 129000

APPENDIX E

WORK INSTRUCTIONS

1. PURPOSE

This procedure describes methods and techniques to be employed when performing surface contamination surveys for Aptuit, LLC (Aptuit) decommissioning activities.

2. APPLICABILITY

This procedure applies to decommissioning activities being conducted at Aptuit by Shaw Environmental, Inc. (Shaw) personnel and its subcontractors.

3. REFERENCES

3.1 Aptuit Radiation Safety Program Manual, June 2011

3.2 Manufacturers' operating manuals

3.3 Instruction manual for Packard Tri-Carb 2900 TR Liquid Scintillation Analyzer.

4. DEFINITIONS

TERM/ACRONYM	DEFINITION
^{14}C	carbon-14
FSS	final status survey
IPA	instrument performance assessment
MDC	minimum detectable concentration
PHP	Project Health Physicist
PPE	personal protective equipment
QC	quality control
SS	Site Supervisor
ST	Survey Technician
^{3}H	tritium

5. RESPONSIBILITIES

5.1 Project Health Physicist

The Project Health Physicist (PHP) is responsible for the maintenance and management of this procedure.

5.2 Site Supervisor/Survey Coordinator

The Site Supervisor (SS) will be responsible for the field oversight of the Survey Technicians (ST) performing this procedure. A Shaw Health Physicist or Radiological Control Technician will be designated for this position. The SS/SC is responsible for the supervision of data collection activities, including surveys and samples. Specific responsibilities include:

- Selecting proper equipment for the performance of defined data collection activities
- Ensuring properly calibrated and tested equipment is available for the performance of survey/sampling tasks
- Ensuring the proper establishment of reference and sample grids
- Determining locations for biased sample collection and direct measurement
- Reviewing collected data for accuracy and verifying the completion of data collection for each survey unit.

5.3 Survey Technicians

STs will be responsible for the field execution of this procedure and for addressing any issues or suggested modifications with the SS or PHP.

The ST is responsible for the proper execution of survey and sampling activities. Specific responsibilities include:

- Ensuring all portable instrumentation is properly calibrated and checked prior to use
- Performing all data collection activities in full compliance with the established protocols
- Properly documenting all survey/sampling activities.

6. EQUIPMENT AND MATERIALS

- Preprinted survey unit and laboratory survey maps and data forms (plan view of area, items or equipment to be surveyed)
- Paper liquid scintillation smears
- Metal or plastic laboratory tweezers
- Properly prepared liquid scintillation vials containing 17 milliliters of scintillation cocktail
- Gloves, safety glasses
- Ludlum Model 2360 scaler/ratemeter with a Model 43-37 gas proportional probe with 0.8 milligram per square centimeter window for floor monitoring or functional equivalent

- Ludlum Model 2360 scaler/ratemeter with a Model 43-68 probe with 0.4 milligram per square centimeter window or functional equivalent
- Ludlum Model 3 ratemeter with Model 44-9 PGM or functional equivalent
- Packard TriCarb 2900 TR liquid scintillation counter (or equivalent).

7. PREREQUISITES

- Ensure that all instrumentation is properly calibrated and operating properly in accordance with Aptuit Work Instruction WI-002 and manufacturer procedures.
- Ensure STs have proper personal protective equipment (PPE) for area to be surveyed based on area postings and site control requirements.
- Ensure the job hazard analysis has been conducted for the survey/sampling activities and that all workers are properly briefed on the hazards anticipated.
- Review previous surveys of the survey unit, if available, to determine radiological conditions within the survey unit prior to entry.
- STs will be instructed regarding the quality control (QC) measure/sample requirements prior to performing any survey or sampling activity.
- STs will be instructed on the potential radiological hazards that may be present in the survey units.

NOTE: Minimum PPE for performance of survey/sampling activities will be latex or nitrile gloves, and safety glasses.

8. INSTRUCTIONS

8.1 Scan Surveys

The scan survey may include materials and equipment, floors, countertops, wall surfaces, fume hoods and exhaust system components.

This survey will be performed as follows:

- Verify the instrument has been calibrated and set up in accordance with Aptuit Work Instruction WI-002 and manufacturer’s technical manual prior to use.
- With the instrument in operation, at the rate required to meet the calculated beta scan minimum detectable concentration (MDC), and at a height of no greater than 1 centimeter, move the detector over the surfaces across the area to be surveyed. Using the audible response of the instrument, locate the area of maximum count rate for each area and/or grid surveyed and document the instrument reading at that location on the survey map.
- For final status surveys (FSS), any location where the detector reading is twice the material background will be flagged with a small piece of masking tape marked with the word “SCAN,” the meter reading in counts per minute, the background reading in counts per minute, and the initials of the person performing the survey. The anomalous reading will also be noted on field paperwork.

8.2 Direct Measurement Surveys

- Verify that the required instrument/detector combination has been calibrated and set up in accordance with Aptuit Work Instruction WI-002 and manufacturer's technical manual prior to use.
- Place the detector directly on the surface to be surveyed at the desired location. With the instrument operating in "Scaler" mode, take a measurement at the selected sample point for count time determined during instrument setup required to meet static MDC requirements for the parameter being measured. MDCs will be no greater than 50 percent of the applicable derived concentration guideline level. Document the direct surface contamination reading measured at the location on the survey data forms.

8.3 Wipe Surveys

Wipe sampling for removable contamination will be conducted during decommissioning activities. Samples will be taken and then transported to the on-site laboratory for analysis in accordance with Aptuit Work Instruction WI-003. The sample method for beta contamination smears will be a paper smear technique.

- Survey/Sampling Technician will change into new gloves as needed.
- Obtain prepared scintillation vials with 17 milliliters of scintillation cocktail added to each vial by the on-site laboratory.

  Note: Project requirements may dictate another other sample media and configurations for special cases. In any case, the volume used in the prep blank, laboratory control sample, and spikes should be the same as that used for the samples.
- Remove a single smear and wipe the smear over an area of approximately 100 square centimeters (wipe a square area of approximately 4 inches by 4 inches or an "S" pattern approximately 16 inches long).
- Once the wipe is performed, quickly place smear into an individual prepped scintillation vial.
- The lid of the scintillation vial containing the smear will be marked with a unique number identifying the sample location. The vials will be transported to the laboratory for counting and activity determination.

8.4 Quality Control Measurements/Samples

QC measurements and samples will be performed/collected in a manner consistent with the work plans. The survey/sampling technician performing each survey will be given instruction regarding the QC sample requirements for the sampling activity being conducted. For FSS direct measurements, replicate samples are used to measure operator and/or instrument precision and provide an estimate of precision for the operator and procedure used to perform the measurement. For the FSS, replicates to measure operator precision will be performed using the same instrument at the same location. One replicate direct reading will be performed for every 20 direct readings taken. For contamination smears, sampling precision will be checked through recounting of smears, and one smear will be recounted for every 20 smears collected. Relative percent difference values shall be less than 20 for direct readings and less than 30 for smears.

An automatic instrument performance assessment (IPA) will be performed each day of liquid scintillation counter operation. IPA monitors the system background, efficiencies for both tritium (^3H) and carbon-14 (^{14}C), Figure of Merit (E^2/B) and Chi-squared values for both ^3H and ^{14}C. IPA is performed using ^{14}C and ^3H quenched standards and a background standard. Instrument operation must be within pre-established limits.

For FSS samples, QC samples consisting of background and $^3H/^{14}C$ spikes will be counted with each liquid scintillation counter sample batch. Relative bias will be determined by comparing the results obtained from the $^3H/^{14}C$ spike sample run with the sample batch. Bias measurements should be within plus or minus 20 percent.

8.5 Waste Management

Waste streams associated with survey and sampling activities include used PPE (gloves) and liquid scintillation cocktail. If not suspected of being contaminated, PPE items will be disposed as trash. If contamination is suspect based on survey data, PPE will be bagged as potentially radioactive waste and turned over to the Aptuit Radiation Safety Officer for disposition. Scintillation cocktail waste will be managed by Aptuit personnel.

8.6 Documentation of Surveys and Wipe Samples

The SS is responsible to see that, once a survey is completed, all survey data forms and field paperwork is reviewed.

9. ATTACHMENTS

None

10. FORMS

Survey Forms

11. REVISION HISTORY AND APPROVAL

Rev Level	Rev Date	Rev Description	Approver
0	8/7/12	Initial Issue	Rick Greene, CHP Project Health Physicist Site Supervisor

1. PURPOSE

This Work Instruction (WI) describes the requirements for pre-operational inspection and routine verification of operability prior to the use of radiation survey instruments at Aptuit, LLC for the detection of carbon-14 (^{14}C).

2. SCOPE

This WI provides standard practices and operating procedures for the instruments listed in Table 1 and equivalent instruments. This document provides the minimum required steps and quality checks that all employees and subcontractors are to follow when operating these instruments. Proper control, calibration, and daily checks of these instruments ensure that operating parameters demonstrate compliance with applicable data quality requirements and/or regulations. Also provided in this WI are instructions for the documentation of instrument performance and survey data. Use of these detectors is for performance of surveys during decommissioning activities at Aptuit, LLC.

Table 1: Portable Instruments

DETECTORS	DETECTOR TYPE	TYPICAL METERS		USE
Ludlum 43-68	126 cm^2 Gas-flow proportional	Ludlum 2360	Ludlum 2221	Scanning and static measurements of beta surface contamination
Ludlum 43-37	584 cm^2 Gas-flow proportional	Ludlum 2360	Ludlum 2224	Scanning for beta surface contamination
Ludlum 44-9	Geiger-Mueller Pancake	Ludlum 3	Ludlum 12	Scanning for beta surface contamination

FIELD WORK VARIANCE

Project Number 144040 | **Page 1 of 1**

Project Name Aptuit D&D | **Date November 13, 2013**

Variance (Include Justification)
The control limits for portable instruments used during the Aptuit D&D project are established at ±20% for ratemeter type instruments and ±3σ for scaler type instruments. Aptuit Work Instruction (WI) WI-002 – Instruments, states in Sections 6.2.2 and 6.2.3 for Surface Contamination Survey Instruments, that if the background and source measurements are satisfactory (i.e. within ±3σ), continue. If the measurements do not meet these criteria, immediately notify the Site Supervisor (SS). The WI does not state the criteria the SS would use to determine if the instrument can remain in service.

There have been a number of instances, primarily during end of day check in, where an instrument's response fell outside of the control limits and upon review of the data, the SS determined that the instrument was operating properly. Repeated checks of the instrument's response resulted in the instrument meeting the control limits. The gas flow proportional detectors used for radiological surveys during the decommissioning project are susceptible to environmental factors such as humidity, pressure, and temperature. Changes in these environmental factors can impact the variability of the instrument's response.

This variance is issued to provide guidance for when scaler daily instrument checks fall outside of the ±3σ control limits.

Variance: If the response falls outside of the ±3σ control limits, the response will be checked against ±20% control limits for the instrument. If the instrument response is also outside the ±20% control limit during the beginning of day check, the instrument will not be used. If the instrument response is outside ±20% during the end of day check, the SS will review the day's surveys to determine the usability of the data.

Justification: Daily survey instrument performance source checks are generally recommended at ±20% by national consensus standards for survey instruments (e.g. ANSI 323A, 42.34). The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) states that "For analog readout (count rate) instruments, a variation of ± 20% is usually considered acceptable. Optionally, instruments that integrate events and display the total on a digital readout typically provide an acceptable average response range of 2 or 3 standard deviations… From a practical standpoint, a maximum deviation of ± 20% is usually adequate when compared with other uncertainties associated with the use of the equipment."

Applicable Document(s)
Aptuit WI-002 Instruments

Project Health Physicist: Rick Greene **Date: November 14, 2013**

Site Supervisor: **Date:** 11/14/13

Radiation Oversight Committee (ROC) notification required: ☒ **Yes**

ROC contact: Clint Gregg, RSO **Date notified: November 13, 2013**

Notified by: Rick Greene

3. REFERENCES

3.1 Aptuit Radiation Safety Program Manual, June 2011

3.2 Manufacturers' operating manuals

3.3 U.S. Nuclear Regulatory Commission, 2003, ***Consolidated NMSS Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria***, NUREG 1757, Vol. 2, September.

4. DEFINITIONS

TERM/ACRONYM	DEFINITION
Background Radiation	Radiation that occurs naturally in the environment. Background radiation consists of cosmic radiation from outer space, or radioactive elements in geological media, building material, or other natural sources, including radon and its decay products in air and global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation and are not under the control of the licensee. "Background" radiation does not include radiation from source, byproduct, or special nuclear material regulated by the Nuclear Regulatory Commission.
Beta Radiation	Beta particles (β) emitted by some radionuclides while undergoing radioactive decay. With few exceptions, beta-emitting radionuclides also emit photons (gamma or x-ray) during decay. Beta particles cannot penetrate human skin but do pose a hazard to the skin and lenses of the eye.
Ionizing Radiation	Alpha particles, beta particles, gamma rays, neutrons, energetic electrons or protons, and other particles capable of producing ions when interacting with matter.

5. RESPONSIBILITIES

Project Health Physicist

The Project Health Physicist is responsible for the maintenance and management of this procedure, including selection of appropriate instrumentation to meet the data quality objectives of the project.

Site Supervisor/Survey Coordinator

The Site Supervisor (SS)/Survey Coordinator is responsible for the oversight of the Survey Technicians (ST) operating these instruments. The SS is also responsible for making sure STs are following this procedure as described herein.

Survey Technicians

The STs are responsible for compliance with this work instruction, recognizing instrumentation problems and notifying the SS or Project Health Physicist of malfunctioning instruments. STs shall

understand project investigation levels and release criteria and know how to compare instrument response to the applicable investigation levels or release criteria.

6. PROCEDURE

6.1 Ratemeter Pre-Operational Requirements

Instruments are calibrated and operated in accordance with manufacturers' instructions. Instruments are set up and function checked each day of use in accordance with this work instruction.

6.1.1 Calibration Verification

All portable radiological instruments shall have an approved, current calibration label. Calibration verification shall be performed prior to the use of the instrument.

6.1.2 Physical Check

A physical check of radiological instruments is an inspection of the general physical condition of each instrument and detector. A physical check shall be performed prior to using a radiological instrument.

The physical check should include inspecting the instrument for loose or damaged knobs, buttons, cables, and connectors; broken/damaged meter, movements/displays; dented or corroded instrument cases; punctured/deformed probe/probe windows, cables, etc.; and any other physical impairments that may affect the proper operation of the instrument or detector. Any instrument or detector having a questionable physical condition shall not be used until the condition is properly corrected.

The instrument, cable, and detector as calibrated should be kept together as a unit. Do not swap components. However, cables of equal length may be replaced if defective without affecting the calibration of the instrument.

6.1.3 Battery Check

A battery check is performed to help ensure that sufficient voltage is being supplied to the detector and instrument circuitry for proper operation. This check shall be performed in accordance with the instrument's technical manual.

6.1.4 High Voltage Check

The high voltage (HV) is adjusted during instrument calibration; additional adjustment for normal operation is not required. However, an HV check is required prior to each use in accordance with the specific instrument technical manual. For some instruments, an HV check in the field is not possible. An instrument with suspected HV problems shall be immediately reported to the SS.

6.1.5 Response Source Check

A response source check is performed to ensure that the instrument will accurately respond to a known source of radiation. Obtain a check source of the proper size, type, and activity for the instrument/detector being used and perform the response source check as follows:

1. Determine the background radiation level. It must be low enough to allow a measurable response to the check source being used. Careful monitoring of changing background levels is necessary to obtain accurate instrument readings.

2. Begin with the instrument on the highest range/scale and energize the audible device, if applicable.
3. Slowly move the detector towards the check source and check the instrument for an increase in audible and/or visual response.
4. Change the range/scale of the instrument as appropriate to obtain a readable indication and to check each of the meter ranges/scales. If an appreciable response cannot be obtained (even in the lowest range), evaluate instrument performance by comparison to previous source check data for the instrument. If no previous source check data are available, comparison should be made to the data associated with similar instruments in use. Notify the SS of any instrument/detector response problems. Document the response on the Ratemeter Daily Instrument Check Sheet. Plot the response on the Control Graph at the bottom of the Ratemeter Daily Instrument Check Sheet.
5. The SS or designee shall set up the control graph on the Ratemeter Daily Instrument Check Sheet such that lines indicate when an instrument is outside of the +/- 20 percent variability.
6. Instruments with day-to-day responses that vary by more than 20 percent under identical conditions shall be removed from service. Notifying the SS of such a condition is required.

A ratemeter-type instrument and detector used to perform measurements for the documentation of a release survey must meet the requirements of Section 6.2 for scaler-type instruments.

Ratemeter instrument inspections, performance verifications, and corrective actions shall be recorded on the Ratemeter Daily Instrument Check Sheet prior to use.

6.2 Surface Contamination Survey Instruments

Ludlum Model 2360 or Model 2224 meters with either Ludlum 43-68 or Ludlum 43-37 detectors will be prepared for use in accordance with the following steps. Also applicable are Ludlum Model 3 or Model 12 meters with a Ludlum 44-9 detector.

6.2.1 Surface Contamination Survey Instrument Pre-Operational Requirements

Prior to the use of these instruments and detectors, the following inspections/operational verifications shall be performed in addition to those required in Section 6.1 for ratemeter-type instruments (i.e., calibration verification, physical check, battery check, HV check).

6.2.2 Background Measurement (Initial Project Setup)

1. Select the desired counting time. The selected time must be consistently used to perform all source and sample counting operations. The counting time directly influences the Minimum Detectable Concentration (MDC) obtained for the instrument. Although the counting time must be long enough to obtain the desired MDC, it must be short enough to be practical. The background measurements should be performed in conjunction with the MDC calculations.
2. Perform the background measurement for the selected time period (t_b) and record the total counts measured on the Scaler Instrumentation Setup Form.
3. Repeat the background measurement 10 times. Record the total counts observed for each measurement..

4. Calculate the average background counts ($\overline{C_b}$) and the standard deviation (SD_b):

$$\overline{C_b} = \frac{\sum_{i=1}^{N} C_{b_i}}{N} \qquad SD_b = \sqrt{\frac{\sum_{i=1}^{N} (C_{b_i} - \overline{C}_b)^2}{N - 1}}$$

Where:

$\sum_{i=1}^{N}$	=	Summation of item 1,2,3…N
$\overline{C_b}$	=	Average number of background counts
SD_b	=	Standard deviation of the background counts
N	=	Number of measurements
C_{b_i}	=	Background counts 1, 2, 3 … N.

5. Record the average background ($\overline{C_b}$), background count time (t_b), and the standard deviation (SD_b) on the Scaler Instrumentation Setup Form.

6. Divide $\overline{C_b}$ by t_b to determine the average background count rate in cpm ($\dot{C}_b$), and record the result on the Scaler Instrumentation Setup Form.

Background is checked at the beginning and end of each workday the instrument is used. Acceptable background response is assessed using the following equation:

$$C_b = \overline{C_b} \pm 3SD_b$$

Where:

$\overline{C_b}$	=	Average background counts
SD_b	=	Standard deviation of the average background counts.

If the background measurement is satisfactory, continue. If the background measurement does not meet this criterion, immediately notify the SS. Record the background measurement on the Scaler Daily Instrument Check Sheet.

6.2.3 Source Response (Initial Project Setup)

Determine the detector source response with a source of known activity of a nuclide with energy decay products similar to those of the nuclide to be monitored, as follows:

1. Correct the source activity for radioactive decay (when necessary) as follows:

$$A = A_o e^{-\lambda T} \quad Where: \lambda = \frac{0.693}{t_{\frac{1}{2}}}$$

Where:

A	=	Present source activity
A_o	=	Source activity at initial assay
λ	=	Decay constant for the source isotope
T	=	Time elapsed since initial source assay
$t_{1/2}$	=	Source isotope half-life.

NOTE: Time units must be consistent (days, hrs., mins., etc.)

2. Count the source for the same time period (t_s) selected during the background measurements (see Section 6.2.2, step 2).

$$\overline{C}_g = \frac{\sum_{i=1}^{N} C_{g_i}}{N} \qquad \overline{C}_n = \overline{C}_g - \overline{C}_b$$

$$SD_g = \sqrt{\frac{\sum_{i=1}^{N} (C_{g_i} - \overline{C}_g)^2}{N - 1}} \qquad SD_n = \sqrt{(SD_g)^2 + (SD_b)^2}$$

At project setup or as otherwise directed by the project-specific work plans or instructions, or the SS, count the source 10 times and calculate the average net counts ($\overline{C}_n$), the standard deviation of the average gross counts (SD_g), and the standard deviation of the average net source counts (SD_n):

Where:

C_{g_i}	=	Gross Source Counts (total counts observed including background) 1 through N
$\overline{C}_b$	=	Average background counts
$\overline{C}_g$	=	Average gross counts
$\overline{C}_n$	=	Average net counts
SD_n	=	Standard deviation of the average net counts
SD_g	=	Standard deviation of the average gross counts
N	=	Number of measurements
SD_b	=	Standard deviation of the average background counts
$\sum_{i=1}^{N}$	=	Summation of item 1,2,3…N.

Record the gross counts (C_{g_i}, where i =1 to N), $\overline{C}_n$, and the standard deviations (SD_n and SD_g) on the Scaler Instrumentation Setup Form.

3. Divide $\overline{C_n}$ by t_s to determine the average net count rate ($\dot{C}_n$) and record the rate on the Scaler Instrumentation Setup Form.

Source response is checked at the beginning and end of each workday the instrument is used. Acceptable source response is assessed using the following equation:

$$C_g - C_b = C_n = \overline{C_n} \pm 3SD_n$$

Where:

$\overline{C_n}$ = Average net counts

C_n = Net Source Count

C_b = Daily Background counts

SD_n = Standard deviation of the average net counts

$$SD_n = \sqrt{(SD_g)^2 + (SD_b)^2}$$

If the source measurement is satisfactory, continue. If the source measurement does not meet this criterion, immediately notify the SS. Record the source measurement on the Scaler Daily Instrument Check Sheet.

6.2.4 Instrument Efficiency

Record the 2 pi instrument efficiency (ε_i) from the instrument Calibration Certificate on the Scaler Instrumentation Setup Form.

6.2.5 Calculation of Minimum Detectable Concentrations

The calculated MDC is determined to ensure that the detector being used will detect the presence of activity at or above the allowable limit under a given set of counting conditions. The MDC is the concentration that a specific instrument and technique can be expected to detect 95 percent of the time under actual conditions of use. MDC is based on the estimated detector efficiency, sample quantity, and the counting time.

The MDC of each instrument shall be determined upon initial setup of the counting system and as needed following modification, calibration, repair, or replacement (i.e., new detector, cables, calibration, etc.). An MDC may need to be determined on specific materials that exhibit a different background than at initial setup. The PHP shall be contacted to determine if an MDC determination is necessary for specific materials.

For scanning building surfaces, the MDC_{scan} should be determined using the following equation (using a value recommended in Appendix A of U.S. Nuclear Regulatory Commission, NUREG-1757, Vol. 2, “Consolidated NMSS Decommissioning Guidance,” for the index sensitivity d’ of 1.38, which is for 95 percent detection of a concentration equal to MDC_{scan} with a 60 percent false positive). The background collection times shall be at least 1 minute, to ensure consistent data collection.

1. Calculate the MDC_{scan} in disintegrations per minute (dpm)/100 square centimeters (cm^2):

$$MDC_{scan}\left(building\ \ surfaces\right)=\frac{1.38\sqrt{\overline{C_{bscan}}}*60}{\sqrt{p}*\varepsilon_i*\varepsilon_s*t_{scan}*\left(A/100\,cm^2\right)}$$

Where:

1.38	=	Index of sensitivity d'
$\overline{C_{bscan}}$	=	Average background counts in time interval t_{scan}
p	=	Surveyor efficiency (0.5)
ε_i	=	Instrument Efficiency for the emitted radiation
ε_s	=	Source Efficiency in emissions/disintegration (0.25 for ^{14}C)
t_{scan}	=	Sample count time, time interval of the observation while the probe passes over the source in seconds.
A	=	Active area of probe in cm^2.

2. Record the calculated MDC_{scan} on the Scaler Instrumentation Setup Form.
3. For static measurements of surface concentrations by either direct measurement or by a smear sample, the MDC_{static} should be determined using the equation from NUREG-1507. The sample collection times should be the same as the selected background times in Section 6.4.1, step 2, if practical. The SS shall consult with the PHP for all other conditions.
4. Calculate the MDC_{static} in dpm/100cm²:

$$MDC_{static}=\frac{3+4.65\sqrt{\overline{C_{bstatic}}}}{K\,(t_{static}\ \ )}=\frac{3+4.65\sqrt{\overline{C_{bstatic}}}}{\varepsilon_i*\varepsilon_s*(A/100cm^2)*t_{static}}$$

Where:

$\overline{C_{bstatic}}$	=	Average background counts during time interval t_{static}
t_{static}	=	Sample counting time, time interval in min. the probe is in direct contact with the surface or smear
K	=	$\varepsilon i*\varepsilon s*(A/100)$ A calibration constant (best estimate) to convert counts/min to dpm/100 cm^2.
A	=	Probe's sensitive area, in cm^2
ε_i	=	Instrument Efficiency for the emitted radiation
ε_s	=	Source Efficiency in emissions/disintegration (0.25 for ^{14}C).

5. Record the calculated MDC_{static} on the Scaler Instrumentation Setup Form.

The calculated MDC_{static} should be less than 50 percent of the appropriate derived concentration guideline level, and while there is no specific recommendation of MDC_{scan}, it should be no more than 50 percent of the appropriate derived concentration guideline level if possible. If the desired MDC

cannot be attained, inspect the instrument for equipment problems (contaminated detector or sample holder, loose cables/connectors, etc.) and notify the PHP. If no equipment problems are found, parameters such as sample quantity, count time, or background radiation levels may have to be adjusted appropriately to obtain an acceptable MDC. If reasonable adjustment of these parameters (as directed by the Radiation Safety Officer) does not result in an acceptable MDC, a more suitable instrument/detector shall be used.

Static counts are reported in dpm/100 cm^2.

7. FORMS

Ratemeter Daily Instrument Check Sheet

Scaler Instrumentation Setup Form

Scaler Daily Instrument Check Sheet

8. REVISION HISTORY AND APPROVAL

Rev Level	Rev Date	Rev Description	Approver
0	8/7/12	Initial Issue	Rick Greene Project Health Physicist Site Supervisor

1. PURPOSE

The purpose of this work Instruction is to describe the methods and procedure for use of the liquid scintillation counter for counting samples at Aptuit, LLC (Aptuit).

2. APPLICABILITY

This procedure is applicable to any Shaw Environmental, Inc. (Shaw) individual involved in the use of the liquid scintillation counter at Aptuit.

3. REFERENCES

3.1 Instruction Manual for Packard Tri-Carb 2900 TR Liquid Scintillation Analyzer

3.2 Aptuit Radiation Safety Program Manual, June 2011

4. DEFINITIONS

TERM/ACRONYM	DEFINITION
Batch	Samples received per shipment date per project
IPA	Instrument Performance Assessment
LSA	Liquid scintillation analyzer
NIST	National Institute of Standards and Technology
SNC	System normalization and calibration
SS	Site Supervisor

5. RESPONSIBILITIES

5.1 Project Health Physicist

The Project Health Physicist is responsible for the maintenance and management of this procedure.

5.2 Site Supervisor/Survey Coordinator

The Site Supervisor (SS)/Survey Coordinator will be responsible for the field oversight of the Survey Technicians performing this procedure. The SS is also responsible for ensuring workers are following this procedure as described herein.

5.3 Survey Technicians

Survey Technicians will be responsible for the field execution of this procedure and for addressing any issues or suggested modifications with the SS or Project Health Physicist.

6. SCOPE

The liquid scintillation instrument consists of opposing photomultiplier tubes, a sample elevator, computer, software, and a printer. This standard operating procedure provides an outline of the procedure for acquiring and analyzing samples for beta radiation using a liquid scintillation analyzer (LSA). This should be combined with the instrument manual and hands-on training for project-specific analysis. The specific LSA used in this laboratory is a Packard Tri-Carb 2900 TR.

Wipe assays are routinely performed to monitor surface contamination for low energy beta emitters. This procedure is applicable to the direct counting of paper wipes in Fisher ScintiSafe Plus scintillation cocktail by LSA.

7. PRINCIPLE

When a beta particle from a wipe is emitted and passes through the liquid scintillation cocktail, a light pulse is emitted by the cocktail. This light emission is detected by the photomultiplier tubes and is registered as a count.

Contamination of a surface can be in many forms, including water-soluble or organic-soluble materials. If water soluble compounds are expected, it may be advisable to add a small amount of water (1-2 percent) to commercially available cocktails designed to accept water-soluble samples. If the contaminant is water-soluble, the water solubilizes it from the surface of the solid support and ensures good contact with the scintillation cocktail. Since a scintillation cocktail is a mixture of organic solvents, there is a good chance that an organic contaminant will also be soluble in the counting solution. Results are reported as disintegrations per minute per wipe.

8. APPARATUS

- National Institute of Standards and Technology (NIST) traceable standards
- Packard Tri-Carb 2900 TR
- Sample Cassettes.

9. LSA COUNTING METHODOLOGY

Counting protocols for the 2900 TR are stored on the instrument computer. Established protocols are defined for the isotope of interest and associated with counting flags. Each individual protocol has parameters, counting options, and data options that are defined and stored when created. The analyst configures the protocols to meet the data quality objectives of each associated analytical procedure or a client specific request.

10. CALIBRATION/INSTRUMENT PERFORMANCE CHECKS

SNC (system normalization and calibration) protocol plug/Instrument Performance Assessment (IPA) standards consist of a purchased set of three NIST traceable sealed quenched standards that are maintained in a sample cassette in the instrument. These standards are run every 24 hours (or prior to instrument use) to monitor instrument background, counting efficiencies, figure of merit (E^2/B), and Chi square values for the tritium and carbon-14 quenched standards. All IPA data are stored on the computer's hard drive for future review. To initialize the SNC count program, the moveable flag on the SNC cassette is pushed to the left position. The F2-Start/Stop key on the computer instrument status page starts the counter.

Blank – Place a clean paper wipe into 17 milliliters of the ScintiSafe cocktail.

11. PROCEDURE

11.1 Sample Collection

Wipe samples are taken and placed directly into 20 milliliters scintillation vials containing 17 milliliters of ScintiSafe cocktail and taken to the laboratory for analysis.

Note: Project requirements may dictate another other sample media and configurations for special cases. In any case, the volume used in the prep blank, laboratory control sample, and spikes should be the same as that used for the samples.

11.2 Sample Preparation

Wear gloves when handling vials to prevent fingerprints. Invert samples until mixed well (should not have any visible emulsion).

Wipe each vial with anti-static wipe and place in counter cassette with appropriate protocol plug.

Load cassettes into sample racks in the following order for counting:

- Blank
- Sample Batch
- QC Samples
- End.

12. CALCULATIONS

Calculations are performed by LSA reporting template.

13. REPORTING

Enter data from instrument printout into appropriate LSA reporting template. All data are reviewed by SS or designee. Results are reported as disintegrations per minute per wipe.

14. QUALITY CONTROL

Minimum detectable concentration is determined each day during the SNC protocol.

15. ATTACHMENTS

None

16. FORMS

None

17. REVISION HISTORY AND APPROVAL

Rev Level	Rev Date	Rev Description	Approver
0	3/15/12	Initial Issue	, CHP Project Health Physicist Site Supervisor

1. PURPOSE

This procedure describes methods and techniques to be employed when performing general decontamination and decommissioning (D&D) activities at the Aptuit, LLC (Aptuit) facility.

2. APPLICABILITY

This procedure applies to decommissioning activities being conducted at Aptuit by Shaw Environmental, Inc. (Shaw) personnel and its subcontractors.

3. REFERENCES

3.1 Aptuit Work Instruction-001, Surface Contamination Surveys for Decommissioning Activities at Aptuit, LLC

3.2 Aptuit Work Instruction-005, Control of Radiological Work for Decommissioning Activities at Aptuit, LLC

3.3 Aptuit Work Instruction-007, Radiological Characterization for Decommissioning Activities at Aptuit, LLC

3.4 Aptuit Radiation Safety Program Manual, March 2008

4. DEFINITIONS

TERM/ACRONYM	DEFINITION
ACM	asbestos containing material
ALARA	as low as reasonably achievable
API	Active Pharmaceutical Ingredients
CFH	chemical fume hood
DCGL	derived concentration guideline level
D&D	decontamination and demolition
DP	decommissioning plan
FT	field technician
HASP	health and safety plan

TERM/ACRONYM	DEFINITION
HEPA	high efficiency particulate air
HP	health physics
LOTO	lockout/tag out
PHP	project health physicist
PPE	personal protective equipment
SO	Scientific Operations
SS	site supervisor

5. RESPONSIBILITIES

5.1 Project Health Physicist

The Project Health Physicist (PHP) is responsible for the maintenance and management of this procedure.

5.2 Site Supervisor

The Site Supervisor (SS) will be responsible for the field oversight of the personnel performing this procedure. Specific responsibilities include:

- Ensuring that the proper tools and equipment are available for the performance of D&D tasks
- Ensuring that the proper personal protective equipment (PPE) is available for the performance of D&D tasks
- Reviewing this procedure with all personnel that will be performing the work prior to beginning the tasks
- Periodically observing the performance of the D&D tasks to ensure that they are being performed according to this procedure
- Reviewing completed tasks to ensure that all objectives and requirements have been met.

5.3 Field Technicians

Field Technicians (FTs) will be responsible for the field execution of this procedure and for addressing any issues or suggested modifications with the SS.

The FT is responsible for the proper execution of D&D activities. Specific responsibilities include:

- Inspecting all tools and equipment prior to use to ensure that they are in good working condition
- Inspecting all PPE prior to use to ensure that it is in good working condition

- Performing all D&D activities in full compliance with this procedure, the procedures referenced in Section 3, the project Decommissioning Plan (DP), the project health and safety plan (HASP), and the Aptuit Radiation Safety Program Manual.

6. EQUIPMENT AND MATERIALS

- High efficiency particulate air (HEPA) vacuum cleaner
- Mercury vapor analyzer (Jerome 431-X or other make/model)
- Radiation detection instruments (see Aptuit WI-002)
- Record/log sheets (e.g., survey forms, checklists, sample collection logs, field activity daily logs)
- Hand tools, including wrenches, screw drivers, hammers, pry bars, etc.
- Plastic sheeting
- Duct tape
- Materials for building isolation containment (3 & 6 mil poly sheeting, wood framing, duct tape)
- Power tools, including drills, saws, etc.
- Fixative and fixative applicator Waste packaging
- Ladders
- Manlift
- Fall protection (personal fall arrest systems or fall restraint systems)
- Crane
- PPE.

7. PREREQUISITES

- Prior to being assigned to perform D&D work for the first time, FTs will receive project and site-specific radiation awareness training to include radiation safety requirements of the license. This training will be documented.
- A daily briefing will be conducted prior to start of work to review specific work steps/tasks, to update any work requirements/conditions as applicable, and to review safety hazards and control methods. This meeting will be documented. Documentation may be on the Job Safety Analysis/Tailgate Safety Meeting form.

- Prior to D&D activities, the contents of the Scientific Operations (SO) laboratories, including laboratory equipment and chemicals, will be removed and the areas will be made available to perform decommissioning work.
- The Health Physics (HP) Support Area, which includes rooms B2-116, B2-117, and B2-119, will be designated to house D&D base operations, tools, instrumentation, and equipment. Ladders and other large D&D equipment may be kept in other rooms designated as D&D support areas.
- Utility disconnections will be performed, as necessary, and all energized sources will be properly locked out/tagged out (LOTO) in accordance with 29 CFR 1910.147. Utility disconnects to be conducted prior to the commencement of decommissioning fieldwork may include, but are not limited to, water, gas, air, and electrical power. All utilities will be verified to have been physically disconnected and/or properly LOTO prior to commencement of D&D activities.
- Prior to initiating any component disassembly or removal activities, physical barriers will be established to limit access to work areas. In addition, signage and/or caution tape will be placed around the work sites to provide a warning of the activities taking place.
- Verification that all project staff are trained/qualified commensurate with assignments in accordance with this procedure will be obtained.
- Ensure FTs have proper PPE for activities being performed based on area postings and site control requirements.
- Ensure the job hazard analysis has been conducted for the D&D activities and that all workers are properly briefed on the hazards anticipated.
- FTs will be instructed on the potential radiological hazards that may be present in the work areas.
- Lab benches and other work surfaces will be wiped down with an appropriate cleaner prior to initiating demolition activities.

NOTE: Minimum PPE for performance of D&D activities will be hard hat, steel-toed boots, and safety glasses.

8. INSTRUCTIONS

8.1 Storage Cabinets and Freezers

Storage cabinets and freezers in the Active Pharmaceutical Ingredients (API) area will be surveyed to characterize for waste disposal. The disposal will be performed as follows:

- The storage cabinet and freezer surfaces will be surveyed for radiological contamination as specified in Aptuit WI-001.
- Storage cabinets and freezers that are not radiologically contaminated above Aptuit's acceptable surface contamination levels (i.e., release criteria) will be disposed of as construction debris.
- Storage cabinets and freezers that do not meet the free release criteria (i.e., >acceptable surface contamination levels) will be loaded into the radiological waste container.

- Storage cabinets and freezers may be transported to the appropriate waste container using hand trucks or carts.
- The work area will be cleaned with a HEPA vacuum after the storage cabinet and freezer removal has been completed.

8.2 Wall Cabinetry

All wall cabinetry in the API area will be removed and characterized for waste disposal. The removal and disposal will be performed as follows:

- Cabinets will be removed from the walls by loosening and removing wall mounting hardware, typically found in the interior of the cabinets, with hand or power tools.
- The cabinet surfaces will be surveyed for radiological contamination as specified in Aptuit WI-001.
- Cabinets that do not meet the release criteria will be loaded into the radiological waste container for disposal.
- Cabinets that are not radiologically contaminated above the release criteria will be disposed of as construction debris.
- The cabinets may be transported to the appropriate waste container using hand trucks or carts.
- The work area will be cleaned with a HEPA vacuum after the wall cabinetry removal has been completed.

8.3 Bench Tops and Tables

The bench tops and tables in the API area will be removed and characterized for waste disposal. The removal and disposal will be performed as follows:

- Any bench tops or table tops that are determined to be asbestos containing material (ACM) will be removed by a Missouri registered asbestos contractor. All required controls and PPE will be utilized during the handling of ACM. The ACM will be managed to prevent nonfriable materials from being damaged and made friable.
- The ACM and ACM-related materials, including PPE used during the handling of ACM, will be consolidated to the extent possible.
- Bench tops and tables may be transported to the appropriate waste container using hand trucks or carts.
- ACM bench tops and table tops will be surveyed for radiological contamination as specified in Aptuit WI-001.
- ACM bench tops and table tops with radiological contamination above the release criteria will be properly packaged in accordance with federal and state regulations and disposed of as mixed waste.

- ACM bench tops and table tops that are not radiologically contaminated above the free release criteria will be packaged and disposed of in a permitted landfill in accordance with Missouri ACM disposal rules.
- Non-ACM bench tops and tables will be surveyed for radiological contamination as specified in Aptuit WI-001.
- Non-ACM bench tops and table tops with radiological contamination above the release criteria will be decontaminated or properly packaged and disposed of as radiological waste.
- Non-ACM bench tops and table tops that are not radiologically contaminated above the free release criteria will be disposed of as construction debris.
- The work area will be cleaned with a HEPA vacuum after the bench top and table top removal has been completed.

8.4 Sink Trap and Strainer Removal

The p-traps associated with the sinks in the chemical fume hoods (CFH) will be removed and characterized for waste disposal. In addition, p-traps and strainers associated with laboratory bench tops will also be removed and characterized. The p-traps and strainers will be dismantled as follows:

- Prior to beginning work, plastic sheeting will be placed on the floor and on the bottom of any cabinets in the area of the traps or any required pipe disconnections. The plastic sheeting is intended to protect the floor from any leaked or spilled liquids or debris.
- Personnel will utilize appropriate PPE, including safety-toed shoes, Tyvek® suits, safety glasses or face shields, and nitrile gloves at a minimum. Any traps/strainers found to have mercury vapor readings greater than 0.01 milligrams per cubic meter, which is 1/10 of the U.S. Occupational Safety and Health Administration ceiling level, will be removed using Level C PPE with the appropriate mercury vapor cartridge.
- The sink trap openings will be measured for mercury vapor using a mercury vapor analyzer. The mercury vapor measurements will be recorded.
- The sink trap openings will be measured for radiological contamination as specified in Aptuit WI-001 and WI-007 and the radiological survey measurements will be recorded on radiological survey forms.
- The traps and strainers will be removed at mechanical joints where possible. Where the pipe is welded or rusted together, or otherwise cannot be mechanically disassembled, the traps and strainers may be removed using a pipe cutter or reciprocating saw. Hearing protection will be used while operating power tools.
- The liquid contents of the traps will be poured into U.S. Department of Transportation-approved plastic buckets with lids.
- Once removed, the traps/strainers will be measured a final time for mercury vapor and the value recorded. Traps/strainers that exhibit mercury contamination and any associated solid residues will be segregated as hazardous waste. If only radiological contamination is detected, the trap/strainer and any associated solid residues will be segregated as radioactive waste. The solids residues will be removed from non-mercury, non-radiologically contaminated sink traps/strainers and placed in appropriate containers. Sink traps/strainers

that do not exhibit mercury and meet radiological release criteria will be disposed as construction debris.

- All sink trap and strainer components will be surveyed as specified in Aptuit WI-001 to ensure that radiological release criteria are met. Wipe samples will be collected from the openings of the sink traps. Sink traps and strainers that do not meet radiological release criteria will be segregated and managed as radioactive waste.
- After the final determination of mercury and radiologically contaminated and non-contaminated residues described above is made, trap liquid residues will be combined with like liquids as characterized. All liquid wastes from mercury-only contaminated traps will be combined, containerized appropriately, and labeled as pending analysis. All radiological contamination-only liquid waste will be combined and containerized appropriately for disposal. Liquid collected from traps that are not found to be mercury or radiologically contaminated will be combined and containerized for disposal.
- The work area will be cleaned with a HEPA vacuum after the sink trap/strainer removal has been completed.

8.5 Utility Service Line Removal

The utility service lines in the API area, including the vacuum lines, water lines, and gas lines, as well as a vacuum line remaining in B2-119, will be characterized and removed, as necessary. Most of the lines are made of galvanized steel, carbon steel, or copper and range in diameter from ¾” to 2”. The lines will be removed as follows:

The first step will include performing a survey of the exterior of the lines as specified in Aptuit WI-001.

Any detected removable radiological contamination will be removed with a cleaning agent and water-wetted rags.

After confirming that the system has been properly LOTO, the lines from the fume hoods in the API area to the header will be cut and removed.

The cut lines will be surveyed for waste characterization.

After the feeder lines are removed, wipe samples of the interior of the header line will be collected through the openings.

If the header line is found to be radiologically contaminated, it will be removed and disposed of as radioactive waste.

If the header line is not found to be contaminated, then the openings will be capped and the header will be left in place and returned to service.

The vacuum line in B2-119 will be characterized and either left in place or disposed appropriately.

Utility service lines that are removed and meet the release criteria may be recycled.

The work area will be cleaned with a HEPA vacuum after the line removal has been completed.

8.6 Chemical Fume Hood Removal

CFHs will be removed as part of decommissioning activities. The CFHs will be removed as follows:

CFHs with known radioactive contamination will be delineated and surveyed as specified in Aptuit WI-001 and WI-007 before and after any decontamination attempts.

A visual inspection of the CFHs will be conducted.

If debris or visual contamination is observed, including pooled liquids, oily smears, etc., it is left to the discretion of the worker to decontaminate the area.

A HEPA vacuum may be used to remove debris.

Exterior and accessible interior surfaces of the CFH may be wiped with rags with a detergent-water mixture. If residues remain after the initial cleaning, the affected surfaces may be cleaned again using more vigorous techniques or cleaning agents until visibly clean (as is practicable).

Upon completion of the initial inspection and any decontamination, the following activities will be conducted for each CFH:

- All utilities will be verified to be LOTO and disconnected.
- Yellow caution tape and signs will be posted outside the doors leading to rooms where work is being performed to warn personnel of the activities being performed.
- Plastic sheeting will be placed on the floor in the vicinity to collect any debris and protect the floor.
- Any ACM components (transite panels, benchtop) of the CFH will be thoroughly examined for breaks, which will be secured by covering exposed edges with duct tape.
- Sink traps associated with the CFH will be removed as described in Section 8.4.
- All asbestos abatement will be completed as described in Section 8.3 for any CFHs that contain ACM.
- The CFH may be disassembled, as necessary, so that the pieces are small enough to be transported to the waste container. The CFH will be disassembled using hand tools or power tools to remove the screws or bolts that hold the pieces together.
- The pieces of the CFH may be transported to the appropriate waste container using a hand truck or cart or hand carried if small and light enough.
- The CFH pieces will be surveyed and sampled for surface contamination as specified in Aptuit WI-001 to determine if the radiological release criteria are met.
- CFH pieces with contamination levels in excess of the release criteria will be placed in the radiological waste container and disposed of as radiological waste. It is anticipated that most, if not all, of the CFHs will be disposed of as radiological waste.
- CFH pieces that meet the free release criteria may be disposed of as construction debris.
- The work area will be cleaned with a HEPA vacuum after the chemical fume hood removal has been completed.

8.7 Exhaust Duct Removal

Aptuit will disconnect and remove exhaust ductwork from CFHs and snorkel exhausts. Ductwork will be characterized as described in WI-007 prior to removal. In addition, impacted legacy ductwork will be investigated and removed, as necessary. Disconnection and removal will proceed as follows:

- Yellow caution tape and signs will be posted outside the doors leading to rooms where work is being performed to warn personnel of the activities being performed.
- Plastic sheeting will be placed on the floor below the ductwork to collect any debris and protect the floor.
- The upper side of any adjacent ceiling tiles may be HEPA vacuumed of loose debris and dust as it is removed to allow work on the ducting.
- Personnel will utilize appropriate PPE, including safety-toed shoes, eye protection, Tyvek suits, and nitrile gloves, at a minimum. Task-specific health and safety requirements specified in the job safety analysis will be briefed prior to each shift.
- If radiological contamination exceeds the action level specified in the radiological controls procedure (WI-005), a fixative to prevent removable radiological contamination from becoming airborne may be sprayed on the interior surfaces of the duct sections prior to removing each section.
- Ductwork will be removed from the closest point of amenable disconnection near the laboratory wall face to the CFH. Snorkel exhaust ductwork will be removed from the point of connection to the laboratory equipment to the joint at the main exhaust duct.
- All removed ductwork will be surveyed and sampled as specified in Aptuit WI-001 to ensure that radiological release criteria are met.
- Any ductwork with suspect internal contamination will have the ends wrapped and taped and will be segregated as suspect radioactive waste.
- Sections of ductwork of a manageable length will be disassembled at mechanical joints by removing bolts/screws using wrenches or screwdrivers or cut with an electric saw.
- Personnel on multiple stepladders or manlift, as necessary, will be utilized to safely lower the ductwork sections to the floor in a controlled manner. In addition, temporary supports may be created to support and secure the duct, as necessary, to ensure a safe disassembly.
- The sections will be wrapped in plastic sheeting and packaged with duct tape.
- Ductwork sections that do not meet the release criteria will be placed in the radiological waste container for disposal.
- Ductwork that does meet the release criteria may be disposed of as construction debris.
- The work area will be cleaned with a HEPA vacuum after the ductwork removal has been completed.

8.8 Exterior and Rooftop Exhaust Components

As part of decommissioning activities, the exterior components of the API exhaust system will be removed, surveyed for radiological contamination, and disposed of appropriately. The exterior API exhaust system components include a HEPA filter system, ductwork, two fans, and a 30” diameter metal stack. In addition, select B Building rooftop fan assemblies and associated exhaust duct and stacks will be surveyed for radiological contamination, removed as necessary, and disposed of appropriately.

Disassembly and removal of the exterior and rooftop exhaust components will include the following tasks:

- Prior to beginning decommissioning work on the roof, the structural capacity of the roof will be evaluated by a structural engineer through review of as-built drawings and/or visual inspection. The structural engineer will confirm that the load capacity of the roof where the decommissioning activities are going to be performed is adequate for the weight of the work crew and their equipment.
- All crew members working in proximity of roof edge or roof openings will be trained and equipped in use of mandatory fall protection harness usage and application thereof for all roof operations conducted during the decommissioning.
- Yellow caution tape and warning signs will be posted around all work areas prior to beginning any decommissioning activities. In addition, temporary fencing will be placed around areas where any crane or overhead operations will occur.
- Prior to beginning any crane or overhead work, the work areas will be inspected for any overhead or ground level hazards. All identified hazards will be discussed by the D&D team responsible for performing the work and a hazard abatement plan will be established and adhered to by the team.
- The HEPA filters for the API exhaust system are assumed to be radiologically contaminated above the release criteria based on previous survey results of the interior of the HEPA housing. The HEPA housing is equipped with a bag-in/bag-out containment system. The HEPA filters will be removed utilizing the bag-in/bag-out system and placed in the radiological waste container for disposal.
- The HEPA filter housing is assumed to be radiologically contaminated above the release criteria based on previous survey results and will either be decontaminated or disposed of as radiological waste. The HEPA filter housing will be disassembled with hand tools or power tools, as necessary, so that the pieces are small enough to be transported to the decontamination area or the radiological waste container. Open ends of the housing will be covered with plastic sheeting.
- The duct connecting the HEPA system, fans, and stack will be disassembled, removed, and surveyed for radiological contamination. The duct may be disassembled using hand or power tools. For interior exhaust system components, if radiological contamination exceeds the action level specified in the radiological controls procedure (WI-005), a fixative to prevent removable radiological contamination from becoming airborne may be sprayed on the interior surfaces of the duct sections prior to removing each section. For aggressive dismantling or size reduction on exhaust system components that are exterior to the

building, if radiological contamination exceeds the action level for environmental controls (Decommissioning Action Levels in WI-005), then one or more of the following shall be used to control potential releases to the environment:

  - o Use a fixative to prevent contamination from becoming airborne
  - o Perform the aggressive dismantling/size reduction operations in a containment structure.

- All removed ductwork will be surveyed and sampled as specified in Aptuit WI-001 to ensure that radiological release criteria are met. Any ductwork with suspect internal contamination will have the ends wrapped and taped and will be segregated as suspect radioactive waste.
- Sections of ductwork of a manageable length will be disassembled at mechanical joints by removing bolts/screws using wrenches or screwdrivers or cut with an electric saw.
- For aggressive dismantling or size reduction of exhaust system components that are exterior to the building, if radiological contamination exceeds the action level for environmental controls (Decommissioning Action Levels in WI-005), then one or more of the following shall be used to control potential releases to the environment:
  - o Use a fixative to prevent contamination from becoming airborne
  - o Perform the aggressive dismantling/size reduction operations in a containment structure.
- The sections will be wrapped in plastic sheeting and packaged with duct tape.
- The sections will be lowered to the ground one section at a time using a crane or ropes.
- Ductwork sections that do not meet the release criteria will be placed in the radiological waste container for disposal.
- Ductwork that does meet the release criteria may be disposed of as construction debris.
- The fans and stack associated with the API exhaust system will be removed and surveyed for radiological contamination.
- The fans may be removed with a crane or may be disassembled into components small enough to be handled by hand using carts or with a forklift.
- The stack will be removed using a crane. The open ends of the fans and stacks will be covered with plastic sheeting.
- If the fans and stack sections do not meet the radiological release criteria, they will be placed in the radiological waste container for disposal.
- If the fans and stack sections meet the release criteria, they may be disposed of as construction debris.
- Five fan assemblies located on the rooftop of B Building will be surveyed for radiological contamination and removed if found to be contaminated. The fan assemblies to be surveyed are designated BR-EF 21A, BR-EF 21B, BR-EF 23, BR-EF 24, and BR-EF 26. The fan assemblies may be removed using a crane. All openings on the fan assemblies will be

blanked or sealed prior to moving them. Trained and qualified personnel will perform the rigging and crane operation procedures.

- Fan assemblies identified as radiologically contaminated will be placed in the radiological waste container for disposal.
- Fan assemblies that meet the radiological release criteria may be disposed of as construction debris.
- The rooftop stacks associated with the BR-EF 21A, BR-EF 21B, BR-EF 23, BR-EF 24, or BR-EF 26 exhaust fans that are determined to be radiologically contaminated, as described above, will be removed. The stacks will be lowered to ground level with a crane. Trained and qualified personnel will perform the rigging and crane operation procedures.
- Once on the ground, the stacks will be cut into smaller sections and surveyed for radiological contamination. The open ends of the stack sections will be covered with plastic sheeting.
- Stack sections that do not meet the radiological release criteria will be placed in the radiological waste container for disposal.
- Stack sections that meet the release criteria may be disposed of as construction debris.

8.9 Incinerator Removal

The incinerator in room B2-103A, along with the associated ductwork, filter, and stack, will be removed and disposed of appropriately. The incinerator will be removed as follows:

- The exterior and interior surfaces of the incinerator will be surveyed for waste characterization and contamination control purposes.
- Any removable radiological contamination detected on the exterior will be removed using a cleaning agent and water-wetted rags.
- The ductwork, filter, and filter housing will be removed, characterized, and disposed of appropriately.
- The angle iron securing the stack to the side of B Building will be disconnected or cut and the stack will be lowered to the ground using a crane.
- Once on the ground, the stack will be characterized, cut into smaller sections, and disposed of appropriately, either as radiological waste or construction debris. For aggressive dismantling or size reduction of the incinerator stack, if radiological contamination exceeds the action level for environmental controls (Decommissioning Action Levels in WI-005), then one or more of the following shall be used to control potential releases to the environment:
    - Use a fixative to prevent contamination from becoming airborne
    - Perform the aggressive dismantling/size reduction operations in a containment structure.
-
- Prepare the incinerator by blanking or sealing all openings in the incinerator and the attached pipe, instruments, and equipment.

- Remove a section of the south wall of B2-103A to provide access to move the incinerator out of the building. The walls of B2-103A are constructed of concrete block with brick veneer.
- Survey the wall section planned for removal to determine if the wall materials can be disposed of as nonhazardous construction waste or if they require disposal as radiological waste.
- If radiological surveys indicate that contamination on building surfaces in the incinerator room or incinerator components exceeds the action level for environmental controls (Decommissioning Action Levels in WI-005), then a containment structure shall be used to contain potential releases to the environment.
- The wall section will then be removed using a concrete saw and/or an electric or pneumatic jackhammer. Dust suppression will be implemented, as necessary.
- The wall waste will be disposed appropriately, as indicated by the prior survey results.
- After a hole in the wall has been created, the incinerator will be slid out of B2-103A using a heavy duty forklift, crane lift, or other equipment with a rated capacity to safely handle the load.
- Once removed, the incinerator will be wrapped in plastic sheeting, loaded onto a trailer with a crane and prepared for transportation to the appropriate disposal site.
- After the incinerator has been removed, the floor area under where it had been located will be cleaned with a HEPA vacuum.
- The floor area will then be surveyed to determine if there is any residual radiological contamination on the floor.
- Any detected removable contamination will be removed with a cleaning agent and water-wetted rags.
- Any detected fixed radiological contamination will be cut out and disposed of as radiological waste.

8.10 Laboratory B3-298

Laboratory B3-298 will be decommissioned as follows:

- After all of the equipment and materials have been removed from B3-298, the surfaces in the room, including bench tops, cabinets, floor, and walls, will be cleaned with a HEPA vacuum.
- The surfaces will then be surveyed for radiological contamination as specified in Aptuit WI-001.
- If any removable radiological contamination is detected, it will be removed using a cleaning agent and water-wetted rags.
- Any surfaces with fixed radiological contamination above the release criteria will be removed, packaged, and placed in the radiological waste container for disposal.

8.11 Waste Storage Building

The waste storage building will be decommissioned as follows:

- After all of the equipment and materials have been removed from the waste storage building, the surfaces in the room, including shelves, floor, and walls, will be cleaned with a HEPA vacuum.
- The surfaces will then be surveyed for radiological contamination as specified in Aptuit WI-001.
- If any removable radiological contamination above the release criteria is detected, it will be removed using a cleaning agent and water-wetted rags. Brushes may be used if more vigorous cleaning is required to remove the contamination.
- The cleaning items will be placed in a closed-top bucket or drum suitable for radiological waste, which will then be placed in a radiological waste container for disposal.
- Any surfaces with fixed radiological contamination above the release criteria will be removed, packaged, and placed in a radiological waste container for disposal.

8.12 Walls, Floors, Drains

The walls, floors, and drains of the SO area will be decommissioned as follows:

- After the rooms have been cleared of equipment, hoods, bench tops, tables, and cabinets, the building surfaces, including walls, floors, and drain openings will be cleaned with a HEPA vacuum, if they have not already been cleaned with a HEPA vacuum.
- A visual inspection and radiological survey will be performed on building surfaces including walls, floors, and drain openings. The visual inspection will be conducted to identify any visible contamination (e.g., oily smears, etc.).
- If debris or residues are observed, a HEPA vacuum may be tried again to remove any remaining debris. In addition, rags wetted with water or a cleaning agent may be used to remove any residues until visibly clean. Brushes may be used if more vigorous cleaning is required to remove the residue.

- Radiological characterization surveys will consist of scanning and bias measurements of gross beta activity and wipe sampling to determine removable contamination levels. The survey locations, methods, and findings will be documented. Survey results will be used to determine if remedial actions are needed to meet release criteria (i.e., activity below derived concentration guideline level (DCGL) and as low as reasonably achievable [ALARA]).
- Surfaces that are found to meet the radiological release criteria will be left in place.
- Surface areas that exceed the release criteria will be removed by cutting out the contaminated areas with the appropriate saw or tool. The removed surfaces will be properly packaged and placed in a radiological waste container for disposal.

8.13 HP Support Areas

The final spaces to be decommissioned are the HP support areas, which include rooms B2-116, B2-117, and B2-119. The HP support areas will be decommissioned as follows:

- After the HP support areas have been cleared of equipment, bench tops, tables, and cabinets, the building surfaces, including walls, floors, and drain openings will be cleaned with a HEPA vacuum.
- A visual inspection and radiological survey will be performed on building surfaces including walls, floors, and drain openings. The visual inspection will be conducted to identify any visible contamination (e.g., oily smears, etc.).
- If debris or residues are observed, a HEPA vacuum may be tried again to remove any remaining debris. In addition, rags wetted with water or a cleaning agent may be used to remove any residues until visibly clean. Brushes may be used if more vigorous cleaning is required to remove the residue.
- Radiological surveys will consist of scanning and bias measurements of gross beta activity and wipe sampling to determine removable contamination levels. The survey locations, methods, and findings will be documented. Survey results will be used to determine if remedial actions are needed to meet release criteria (i.e., activity below DCGL and ALARA).
- Surfaces that are found to meet the radiological release criteria will be left in place.
- Surface areas that exceed the release criteria will be removed by cutting out the contaminated areas with the appropriate saw or tool. The removed surfaces will be properly packaged and placed in the radiological waste container for disposal.

9. ATTACHMENTS

None

10. FORMS

None

11. REVISION HISTORY AND APPROVAL

Rev Level	Rev Date	Rev Description	Approver
0	8/7/12	Initial Issue	
1	3/14/13	Added text to Sections 6, 8.8, and 8.9 to address use of environmental controls	Rick Greene Project Health Physicist Site Supervisor

1. PURPOSE

This procedure provides information necessary to control radiological work during Aptuit, LLC (Aptuit) decommissioning activities. Control of work involving radioactive materials shall be accomplished by establishing radiological standards and responsibilities, using radiological protection personnel to monitor performance of radiological work, training workers in radiation hazards, and providing personnel with Work Instructions (WI)s and/or Radiation Work Permits (RWPs). RWPs shall include the radiological protection measures and controls necessary for safe and compliant completion of the job.

2. APPLICABILITY

This procedure applies to decommissioning activities being conducted at Aptuit by all decommissioning personnel.

3. REFERENCES

3.1 Aptuit Radiation Safety Program Manual, March 2008

3.2 U.S. Nuclear Regulatory Commission (NRC), 1993, *Air Sampling in the Workplace*, NUREG-1400, September.

4. DEFINITIONS

TERM/ACRONYM	DEFINITION
ALARA	As Low As Reasonably Achievable
ALI	annual limits on intake
API	Active Pharmaceutical Ingredients
Ci	Curie
^{14}C	carbon-14
CA	Contamination Areas
D&D	decontamination and demolition
^{3}H	tritium
HEPA	high efficiency particulate air

TERM/ACRONYM	DEFINITION
mrem	millirem
PHP	Project Health Physicist
PPE	personal protective equipment
QC	quality control
RCT	Radiological Control Technician
RSO	Radiation Safety Officer
RSPM	Radiation Safety Program Manual
RWPs	Radiation Work Permits
SS	Site Supervisor
SS/SC	Site Supervisor/Survey Coordinator
ST	Survey Technician

5. RESPONSIBILITIES

5.1 Project Health Physicist

The Project Health Physicist (PHP) is responsible for the maintenance and management of this procedure and for determination of action levels.

5.2 Site Supervisor/Survey Coordinator (SS/SC)

The Site Supervisor (SS) will be responsible for the field oversight of the Survey Technicians (ST) involved with decommissioning activities. A Shaw Health Physicist or Radiological Control Technician (RCT) will be designated for this position. The SS/SC is responsible for the supervision of the following:

- Proper donning and doffing of personal protective equipment (PPE)
- Proper entry and exit of personnel from Contamination Areas (CA)
- Selecting and ensuring properly calibrated and tested equipment is available for the performance of survey/sampling tasks
- Ensuring proper training has been provided prior to start of work
- The implementation of use of personnel monitoring, as applicable
- Establishment of Radiation Work Permits (RWP) as necessary
- Reviewing collected data for accuracy

- Establishment of methods to ensure contamination control
- Use of proper postings in designated areas

5.3 Survey Technicians

STs are responsible for the proper execution of survey and sampling activities. Specific responsibilities include:

- Ensuring all portable instrumentation is properly calibrated and checked prior to use
- Performing all data collection activities in full compliance with the established protocols
- Properly documenting all survey/sampling activities.

6. METHODS TO CONTROL RADIOLOGICAL WORK

6.1 Contamination Control Program

Contamination control methods may include pre-cleaning of accessible surfaces, use of a high efficiency particulate air (HEPA) vacuum to remove visible dust, use of plastic sheeting to protect adjacent surfaces as necessary, use of foam or fixatives to prevent the spread of contamination, establishment of contamination control zones, and use of step-off pads at access/egress areas.

6.2 Radiation Work Permits (RWPs)

- RWPs will be utilized to control access to restricted areas including Contamination Areas.
- RWPs will be based on evaluation of individual decommissioning tasks and the hazards applicable to those tasks
- RWPs will be reviewed and approved by the Radiation Safety Officer (RSO) or his designee.
- RWPs will be managed and evaluated by the RSO throughout the decommissioning project
- The RSO or designee will review all procedures in the RWP with individuals performing decommissioning tasks
- Acknowledgement of the understanding of the RWP and agreement to abide with its conditions will be documented on the applicable entry log form

6.3 ALARA

As Low As Reasonably Achievable (ALARA), when used to describe exposures to radiation workers, means that every reasonable effort has been made to maintain exposures to radiation workers as far below the dose limits specified in the regulations as is practical, consistent with the purpose for which the licensed activity is undertaken.

Techniques that will be used on this project to minimize radiation exposure (even though exposures are well below the regulatory limits) include the following:

- Project and site-specific radiation awareness training
- Pre-cleaning exposed surfaces that are potentially contaminated
- Use of PPE as appropriate

- Radiological surveys for exposure and contamination control
- Radiological surveys for uncontrolled release of equipment and areas
- Use of HEPA vacuum to control dust
- Use of containment systems to control contamination
- Use of radiation work permits, as needed, to control radiological work.

6.4 Work Planning

The objectives of the radiological planning of work shall be to ensure that the worker's radiation exposures are maintained ALARA, to minimize the creation and spread of surface contamination, to minimize the creation and spread of airborne radioactive material, and to minimize the creation of radioactive waste.

6.5 Personal Protective Equipment (PPE)

STs shall have proper personal protective equipment (PPE) for the area to be entered based on area postings and site control requirements. The minimum PPE for performance of work in Contamination Areas will be latex or nitrile gloves, shoe covers and safety glasses. PPE may be upgraded as conditions warrant (see Section 6.11, Action Levels).

Proper donning and doffing of PPE is required. Proper methods will be reviewed prior to initial entry. The RSO will perform regular review of radiological conditions encountered during decommissioning activities. If contamination levels exceed those anticipated, the RSO will evaluate the need for additional protective measures.

6.6 Training

- All personnel involved with decommissioning must have training and qualifications commensurate with their assignments. Minimum training for workers performing decommissioning activities include current Radiation Worker Training (RWT). Training topics that must be included (but are not limited) in RWT are:
    - Radiological Fundamentals
    - Biological Effects
    - Radiation Detection and Measurement
    - Principles of Radiation Protection
    - Regulatory Requirements
- In addition, all personnel involved with decommissioning will receive project and site-specific radiation awareness training to include radiation safety requirements of the license. This training will be documented.

6.7 Personnel Monitoring

Although personnel external dosimetry, personal air samplers, and other personal measurements (e.g., bioassay monitoring) are not required during decommissioning activities based on potential exposures, Aptuit may, at its discretion, employ certain monitoring methods to acquire data as needed. The RSO will perform regular review of radiological conditions encountered at the site to determine if any necessary actions are required. Surveys for removable contamination will be performed during routine operations and special operations, as determined necessary by the RSO.

6.8 Workplace Air Sampling and Respiratory Protection

Based on the evaluation of maximum potential exposures (see Section X of the Decommissioning Plan), it is unlikely that an individual could have an intake of radioactive material in excess of 1 percent of the applicable annual limits on intake (ALIs), or a total effective dose equivalent in excess of 1 percent of the occupational dose limit. Therefore, the use of respiratory protection is not warranted. Based on this evaluation, there is also no requirement for individual monitoring of occupational dose as established in 10 CFR 20.1502(a)(1) and (b)(1). Although the assessment of potential airborne hazards did not identify the need for air sampling, monitoring or sampling for airborne radioactive material hazards may be conducted when contamination levels exceed the action levels in Section 6.11, as directed by the RSO, when opening contaminated systems or when performing aggressive decontamination or demolition activities.

6.9 Internal Exposure Determination

The evaluation of maximum potential exposures demonstrates that monitoring of internal dose is not required. However, the RSO will determine if decommissioning personnel will participate in the bioassay program based on survey results, activities being performed, and control methods used when contamination levels exceed the action levels in Section 6.11. The general guidelines for internal dose monitoring from the Radiation Safety Program Manual RSPM are found in Table 4-1.

Bioassay for ^{3}H and ^{14}C is by urinalysis. Scheduling of bioassay tests will be coordinated through the RSO. In addition, appropriate bioassay may be performed whenever an internal exposure to radioactive materials is suspected.

Records of all monitored individual exposures are maintained by the RSO.

6.10 Radiological Areas and Postings

- Radiological areas shall be posted as applicable by the RSO. Typical postings may be:
  - **Radioactive Materials Area** - Any area or room where quantities of radioactive materials in excess of 10 times the 10 CFR 20, Appendix C quantities are used or stored, or any area designated by the RSO.
  - **Contamination Area (CA)** - An area, accessible to individuals, in which removable surface contamination levels on equipment or solid surface materials are equal to or exceed 1000 dpm/100 cm^2.
- **Entry/Exit from a CA** – proper entry and exit requirements will be stated in the applicable Radiation Work Permit (RWP). The RWP will be generated by the SS/SC and reviewed with individuals prior to entry into a CA.

6.11 Action Levels

Action levels that require consideration for an upgrade in radiological controls, such as additional PPE (i.e. respirator use, Tyvek overalls, etc.), air monitoring, etc., have been determined for building surfaces and exhaust system components based on an assessment of the radiological hazards involved with decommissioning activities. After a review of the radioactive contaminants of concern, a review of facility operational and characterization surveys, the facility radioactive material inventory, and exhaust stack release data, the most significant potential for dose to the worker during decommissioning activities was determined to be internal exposure during removal of the Active Pharmaceutical Ingredients (API) exhaust system (hoods, ducts, and HEPA housing).

Action levels for ^{3}H and ^{14}C were calculated for both building surfaces and exhaust system components. The activity of each radionuclide that could result in a potential intake that would result in an internal dose of 5 millirem (10 mrem total) was calculated following the methods in NUREG-1400 (NRC, 1993) [1]. These activities were then divided by the building surface area (floors and walls) of the API laboratories and the API exhaust duct work to determine action levels for building surfaces and exhaust system components, respectively. These action levels are given in the table below.

Action levels were also included for the use of environmental contamination control techniques when aggressive dismantling or size reduction activities are conducted outside the confines of the building. Environmental controls will be used if either the total ^{14}C or ^{3}H plus ^{14}C exceeds the action level. This action level is based on the screening level for clearance (rounded up from 6E5 dpm/100 cm^2) for Group 4 radionuclides from ANSI/HPS N13.12, Surface and Volume Radioactivity Standards for Clearance based on a primary radiation dose criterion of 1 millirem per year for clearance of materials from regulatory control.

[1] A release fraction of 0.01 (nonvolatile powders), a confinement factor of 1 (uncontained material), and a dispersibility factor of 10 (adding energy to the system) were used in calculating the intake potential.

Decommissioning Action Levels

Action	**^{3}H (dpm/100 cm^2)**	**^{14}C (dpm/100 cm^2)**
Release of materials & equipment	≤1000 removable	≤1000 removable ≤5000 average ≤15000 maximum
Aptuit DCGLs	3.7E4 removable (^{3}H & ^{14}C combined)	3.7E5 total 3.7E4 removable (^{3}H & ^{14}C combined)
NRC Screening DCGLs[2]	1.2E8	3.7E6
Environmental controls	>1E6 total or removable	
Consideration of additional radiological controls – building surfaces	>3 e10	>6E8
Consideration of additional radiological controls – exhaust system	>5e10	>1E9

[2]Included for comparison. These building surface screening levels represent surface concentrations of individual radionuclides that would be deemed in compliance with the 25 mrem/y unrestricted release dose limit in 10 CFR 20.1402.

7. SEALED SOURCES

All sealed sources will have documentation showing that all necessary leak tests have been performed at appropriate intervals

8. ATTACHMENTS

None

9. FORMS

Radiation Work Permit

10. REVISION HISTORY AND APPROVAL

Rev Level	Rev Date	Rev Description	Approver
0	8/7/12	Initial Issue	
1	3/18/13	Inserted action level for institution of environmental controls	Rick Greene Project Health Physicist Site Supervisor

1. PURPOSE

This procedure describes methods and techniques to be employed for management of decontamination and decommissioning (D&D) waste for Aptuit, LLC (Aptuit) decommissioning activities.

2. APPLICABILITY

This procedure applies to decommissioning activities being conducted at Aptuit.

3. REFERENCES

3.1 Aptuit Radiation Safety Program Manual, March 2008

4. DEFINITIONS

TERM/ACRONYM	DEFINITION
D&D	Decontamination & Decommissioning
FTs	Field Technicians
HASP	Health and safety plan
HP	health physics
LOTO	locked out/tagged out
PHP	Project Health Physicist
PPE	personal protective equipment
RPP	radiation protection plan
RSO	Radiation Safety Officer
RSPM	Aptuit Radiation Safety Program Manual
SO	Scientific Operations
SS	Site Supervisor

5. RESPONSIBILITIES

5.1 Project Health Physicist

The Project Health Physicist (PHP) is responsible for the maintenance and management of this procedure.

5.2 Site Supervisor

The Site Supervisor (SS) will be responsible for the field oversight of the personnel performing this procedure. Specific responsibilities include:

- Reviewing this procedure with all personnel that will be performing the work prior to beginning the tasks
- Ensuring that all generated waste is properly handled, packaged, stored and processed, as necessary
- Ensuring that the proper tools and equipment are available for the performance of D&D tasks
- Ensuring that the proper PPE is available for the performance of D&D tasks
- Periodically observing the performance of the D&D tasks to ensure that they are being performed according to this procedure
- Reviewing completed tasks to ensure that all objectives and requirements have been met.

5.3 Field Technicians

Field Technicians (FTs) will be responsible for the field execution of this procedure and for addressing any issues or suggested modifications with the SS.

The FT is responsible for the proper execution of D&D activities. Specific responsibilities include:

- Collecting waste in a proper manner so as to limit contamination of personnel and areas
- Inspecting all tools and equipment prior to use to ensure that they are in good working condition
- Inspecting all PPE prior to use to ensure that it is in good working condition
- Performing all D&D activities in full compliance with this procedure and the health and safety plan (HASP) and radiation protection plan (RPP).

6. PROPER HANDLING OF WASTE STREAMS GENERATED DURING D&D ACTIVITIES

6.1 Remediation-Derived Waste

- All remediation-derived waste (RDW) will be placed in appropriate containers that conform to federal and state regulations.
- Waste containers will be properly labeled and inventoried on site. If necessary, temporary accumulation areas will be established in accordance with applicable regulatory requirements.
- Nonhazardous waste will be disposed as construction debris in a local, licensed landfill.
- Aptuit will prepare manifests for all hazardous waste.
- A licensed hazardous waste disposal subcontractor will be utilized for the transportation and disposal of all hazardous waste generated during the D&D activities.

- All secondary RDW (e.g. PPE, wash rags, plastic, etc.) will be assumed to have contaminant concentrations consistent with the waste streams being generated for any given activity.

Decommissioning RDW will generally include but not be limited to the following:

- Regulated components – ceiling tiles, floor tiles, as well as any other items or surfaces not meeting radiological release criteria
- Rinse water
- Cleaning materials (e.g. wipes, brushes, rags, etc.)
- PPE
- Other wastes associated with D&D activities.

6.1.1 Asbestos-Containing Material

- All ACM will be packaged and labeled in accordance with federal and state regulations by a fully licensed and permitted contractor.
- The ACM will be wetted and packaged to prevent nonfriable materials from being damaged and made friable.
- The ACM and ACM-related materials, including PPE used during the handling of ACM, will be consolidated to the extent possible.
- The properly containerized ACM materials will be moved to a temporary, on-site storage location.
- The asbestos abatement subcontractor, upon Aptuit's approval, will dispose of nonradioactive ACM waste at a landfill licensed to accept ACM.
- Any ACM that does not meet radiological release criteria will be segregated from nonimpacted ACM and disposed as radioactive mixed waste.

6.1.2 Sink Traps and Associated Wastes

- All water and other contents of the traps will be placed in appropriate containers and samples collected for waste disposal purposes. The water samples will be analyzed for RCRA metals and semivolatile organic compounds.
- The contaminated sink traps and fittings will be placed into appropriate containers by Aptuit and disposed as radioactive waste. Management of the sanitary sink trap RDW will include the following:
    - Contents of the sink traps will be accumulated, and ultimately, a composite sample for characterization will be obtained for off-site analysis.
    - Trap contents and rinse water will be sampled and characterized, as necessary, to determine disposal requirements. The analytical data will be of sufficient quantity and quality to accurately determine constituent concentrations in RDW. Secondary wastes will be characterized based on analytical data obtained from the corresponding waste stream.

- Samples of sink trap liquids will be collected by thoroughly mixing the waste container and bailing out the required volumes with a stainless-steel or Teflon® bailer.
- Samples of the sink trap liquid will be analyzed for RCRA metals and semivolatile organic compounds. The results of the analyses will be compared to the hazardous waste characteristic levels for toxicity identified in 40 CFR 261.
- Any liquid or solid trap contents that are potentially radioactive will be sampled and analyzed for 3H and 14C. All radionuclide results will be reviewed by the RSO prior to disposition of wastes.
- The removed sink traps and fittings will be monitored for mercury vapor and radioactive contamination. If neither is detected, the sections will disposed of as non-regulated construction debris. Any sections with positive indication of mercury contamination will be segregated and managed as hazardous waste. Additionally, pipe sections with radiological contamination exceeding release criteria in addition to the mercury contamination will be managed as mixed waste. Trap sections with no mercury contamination that exceed radiological release criteria will be managed as radioactive waste.

6.1.3 Radioactive Waste

- All known or suspected radioactive waste will be packaged and labeled at the point of generation.
- Prior to packaging, all required survey data will be obtained to support proper management and characterization for impending disposition.
- All radioactive material will be handled and managed in accordance with Aptuit's radioactive materials license.
- All potentially contaminated waste media generated during the project that cannot be adequately characterized by field survey (e.g. liquids, vacuum contents, drain solids, filter media, etc.) or by the on-site laboratory will be analyzed by an off-site laboratory.

6.1.3.1. The following basic criteria related to acceptance for shallow land burial will be followed:

- Any medium that is potentially or known to be hazardous shall not be commingled with radioactive wastes.
- Packages shall contain no standing water or excessive moisture.
- All clean industrial trash shall always be segregated unless potentially contaminated.
- No chemical containers or pressurized aerosol cans will be included.

7. WASTE MINIMIZATION

The generation of radioactive waste will be minimized by employing work practices such as:

- Restricting material entering contamination areas to those needed for performance of work

- Restricting quantities of hazardous materials (paints, solvents, chemicals, etc.) entering contamination areas
- Surveying potentially contaminated material to separate uncontaminated from contaminated materials

8. WASTE STORAGE AND HANDLING

- Radioactive waste shall be stored in a manner which prevents inadvertent spread and minimizes personnel exposure, as applicable.
- Radioactive waste will be stored in a designated radioactive materials storage area The access controls instituted shall be based on the types and amounts of material present and routine radiological surveys.

9. EMERGENCY RESPONSE

Emergency procedures are contained in the Aptuit RSPM.

10. RADIOACTIVE WASTE SHIPPING

All shipments of radioactive waste will be shipped in accordance with 49 CFR 173, Subpart I.

11. ATTACHMENTS

None

12. FORMS

Survey Forms

13. REVISION HISTORY AND APPROVAL

Rev Level	Rev Date	Rev Description	Approver
0	8/7/12	Initial Issue	Rick Greene
1	2/18/13	Correct formatting in Section 6.1.2	Project Health Physicist
2	3/14/13	Correct reference (3.1) to RSPM March 2008	Site Supervisor

1. PURPOSE

This procedure describes methods and techniques to be employed when characterizing the radiological impact of activities performed at Aptuit LLC, Kansas City, MO (Aptuit). Characterization surveys include building surfaces, air exhaust, vacuum, and drainage systems, overhead areas, and environmental media. Characterization surveys/sampling will be performed to:

- Provide sufficient characterization data to enable a determination on the scope of decontamination and decommissioning (D&D) activities that are warranted to make the site suitable for unrestricted use.
- Provide data for remediation alternatives and waste characterization.
- Provide data for establishing radiological controls.
- Provide input into the final status survey design, and, in some cases provide data to meet final status survey (FSS) requirements.

2. APPLICABILITY

This procedure applies to facilities, equipment, systems, and environmental media that are subject to decommissioning activities being conducted at Aptuit.

3. REFERENCES

Aptuit Radiation Safety Program Manual, March 2008

Manufacturers' operating manuals

4. DEFINITIONS

TERM/ACRONYM	DEFINITION
ALARA	as low as reasonably achievable
D&D	decontamination and decommissioning
DQOs	data quality objectives
FSS	final status survey
HEPA	High efficiency particulate air
LSC	liquid scintillation counter
PHP	Project Health Physicist
PPE	personal protective equipment

TERM/ACRONYM	DEFINITION
QC	quality control
SS	Site Supervisor
SS/SC	Site Supervisor/Survey Coordinator
ST	Survey Technician

5. RESPONSIBILITIES

5.1 Project Health Physicist

The Project Health Physicist (PHP) is responsible for the maintenance and management of this procedure.

5.2 Site Supervisor/Survey Coordinator (SS/SC)

The Site Supervisor (SS) will be responsible for the field oversight of the Survey Technicians (ST) performing this procedure. A Shaw Health Physicist or Radiological Control Technician will be designated for this position. The SS/SC is responsible for the supervision of data collection activities, including surveys and samples. Specific responsibilities include:

- Selecting proper equipment for the performance of defined data collection activities.
- Ensuring properly calibrated and tested equipment is available for the performance of survey/sampling tasks.
- Ensuring that the proper personal protective equipment (PPE) is available for the performance of Characterization tasks.
- Reviewing this procedure with all personnel that will be performing the work prior to beginning the tasks.
- Periodically observing the performance of the Characterization tasks to ensure that they are being performed according to this procedure.
- Determining locations for biased sample collection and direct measurement.
- Reviewing collected data for accuracy and verifying the completion of data collection.

5.3 Survey Technicians

STs will be responsible for the field execution of this procedure and for addressing any issues or suggested modifications with the SS or PHP.

The ST is responsible for the proper execution of survey and sampling activities. Specific responsibilities include:

- Ensuring all portable instrumentation is properly calibrated and checked prior to use
- Performing all data collection activities in full compliance with the established protocols

- Properly documenting all survey/sampling activities.

6. EQUIPMENT AND MATERIALS

- High efficiency particulate air (HEPA) vacuum
- Paper liquid scintillation smears
- Cotton swabs
- Metal or plastic laboratory tweezers
- Properly prepared liquid scintillation vials containing 7 milliliters of scintillation cocktail
- Mercury vapor analyzer (Jerome 431-X or other make/model)
- Radiation detection instruments (see Aptuit WI-002)
- Record/log sheets (e.g., survey forms, checklists, sample collection logs, field activity daily logs)
- Tin snips
- Plastic sheeting
- Power tools, including drills, saws, etc.
- Ladders
- PPE.
- Gallon size zip lock bags / metal colander
- Soil sample container
- Hand trowel or shovel
- Mild soap

7. PREREQUISITES

- Ensure that all instrumentation is properly calibrated and operating properly in accordance with Aptuit Work Instruction WI-002 and manufacturer procedures.
- Survey and sampling activities should be of a quality to meet the data quality objectives (DQOs) of the FSS.
- Ensure STs have proper PPE for area to be surveyed/sampled based on area postings and site control requirements.
- Ensure the job hazard analysis has been conducted for the survey/sampling activities and that all workers are properly briefed on the hazards anticipated.
- Review previous surveys of the survey unit, if available, to determine radiological conditions within the survey unit prior to entry.

- STs will be instructed on the potential radiological hazards that may be present in the survey units.

NOTE: Minimum PPE for performance of survey/sampling activities will be latex or nitrile gloves, steel toed boots, a Tyvek™ lab coat and safety glasses.

8. INSTRUCTIONS

8.1 General

The characterization survey includes:

- Performing scans of potentially contaminated building surfaces for surface contamination including expansion joints, stress cracks, and wall/floor interfaces.
- Performing systematic direct measurements and smears.
- Performing judgmental direct measurements and smears on building surfaces and in exhaust systems, drains and traps, and overhead areas.
- Performing judgmental direct measurements and smears of areas of elevated activity.
- Sampling potentially impacted environmental media (e.g., surface soil).
- Documenting survey and sampling locations and results.

8.2 Building Surfaces

The characterization survey of building surfaces includes:

- Surface scans of designated and adjacent areas to identify locations which may indicate residual contamination.
- Systematic measurements and sampling are performed throughout the designated areas. The number and spacing of the measurement locations must be such that sufficient data points to evaluate the radiological condition of the property are generated.
- Judgmental measurements and samples are collected at representative "hot spot" locations, identified by surface scans.
- Judgmental measurements and samples are collected in areas most likely to be contaminated (e.g., in front of hoods, areas where spills have occurred, etc.).

Perform surveys in accordance with Aptuit Work Instruction WI-001. Characterization surveys to be used in the determination of final status shall meet the FSS design.

8.3 Exhaust Systems

All of the existing exhaust systems associated with the Aptuit Scientific Operations will be removed. In order to be removed safely and disposed of properly, each section removed from the system will be characterized for radiological contamination.

These sections will be characterized as follows:

- Exhaust systems that are not able to be surveyed from the ground will be accessed by a ST via a step ladder.

- Survey the existing opening using the appropriate PPE per Aptuit WI-005 and following the survey procedure from Aptuit WI-001. If the scanning survey, direct measurement, or wipe sample exceeds the action level in Aptuit WI-005, stop work and institute the appropriate radiological controls as directed by the RSO before continuing the characterization survey.
- After the conditions of the existing opening have been assessed, create a small hole in the exhaust system no greater than 5 feet from the opening or previous survey point using a power drill. Using a cotton swab on a stick, wipe the inside of the newly created hole and count the swab in the liquid scintillation counter (LSC) per Aptuit WI-003.
- If there is indication that the action level may be exceeded, stop work and institute the appropriate radiological controls as directed by the RSO.
- Once the exhaust system has been assessed, create 10 inch by 10 inch opening in the side of the system using tin snips (manual or pneumatic) and perform a survey of the inside of the exhaust system, per Aptuit WI-001.
- For characterization and as low as reasonably achievable (ALARA) purposes, the highest readings observed at either end of the section to be removed will be applied to the entire section.

It is assumed that the majority of the contamination will have been contained within the exhaust system prior to the HEPA filter and housing. Each section prior to the HEPA housing and each section past the housing will be surveyed in this manner until a section falls below the Aptuit equipment release limit.

After this point has been reached, sections may be removed as regular construction debris although each section will still be characterized by surveying each opening prior to being released.

8.4 Drains and Traps

Based on a walk down of the sewerage system, one holding tank (i.e. mixing pit) exists between the lab drains, including lab and sanitary sinks, eyewash drains and floor drains, and the site pH treatment building. Samples have been collected and analyzed for radioactive contamination from the pH treatment building bi-monthly since 2011. Because of this, it is not deemed necessary to scope the entire drain system. Rather, the drains will be characterized by performing scanning, static and wipe surveys per Aptuit WI-001 in accessible cleanouts, drain openings, mixing pit, and pH treatment building.

The drains will be accessed by using the dismantling techniques in the Aptuit WI-004 section 8.4.

Above Slab Drain Lines

If an above slab drain line is deemed to be contaminated above the Aptuit free release limit, it will be removed to a point 5 feet beyond the last identified area of contamination and then resurveyed until no contamination above the Aptuit free release limit is found.

Below Slab Drain Lines

Drain lines found to be contaminated at slab penetrations will be assessed using RESRAD-Build. All available data for each line, including, but not limited to, static and wipe measurements at the penetration, any available cleanouts downstream, outdoor manhole locations and at the pH treatment plant will be used to assess a source term and the resulting potential dose to the public.

If the model shows that the residual contamination in the drain line, in conjunction with other residual contamination at the facility, is less than that permitted by 10 CFR 20.1402, the drain lines will be left in place. If the residual contamination in the drain line is found to result in a potential dose to the public, in conjunction with other residual contamination at the site, that exceeds that permitted by 10 CFR 20.1402, the drain line will be remediated to reduce the potential dose contribution so that the total dose to the public is below the regulatory limits.

8.5 Overhead Areas

In areas where it is deemed necessary to characterize above 6 feet, these steps will be followed:

- Prior to the survey, plastic sheeting will be placed below the area to be surveyed to prevent the potential spread of contamination.
- Wall areas above 6 feet and overhead areas will be accessed via step ladder. The ST performing the survey will stand no higher than the second highest ladder step. If this cannot be accomplished, a taller ladder will be acquired before proceeding with the survey.
- In the case of a ceiling or exposed pipe/system, the ladder will be placed as close to the area to be surveyed as possible. Once this is accomplished, a survey will be performed according to Aptuit WI-001.
- In the case of a ceiling tile, the ladder will be placed adjacent to the tile to be surveyed. A scanning survey will be performed around the edges of the tile to determine if there is any indication of contamination above the release criteria. If there is indication that the release criteria will be exceeded, work will stop and appropriate PPE will be obtained.
- After the initial scanning survey, the tile will be lifted out of place and set above the other ceiling tiles. A visual inspection of the tile and surrounding tiles will be performed.
- If there is a noticeable amount of debris above or on the tile, it may be vacuumed using a HEPA vacuum.
- After the tile has been inspected, it will be handed to another ST to be placed on the plastic sheeting.
- Once the tile has been placed on the plastic sheet, a survey will be performed per Aptuit WI-001.
- After the tile has been surveyed, it will be replaced as it was found initially.

8.6 Surface Soil Sampling

In areas where it is deemed necessary to characterize soil, the appropriate steps are as follows:

- Soil sample locations shall be identified on a map showing systematic and bias sample locations and identification numbers.
- Composite samples will be collected using a trowel or a hand shovel to take a representative sample to 6 inches in depth. The sample will then be placed in a metal bowl or new gallon sized zip lock bag to composite.

- After compositing, the soil sample will be placed in the appropriate lab container for analysis. Each container will be labeled using a permanent marker to include the sample identification number; sample time, date, and sample analysis.
- To prevent cross contamination between soil samples, sampling tools shall be decontaminated using soap and water. In addition, gloves will also be changed between each sample location.
- The outside of soil sample containers will be cleaned of any residual soil, and radiologically surveyed prior to analysis.

9. ACTIVITY ASSIGNMENT

Once the systems, surfaces and equipment have been surveyed and characterized per this WI, an activity will be assigned to them to ensure proper characterization for use in the waste manifest. This will be accomplished using the survey data.

^{14}C Activity Assignment

Total ^{14}C activity will be assessed by converting direct measurements obtained during the characterization survey and converting them into dpm/100cm^2 using the following equation:

$$\text{dpm/100cm}^2 = (\text{cpm direct} - \text{cpm bkg.}) / (\text{inst eff.} * (\text{Probe area} / 100))$$

Where:

dpm/100cm^2 = disintegrations per minute per 100 centimeters squared
cpm direct = counts per minute measured by the detection instrument
cpm bkg. = instrument specific background in counts per minute
inst eff. = calculated total efficiency
probe area = physical area of probe used to obtain the measurement in centimeters squared
100 = 100 centimeters squared

Using this equation, the highest dpm/100cm^2 will be applied to a manageable section of the material being surveyed (e.g. 5' section of ductwork, 5' section of casework, 10' x 10' section of flooring, etc.). This reading will be applied to the total surface area of the section and be recorded in a spreadsheet for use on the disposal manifest. The spreadsheet is used to calculate the total activity of the items in appropriate activity units.

^{3}H Activity Assignment

Total ^{3}H activity will be assessed by following the assumption in NUREG 1757, Vol 2, Rev 1 Table H.1. Namely that removable contamination is 10% of the total activity.

Using this assumption, the highest ^{3}H wipe location (again per each manageable section of surveyed material as referenced above) will be multiplied by a factor of ten in order to estimate total ^{3}H activity. This activity will be used to calculate the total activity of the items in appropriate activity units for the waste manifest.

This method will be used due to the unreliability of directly measuring ^{3}H on material surfaces.

10. ATTACHMENTS

None

11. FORMS

Survey Forms

12. REVISION HISTORY AND APPROVAL

Rev Level	Rev Date	Rev Description	Approver
0	8/07/12	Initial Issue	
1	5/14/13	Changed Section 8.4 to address characterization and evaluation of above slab and below slow drain lines. Added Section 9 to address assignment of activity for waste characterization purposes.	Rick Greene Project Health Physicist Site Supervisor

1. PURPOSE

This procedure describes the process for routine submittal, analysis, and evaluation of urine samples for determination of dose from H-3 and C-14.

Based on the decommissioning tasks to be performed Aptuit has determined that a single intake, single void model is appropriate to determine dose from decommissioning activities using ICRP 68 dose conversion factors.

Based on the potential form of tritium contamination remaining, Aptuit has determined that the appropriate biokinetic model and dose conversion factor for tritium is that for organically bound tritium (OBT).

The biokinetic model and dose conversion factor for labeled organic carbon compounds/particulate ($C_{organic}$) is appropriate for the expected chemical forms of C-14 remaining at Aptuit.

2. APPLICABILITY

This procedure applies to decommissioning activities being conducted at Aptuit by all decommissioning personnel.

3. REFERENCES

3.1 Aptuit Radiation Protection Plan Manual, March 2008

3.2 Evaluation of Tritium and C-14 Urinalysis for Decommissioning Activities at Aptuit, April 1, 2013.

4. DEFINITIONS

TERM/ACRONYM	DEFINITION
C-14	carbon-14
$C_{organic}$	organic carbon compounds/particulate
dpm	Disintegrations per minute
H-3	tritium
LSC	Liquid scintillation counter

TERM/ACRONYM	DEFINITION
ml	milliliter
OBT	Organically bound tritium
PHP	Project Health Physicist
ROC	Radiation Oversight Committee
RSO	Radiation Safety Officer

5. RESPONSIBILITIES

5.1 Project Health Physicist

The Project Health Physicist (PHP) is responsible for the maintenance and management of this procedure.

5.2 Radiation Safety Officer

The Radiation Safety Officer (RSO) will be responsible for the determining who will participate in the bioassay program and the scheduling. The RSO will perform regular review of radiological conditions to determine if conditions warrant modifications to the participate list, scheduling or evaluation methods.

5.3 Decommissioning Personnel

Decommissioning Personnel will be responsible for participating in the bioassay program as directed by the RSO.

6. EQUIPMENT AND MATERIALS

- Specimen cups
- Liquid scintillation counter (LSC)
- Counting vials
- LSC cocktail

7. INSTRUCTIONS

7.1 Baseline Bioassay

Decommissioning personnel selected to participate in the bioassay program will leave a baseline sample prior to engaging in decommissioning tasks involving radioactive materials.

7.2 Sample Collection

Bioassay program participants shall leave a sample by 3 P.M. on the last working day of the week. Specimen cups are located in the rest rooms. Samples may also be collected, at the discretion of the RSO, if in intake is suspected or if abnormal conditions indicate the need for an internal dose assessment.

Bioassay program participants shall leave a minimum of 10 ml of urine in the specimen cup.

After submitting the sample, the program participant shall write his/her name and the date and time of the sample on the specimen container.

The specimen container shall be placed in the designated location in the restroom.

7.3 Sample Analysis

Using an Eppendorff pipet, take I mL of water and inject into a 10-ml vial with 6 mL of scintillation cocktail. Repeat three times to determine which is the lowest reading for the background sample.

Take a 1 mL aliquot of each individual's urine and inject it into a vial containing 6 mL of cocktail. Label the cap of the scintillation vial with the individual's initials. Labeling the tray is also sufficient. Using the "Urinalysis" program on the scintillation counter, count each sample for 0.5 minutes for a quick survey to determine if any exposures are suspect or additional samples will be necessary.

7.4 Sample Evaluaton

Spot samples are used for screening analysis of potential intakes of radioactive materials. Spot samples can be used to estimate the total activity excreted over a 24-hour period. The estimated activity in a 24-hour urine sample is given by:

$$A = C \cdot V$$

where:

A – estimated activity in a 24-hr sample

C - concentration as reported by bioassay (e.g. dpm/ml)

V - volume of urine excreted per day (1.4 liters for standard male, 1.0 liters for standard female).

The activity excreted (A_t) in a 24-hr period at t days post intake for a single compartment model (model used for $C_{organic)}$ is:

$$A_t = f_u \cdot A_0 \cdot (e^{-\lambda(t-1)} - e^{-\lambda t})$$

and for a double compartment model (model used for OBT):

$$A_t = f_u \cdot A_0 \cdot (D_a e^{-\lambda a(t-1)} - D_a e^{-\lambda a(t))}) + (D_b e^{-\lambda b(t-1)} - D_b e^{-\lambda b(t)})$$

where:

A_0 – initial intake

f_u - fraction of excretion via urine (f_u is 1 for OBT and 0.1 for $C_{organic}$)

λ - effective clearance constant (ln2/effective half-life=0.017329 days^{-1} for $C_{organic}$)

A_t – 24-hour excretion activity at time t

D_a - fractional distribution in Compartment A (50% for OBT)

D_b - fractional distribution in Compartment B (50% for OBT)

λ_a - exponential clearance constant for Compartment A (ln2 / clearance half-time = 0.069315 days^{-1} for OBT)

λ_b - exponential clearance constant for Compartment B (ln2 / clearance half-time= 0.017329 days^{-1} for OBT)

t - time (days).

Once the intake A_0 has been determined:

$$D = A_0 \cdot DCF$$

where:

D - dose (committed effective dose)

DCF - dose conversion factor for OBT - 151.85 rem per curie inhaled
- dose conversion factor for $C_{organic}$ – 2148.1 rem per curie inhaled.

The Excel spreadsheet “Aptuit Bioassay Results.xlsx” may be used to perform the dose calculations.

7.5 Evaluation Level

Evaluation levels correspond to a dose of approximately 100 mrem. Evaluation levels were calculated using the biokinetic models for OBT and organic carbon compounds. The evaluation level are:

OBT = 3.1E4 dpm/ml
$C_{organic}$ = 100 dpm/ml

The evaluation levels are based on the urine concentration at 7 days following intake.

Should measured excretion levels exceed the Aptuit evaluation level, Aptuit will evaluate the urinalysis data, including the individual's bioassay history, to determine the type of exposure (single vs continuous intake) and evaluate if a compound specific biokinetic model should be used for final dose evaluation. Other supporting data, such as survey or air sampling results, should be used to obtain the best estimate of actual intake.

7.6 Investigation Level

Investigation levels correspond to a dose of approximately 500 mrem. Investigation levels were calculated using the biokinetic models for OBT and organic carbon compounds. The investigation levels are:

OBT =1.56E5 dpm/ml
$C_{organic}$ = 570 dpm/ml

The investigation levels are based on the urine concentration at 7 days following intake.

Should measured excretion levels exceed the Aptuit investigation level, give the individual 5 fresh scintillation vials for another same day sample, then 2 each for the following 2 days. A sample is also required upon return to the site.

Do not allow any individual to return to decommissioning activities until sample results are below the investigation limits without prior approval of the ROC.

Count each additional sample for 60 minutes to obtain more accurate survey data.

8. ATTACHMENTS

None

9. FORMS

None

10. REVISION HISTORY AND APPROVAL

Rev Level	Rev Date	Rev Description	Approver
0	8/7/12	Initial Issue	Rick Greene Project Health Physicist
1	8/22/13	Revised based on NRC comments on radionuclide forms, metabolic models, and single intakes expected for decommissioning activities. The initial issue was Aptuit procedure 7002 which was used during routine operations.	Site Supervisor

APTUIT WORK INSTRUCTION	Shaw
TITLE: BAG-IN / BAG-OUT OPERATING AND MAINTENANCE GUIDE.	No: Aptuit WI-009 Date: August 28, 2012 Page: 1 of 1

1. PURPOSE

This procedure describes the bag-in / bag-out operating and maintenance guide for bag-in / bag-out Containment Housings.

2. APPLICABILITY

This procedure applies to facilities, equipment, systems, and environmental media that are subject to decommissioning activities being conducted at Aptuit.

3. REFERENCES

Aptuit Radiation Safety Program Manual, March 2008

Manufacturers' operating manual.

4. ATTACHMENTS

Barnebey Sutcliffe: Bag-in / Bag-out Operating and Maintenance Guide

5. REVISION HISTORY AND APPROVAL

Rev Level	Rev Date	Rev Description	Approver
0	8/7/12	Initial Issue	Rick Greene, CHP Project Health Physicist Site Supervisor

BAG-IN/BAG-OUT OPERATING AND MAINTENANCE GUIDE

Bag-In/Bag-Out Containment Housings

For containment of hazardous chemicals, biological, and radioactive contaminants.

Applies to:
CM/CMP Series For Gasketed Filters
KE/KEP Series For Fluid Seal Filters

CAUTION

NOTICE TO READER:

This manual is only an operating and maintenance guide. Thorough on-site safety reviews must be conducted before attempting any action discussed herein.

This manual is to be used by the reader as an assistance guide and an operational framework when installing and exchanging filters in the Bag-In/Bag-Out Housings: Model CM and Model KE. Since system designs and environments vary, procedures in this manual must be adapted for particular and appropriate on-site need. It is written and presented with the understanding that operators and maintenance personnel participating in the use and maintenance of the equipment are properly trained and equipped to perform assigned functions in a safe manner.

IMPORTANT

TO ACHIEVE MAXIMUM PROTECTION, IT IS IMPERATIVE THAT THE READER IS COMPLETELY FAMILIAR WITH THE METHODS DESCRIBED HEREIN AND REVIEWS PROCEDURES WITH ON-SITE SAFETY PERSONNEL OR AN OUTSIDE CONSULTING GROUP BEFORE PERFORMING ANY FILTER EXCHANGE.

Depending upon the nature of the contaminants in the environment, it may be necessary for the operator to wear specialized protective clothing or utilize other personal protective devices when installing or exchanging filters. The operator must therefore be familiar with all of the on-site safety policies and procedures. Change-out methods require study and skilled practice.

This manual does not address system installation, nor does it address the suitability of a product for particular usage. If you have any questions concerning any of the guidelines or procedures in this operating guide, please contact Barnebey Sutcliffe by using the contact information on the bottom of the final page.

1. CONTAINMENT HOUSINGS

The Bag-In/Bag-Out contaminant filtration system, if properly selected and operated, provides protection from hazardous air contaminants, e.g., biological, radiological or chemical. For maximum protection with containment housings, correct filter element installation and filter element exchange procedures must be followed.

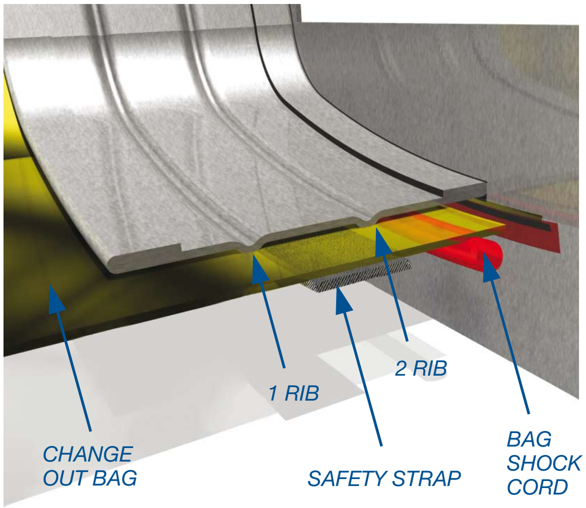
It is imperative that the operator be thoroughly familiar with Bag-In/Bag-Out Containment Housings and that appropriate adaptations are implemented on-site before proceeding with filter element installation or filter element exchange. It is also important for the operator to practice the bag sealing method on a new piece of 8-mil PVC before working directly with the change-out bag.

Filtration system housings are available in a variety of models that are designed to meet specific needs. Because of the system needs and the environments in which they operate vary, a schedule for the frequency of filter exchange is site-specific. Safeguards should be established on-site to ensure that filter exchanges occur as part of regularly scheduled maintenance.

The Bag-In/Bag-Out housing system consists of a series of modular sections. A typical system consists of a combination 2-inch, 4-inch or 6-inch prefilters and a standard 11½-inch deep HEPA filter and/or an activated carbon adsorber. Activated carbon adsorbers are provided in 12-inch, 16-inch, and 18-inch depths and chosen based on the application.

An all-welded construction of the housings ensures an air tight enclosure. Both the front and rear panels are of single-piece construction. This reduces the number of welds and the potential for leakage. All discontinuities in weld are free of burrs and sharp edges. All welds and welders are qualified in accordance with Section IX of the ASME BPV code.

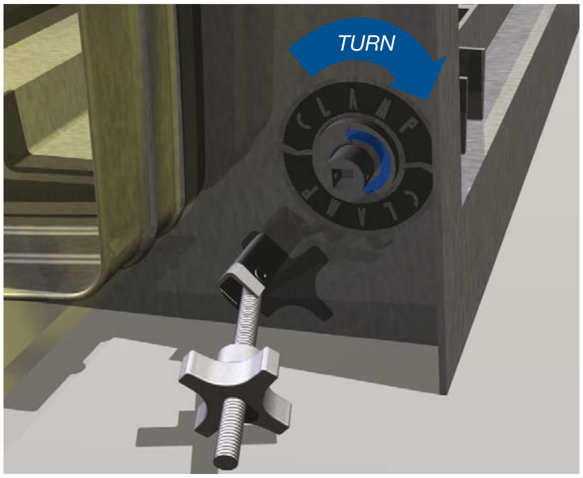
Collar Design



Filters are accessed through a bag-in/bag-out porthole. A collar around each porthole provides a means of securing the change-out bag. The collar is hemmed to prevent damage to the change-out bag during the sealing operation. Two parallel ribs are located on the outside perimeter of the collar. These ribs help in securing the straps during filter change-out. The door is sealed against the front of the housing, and secured by four swing-bolt latches with threaded aluminum knobs.

2. FILTER LOCKING MECHANISM – MODEL CM

In the Barnebey Sutcliffe CM SERIES filter systems, a positive clamped gasket provides the seal between the filter gasket and the sealing surface of the housing. The filter-locking mechanism consists of a drive screw, travel nut, and spring-loaded pressure bar. Filters are secured in place with a top and bottom locking mechanism that is spring-loaded. These mechanisms maintain constant pressure between the filters and the frame. This pressure compensates for any relaxation of gasket material that may occur. The clamping

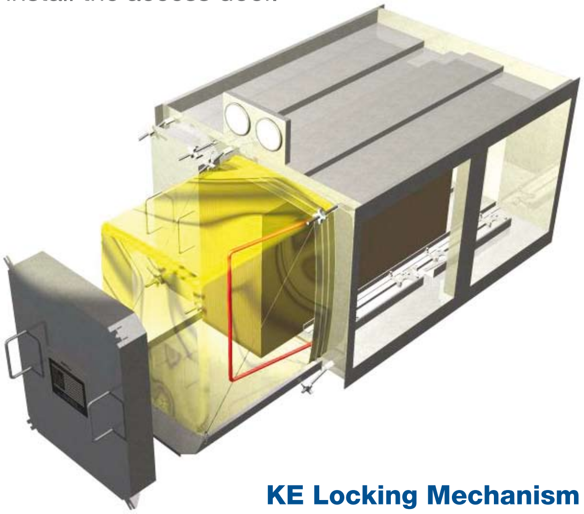


CM Locking Mechanism

mechanism actuators penetrate the housing wall by means of a leak-tight packing gland. Using a standard 3/8 inch drive ratchet operates the actuators.

3. FILTER LOCKING MECHANISM – MODEL KE

KE SERIES filters are secured in place with a locking arm. The filter elements used in the KE SERIES housings feature a liquid-filled channel on one side of the integral frame. This channel, which is filled at the factory with sealing fluid, mates to the knife-edge in the housing. Four metal retracting clips are required and attached to the filter to facilitate filter removal. When the locking arm is pushed or pulled, the locking mechanism respectively directs the filter into the correct location. This design also incorporates the unique safety feature that requires the filter to be properly installed in order to properly install the access door.



KE Locking Mechanism

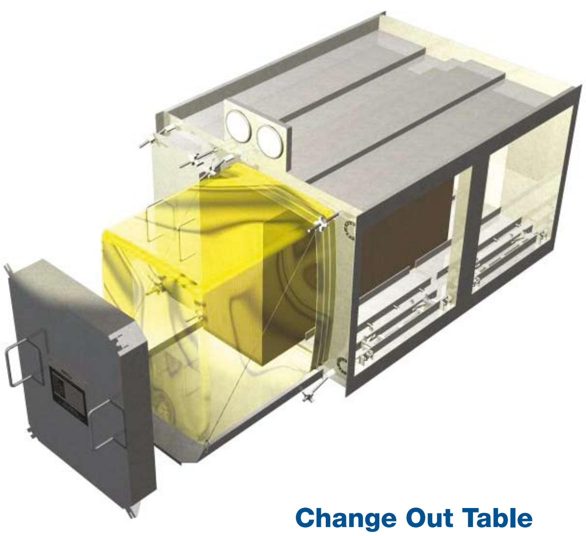
4. CHANGE-OUT BAGS AND TABLE

Change-Out Bags

The Bag-In/Bag-Out containment housing utilizes a heavy-gauge, 8-mil PVC change-out bag with an elastic retainer cord. The cord is hemmed into the mouth of the bag for a positive fit when stretched over the collar of the porthole. Special sleeves with gloves are formed into each bag. These sleeves assist in the handling of filters and stump removal of the old bag generated during the change-out procedure. Safety and cinch straps can be purchased with each change-out kit for additional safety. Filter installation and exchanging are handled through the bag as described in this guide.

Change-Out Table

An optional change-out table is available from Barnebey Sutcliffe to assist the operator with filter exchanging. It is held in place and supported by the swing-bolt latches used to secure the access door. The change-out table is positioned to help prevent the filter from dropping and ripping the bag. The operator should check the system to see if an optional change-out table has been incorporated. If not, the operator should use an appropriate support during filter installation and exchanging for ease of maintenance.



Change Out Table

5. RECEIVING INSPECTION

NOTE: ALL EQUIPMENT MUST BE IMMEDIATELY INSPECTED UPON RECEIPT FROM THE CARRIER. ANY DAMAGE MUST BE REPORTED TO THE CARRIER IMMEDIATELY AND ACKNOWLEDGED IN WRITING TO PRESERVE ANY CLAIM.

Inspect all equipment for damage and ensure that all received material agrees with shipping documents.

Pay particular attention to:
- Housings – for dents, bent flanges, or gasket damage
- Filters – for gasket damage, or damage to the media or filter frames
- Auxiliary or optional equipment for any damage

After inspection, keep the filter(s) in their respective shipping carton until they have been transported to the proper housing location. Unpack the filter(s) according to the filter manufacturer's instructions that are normally provided on the shipping carton. HEPA filters are especially fragile; be certain not to cause any damage to the filter media or gaskets during unpacking and installation.

6. MATERIALS AND TOOLS NEEDED

Assemble required materials and tools:
- Correct quantity and size of new adsorbers or filters
- Correct quantity and size of new change-out bags (see REPLACEMENT PARTS)
- Support for the adsorbers or filter installation or exchange, either from optional Barnebey Sutcliffe change-out table (see CHANGE OUT BAGS & TABLE) or locally provided support
- Standard 3/8-inch drive ratchet*
- Silicone grease for CM Series*

* Not provided

7. INITIAL FILTER INSTALLATION – MODEL CM

***NOTE:** The following chapters include specific filter installation procedures for Model CM and Model KE containment housings.*

Before proceeding with filter installation, ensure that the housing has been anchored as required. Confirm the inlet and outlet flanges have been properly welded, gasketed, bolted, and then tested for leaks.

WARNING: BEFORE BEGINNING PROCEDURE, MAKE SAFETY PROVISIONS TO STOP AIRFLOW AND LOCK OUT, TAG, AND TRY SYSTEM IN ACCORDANCE WITH APPLICABLE PLANT SAFETY DIRECTIVES.

Step 1 – Remove the housing access door by loosening the aluminum knobs and swing knobs away from door hold-down clips. Remove door by pulling the door toward you.

Step 2 – Turn each filter-locking mechanism with a 3/8 inch drive ratchet in a clockwise direction, alternating top to bottom until it reaches its full open position. Full open position occurs when the travel nuts contact the guide blocks and the ratchet no longer turns. Do not apply excess pressure when opening or severe damage will result to clamping mechanism.

Step 3 – Evenly coat the entire face of the new filter gasket with silicone grease. This prevents the filter gaskets from sticking to the housing sealing surface and will help achieve and maintain good filter-to-housing seal.

Step 4 – Position the filter element(s) into the housing opening (with gasket facing the sealing surface) while ensuring that the filter element(s) being installed is (are) in the correct orientation. Install filters; particulate filter(s) will have pleats vertical and the carbon adsorber(s) will have horizontal panels. Slide filter element(s) into the housing while taking precaution not to damage the gasket. Use the pressure bars of the locking mechanism as a guide by butting the nongasket side of the filter element(s) to the bars, and gently but firmly, pushing the filter element(s) until it touches the back of the housing or adjacent filter element(s). Repeat until all filters are installed (see section on MULTIPLE FILTERS).

Step 5 – Seal and lock the filter(s) in place by alternately rotating each locking mechanism. With a 3/8-drive ratchet, rotate one locking mechanism counter-clockwise two turns. Then turn the other locking mechanism counter-clockwise two turns. Alternate the procedure until completely tightened. When completely tightened, the 1/4-inch gasket will be compressed to approximately 1/8 of an inch. Do not overtighten or filter damage will result and could damage the clamping mechanism.

Step 6 – Place the change-out bag over the collar. Ensure that the elastic cord of the bag is located between the second rib of the collar and the housing frame. For added safety, attach the safety strap around the change-out bag, between the two ribs and draw the strap tight.

Step 7 – Gather the bag near the collar until the slack of the bag around the lip is almost gone. Leave only enough slack in the bag around the collar so that the remaining bulk of the bag may be stored inside the collar when the door is replaced. At the point where the gather in the bag occurs, wrap the cinch strap around the bag. Tighten the cinch strap so that the gather will not unravel. Roll or fold the remainder of the bag so it will not interfere with the access door seal when it is replaced. Failure to do this could result in bags being drawn into the housings or improper door sealing.

Step 8 – Replace the access door. Confirm that the bag is neatly tucked inside of the collar of the porthole. Tighten the aluminum knobs alternately until the door is securely sealed.

CAUTION: BE SURE TO INSTALL MULTIPLE FILTERS AS NEEDED BEFORE PLACING THE HOUSING "ON STREAM" (see section on MULTIPLE FILTERS).

NOTE: REPEAT STEPS 1 THRU 8 FOR EACH BANK AND EACH TIER OF THE SYSTEM.

Step 9 – Once the steps are complete for each unit and tier, the unit is ready for operation.

8. INITIAL FILTER INSTALLATION PROCEDURES – MODEL KE

WARNING: BEFORE BEGINNING PROCEDURE, MAKE SAFETY PROVISIONS TO STOP AIRFLOW AND LOCK OUT, TAG, AND TRY SYSTEM IN ACCORDANCE WITH APPLICABLE PLANT SAFETY DIRECTIVES.

Step 1 – Remove the housing access door by loosening the aluminum knobs and swing knobs away from door hold-down clips. Remove door by pulling the door toward you.

Step 2 – Unlatch and swing the locking arm toward you. This action actuates the clamping angles attached to the locking mechanism by moving the locking mechanism away from the knife-edge. This allows adequate room for the operator to slide the filter elements in place.

Step 3 – Slide the filter element(s) into the housing while ensuring that the filter element(s) being installed is (are) in the correct orientation, e.g., fluid seal channel facing the knife-edge of the frame. For correct orientation, refer to page 2, section 3. Confirm that all four retracting clips are overlapping the locking mechanism angles. Gently, but firmly, push the filter element(s) until it touches the back of the housing or an adjacent filter element.

Step 4 – After pushing the filter element(s) into place, move the locking arm slowly inward toward the filter and latch. This action will seat the fluid-filled channel onto the knife-edge. CAUTION: If the filter incurs resistance prior to the knife-edge penetrating the channel it will be necessary for the operator to back the filter element(s) away from the knife-edge and continue to push on the side of the filter element and repeat. NOTE: The locking arm position will prevent the door from being replaced if the filter element is not properly seated.

Step 5 – Place the change-out bag over the collar. Ensure that the elastic cord of the bag is located between the second rib of the collar and the housing frame. For added safety attach the safety strap around the change-out bag, between the two ribs, and draw the strap tight.

Step 6 – Gather the bag near the collar until the slack of the bag around the lip is almost gone. Leave only enough slack in the bag around the collar so that the remaining bulk of the bag may be stored inside the collar when the door is replaced. At the point where the gather in the bag occurs, wrap the cinch strap around the bag. Tighten the cinch strap so that the gather will not unravel. Roll or fold the remainder of the bag so it will not interfere with the access door seal when it is replaced. Failure to do this could result in bags being drawn into the housings or improper door sealing.

Step 7 – Replace the access door. Confirm that the bag is neatly tucked inside of the collar of the porthole. Tighten the aluminum knobs alternately until the door is sealed securely.

Step 8 – Once the steps are complete for each unit and tier, the unit is ready for operation.

CAUTION: *BE SURE TO INSTALL MULTIPLE FILTERS AS NEEDED BEFORE PLACING THE HOUSING "ON STREAM" (see section on MULTIPLE FILTERS).*

NOTE: REPEAT STEPS 1 THRU 7 FOR EACH BANK AND EACH TIER OF THE SYSTEM.

9. PREFILTER INSTALLATION FOR MODELS CMP & KEP

WARNING: BEFORE BEGINNING PROCEDURE, MAKE SAFETY PROVISIONS TO STOP AIRFLOW AND LOCK OUT, TAG, AND TRY SYSTEM IN ACCORDANCE WITH APPLICABLE PLANT SAFETY DIRECTIVES.

Step 1 – Remove the housing access door by loosening the aluminum knobs and swing knobs away from door hold-down clips. Remove door by pulling the door toward you. Install filters with pleats in a vertical position.

Step 2 – Place the change-out bag over the collar. Ensure that the elastic cord of the bag is located between the second rib of the collar and the housing frame. For added safety, attach the safety strap around the change-out bag between the two ribs and draw the strap tight.

NOTE: Failure to do this could result in bags being drawn into the housings or improper door sealing.

Step 3 – Gather the bag near the collar until the slack of the bag around the lip is almost gone. Leave only enough slack in the bag around the collar so that the remaining bulk of the bag may be stored inside the collar when the door is replaced. At the point where the gather in the bag occurs, wrap the cinch strap around the bag. Tighten the cinch strap so that the gather will not unravel. Roll or fold the remainder of the bag so it will not interfere with the access door seal when it is replaced.

Step 4 – Replace the access door. Confirm that the bag is neatly tucked inside of the collar of the porthole. Tighten the aluminum knobs alternately until the door is securely sealed.

Step 5 – Once the steps are complete for each unit and tier, the unit is ready for testing.

CAUTION: *BE SURE TO INSTALL MULTIPLE FILTERS AS NEEDED BEFORE PLACING THE HOUSING "ON STREAM" (see section on MULTIPLE FILTERS).*

NOTE: *REPEAT STEPS 1 THRU 4 FOR EACH BANK AND EACH TIER OF THE SYSTEM.*

TESTING

After the assembly has been completed and to ensure proper installation, the filter/adsorber bank should be tested. This test should be performed in accordance with site testing procedures.

10. FILTER EXCHANGE – SINGLE FILTER

WARNING: *BEFORE BEGINNING PROCEDURE, MAKE SAFETY PROVISIONS TO STOP AIRFLOW AND LOCK OUT, TAG, AND TRY SYSTEM IN ACCORDANCE WITH APPLICABLE PLANT SAFETY DIRECTIVES.*

NOTE: Barnebey Sutcliffe recommends that the operator use the band method of sealing the change-out bag.

PRELIMINARY STEPS

Step 1 – Confirm correct sizes and quantities of filters and change-out bags are available to be used in the filter exchange. See Filter/Adsorber Change-Out Bags (page 12) for the appropriate size bag.

Step 2 – Provide a heavy-duty, appropriate support or table to support the filter elements. Locate the support approximately 20 inches in front of the housing and a few inches below the bottom of the appropriate door.

An optional change-out table is available from Barnebey Sutcliffe. Refer to Change-Out Table, page 3 of this manual, for details on the change-out table.

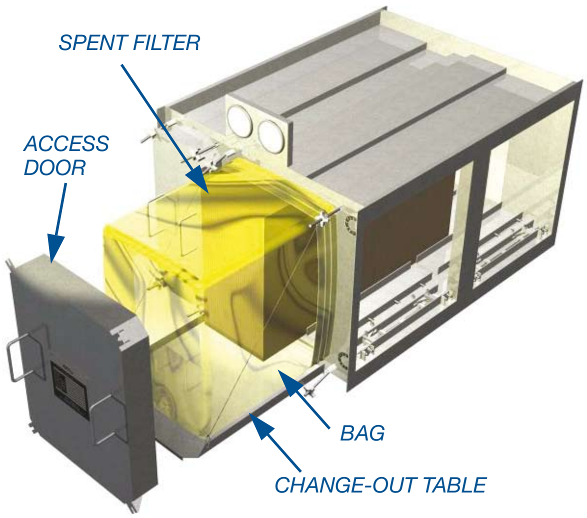
Assemble required materials and tools:

- Correct quantity and size of new adsorbers or filters
- Correct quantity and size of new change-out bags (see REPLACEMENT PARTS)
- Support for the adsorbers or filter installation or exchange, either from optional Barnebey Sutcliffe change-out table (see CHANGE OUT BAGS & TABLE), or locally provided support
- Standard 3/8-inch drive ratchet*
- Silicone grease for CM Series*

*Not provided

Step 3 – Make provisions to stop the airflow to the housing and lock out prior to starting this procedure. Open the breather valve if provided. This will release the vacuum and equalize pressure to ambient conditions.

Step 4 – Remove the access door. Remove the cinch strap. Place the optional change-out table or suitable support in front of the opening. Unroll the previously installed bag. Spread the bag over the support or table. Leave the breather valve opened, if provided with the housing assembly.

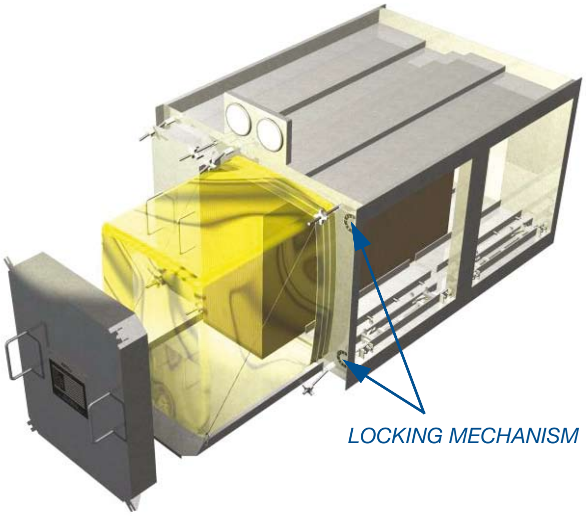


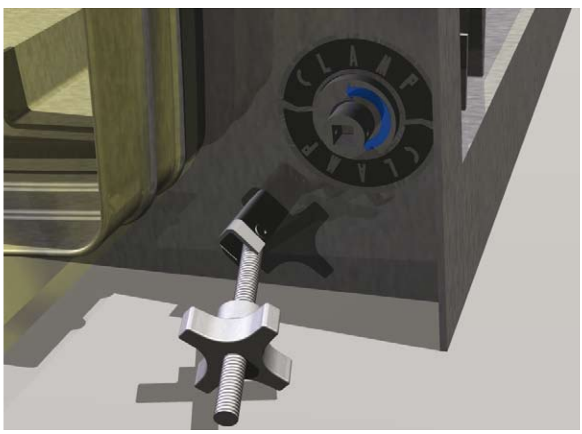
Step 5 – Disengage the filter element from the sealing surface by rotating the locking mechanism clockwise using a 3/8-inch ratchet for the CM design OR by unlatching and swinging the locking arm toward you for the KE design (see diagram on next page).

Step 6 – Place hands and arms in the sleeves provided in the change-out bag and push the change-out bag inward toward the filter. Firmly grip the filter. Slide the used filter from the housing and into the extended bag. Be careful not to damage or tear the plastic bag. Manipulate the filter to the back of the bag to ensure a maximum of slack in the bag between the filter and the housing collar.

CAUTION: *FOR ACTIVATED CARBON FILTERS DUE TO THE WEIGHT (120 TO 240 LBS.) AND THE AWKWARDNESS OF THE LOAD, THE OPERATOR SHOULD BE ASSISTED WHILE HANDLING THE FILTER(S).*

CM DESIGN: Disengage the filter element by rotating the locking mechanism.



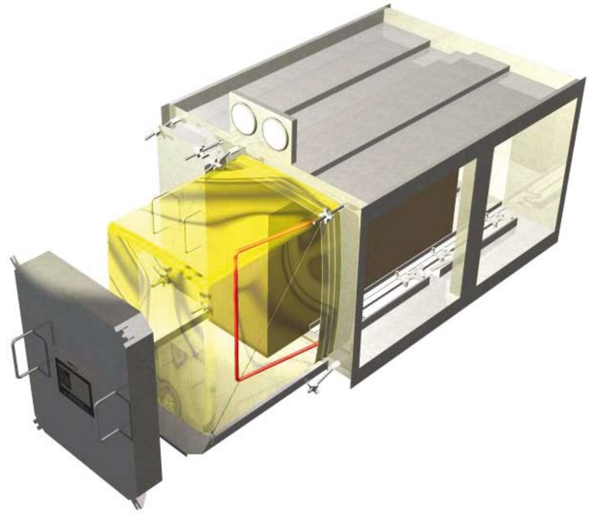


CM Locking Mechanism

Step 7 – Gather the excess material of the bag together at a midpoint between the filter and collar. Pinchoff the bag at this point by making two parallel seals approximately 6 to 7 inches apart and seal using two plastic ties provided with the kit. Cinch tightly to hold the bag in the gathered position. Locate the ties about 4 inches apart and the bands about 1 inch away from the plastic ties. (Refer to BAND SEALING METHOD of this manual). With both bands securing the bag gather, open the cutting tool and make a single cut between the two stainless bands. Tape over each seal end with duct tape for added security. Remove the newly sealed filter.

***NOTE:** FOLLOW ON-SITE DISPOSAL PROCEDURES FOR FILTERS OR CONTACT BARNEBEY SUTCLIFFE FOR FILTER DISPOSAL ASSISTANCE.*

KE DESIGN: Disengage the filter element by swinging out the locking arm.



Step 8 – The remaining part of the old change-out bag now forms a diaphragm, also referred to as a “stump”. Remove the safety strap and set aside (it will be used in the final closure step). Pull/slide the shock cord of the diaphragm until it is located between the two ribs in the collar. The first rib should remain covered. For multiple filter systems, refer to FILTER EXCHANGE for further instructions before proceeding with installation of new filters.

Step 9 – Use caution handling the new filter. Check to ensure that the dimensions of the new filter are correct.

***CAUTION:** FOR ACTIVATED CARBON FILTERS DUE TO THE WEIGHT (BETWEEN 120 TO 240 LBS.) AND THE AWKWARDNESS OF THE LOAD, THE OPERATOR SHOULD BE ASSISTED WHILE HANDLING THE FILTER(S).*

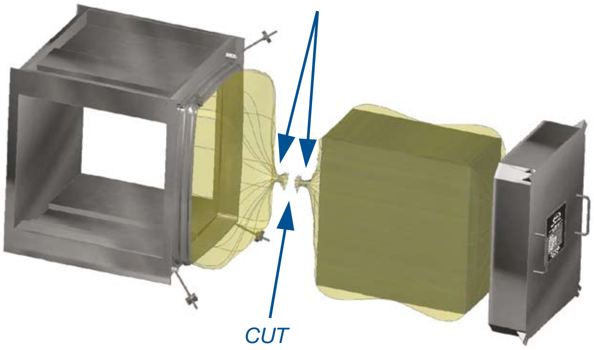
Check for dents or bent flanges. Check for gasket damage. Check for filter media damage. Look for tears in paper media (particulate filters) and dents or fractures in screen material of carbon adsorbers. Evenly coat the entire face of the new filter gasket with silicone grease. This prevents the filter gasket from sticking to the housing sealing surface and will help achieve and maintain good filter-to-housing seal. Place the new filter inside a new bag on the outside support, in front of the collar and with the sleeve hanging down. Make sure that the gasket is facing the seal face.

ALWAYS ENSURE THAT THE FILTERS ARE PROPERLY ORIENTED IN THE BAG PRIOR TO PROCEEDING. THE CORRECT ORIENTATION FOR PARTICULATE FILTERS IS WITH PLEATS IN THE VERTICAL POSITION. WHEN INSTALLING CARBON FILTERS, THE BEDS WILL BE HORIZONTAL (PARALLEL TO THE FLOOR).

Slip the open end of the bag over the stump until the elastic cord rests between the front of the housing and the second rib. Ensure complete confinement of the diaphragm or that stump is inside the new bag.

Step 10 – Withdraw the stump from the collar until it lies loosely inside the new bag. Install the safety strap between the two ribs and draw tight for added safety. Pull the stump into the sleeve of the new bag. Cut off the sleeve with the stump inside using the same process outlined in Step 7 for added security.

NOTE: THE INSTRUCTIONS FOR STEP 11 ARE SPECIFIC FOR EITHER A CM SERIES OR KE SERIES HOUSING. BE SURE TO FOLLOW APPROPRIATE STEPS FOR YOUR MODEL. STEP 11A IS FOR CM SERIES AND 11B IS FOR KE SERIES.



LOCATION OF SEALS AND CUT

Step 11A – CM SERIES

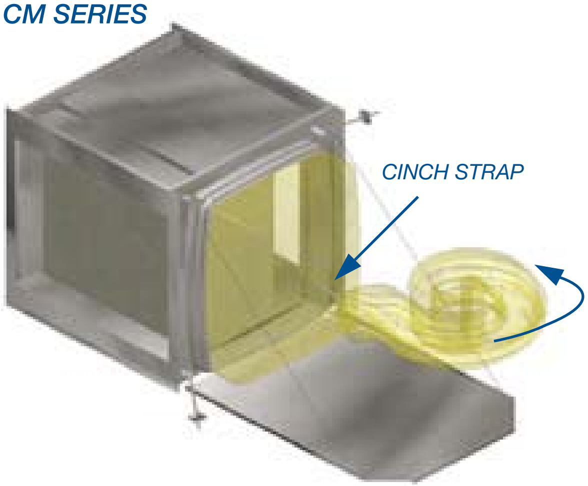
Position the filter element(s) into the housing opening (with gasket facing the sealing surface) while ensuring that the filter element(s) being installed is (are) in the correct orientation.

ALWAYS ENSURE THAT THE FILTERS ARE PROPERLY ORIENTED IN THE BAG PRIOR TO PROCEEDING. THE CORRECT ORIENTATION FOR PARTICULATE FILTERS IS WITH PLEATS IN THE VERTICAL POSITION. WHEN INSTALLING CARBON FILTERS, THE BEDS WILL BE HORIZONTAL (PARALLEL TO THE FLOOR).

Slide filter element(s) into the housing while taking precaution not to damage the gasket. Use the pressure bars of the clamping mechanism as a guide by butting the nongasket side of the filter element(s) to the bars, and gently but firmly, pushing the filter element(s) until it touches the back of the housing or adjacent filter element(s). For multiple filters, see FILTER EXCHANGE in manual.

Slide the filter into the housing until it stops. Lock the filter into place by alternately rotating each clamping mechanism. With a 3/8-inch drive ratchet, first rotate one mechanism counter-clockwise two turns. Then turn the other mechanism two turns. Alternate procedures until completely tightened.

CM SERIES

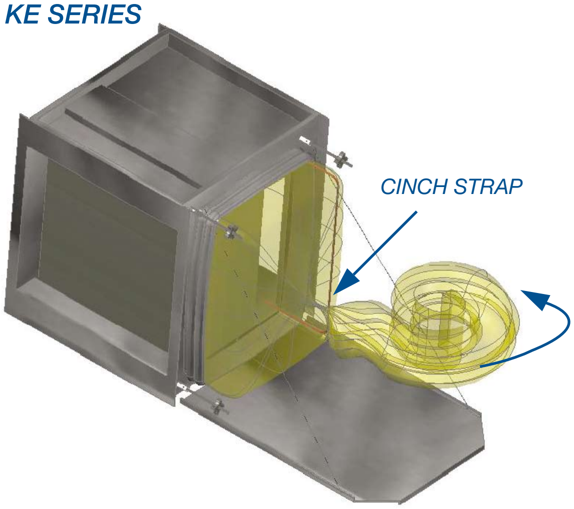


Roll the remainder of the bag so that it will not interfere with the access door seal when it is replaced. Gather the bag near the collar until the slack of the bag around the lip is almost gone. Leave only enough slack in the bag around the collar so that the remaining bulk of the bag may be stored inside the collar when the door is replaced. At the point where the gather in the bag occurs, wrap the cinch strap around the bag. Tighten the cinch strap so that the gather will not unravel. Roll or fold the remainder of the bag so that it will not interfere with the access door seal when it is replaced.

Step 11B – KE SERIES
Slide the filter element(s) into the housing while ensuring that the filter element(s) being installed is (are) in the correct orientation, e.g., fluid seal channel facing the knife-edge of the frame.

ALWAYS ENSURE THAT THE FILTERS ARE PROPERLY ORIENTED IN THE BAG PRIOR TO PROCEEDING. THE CORRECT ORIENTATION FOR PARTICULATE FILTERS IS WITH PLEATS IN

KE SERIES



THE VERTICAL POSITION. WHEN INSTALLING CARBON FILTERS, THE BEDS WILL BE HORIZONTAL (PARALLEL TO THE FLOOR).

Install HEPA according to manufacturer's instructions. Confirm that all four clips are overlapping the locking mechanism angles. Gently, but firmly, push the filter element(s) until it touches the back of the housing or an adjacent filter element. For multiple filters, see FILTER EXCHANGE in this manual.

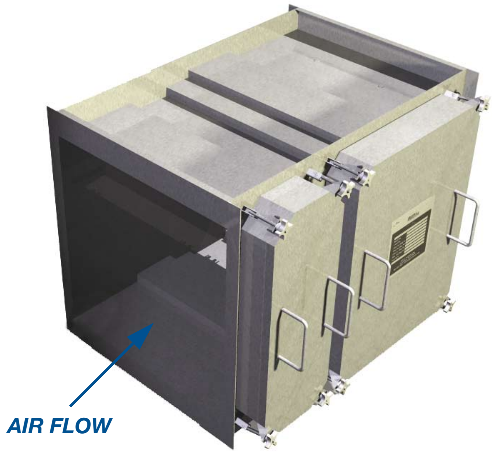
Slowly move the filter-locking arm inward toward the filter, and latch. This action will seat the fluid channel onto the knife-edge. Gather the bag near the collar until the slack of the bag around the lip is almost gone. Leave only enough slack in the bag around the collar so that the remaining bulk of the bag may be stored inside the collar when the door is replaced. At the point where the gather in the bag occurs, wrap the cinch strap around the bag. Tighten the cinch strap so that the gather will not unravel. Roll or fold the remainder of the bag so that it will not interfere with the access door seal when it is replaced.

Step 12 – Replace the access door. Tighten access door knobs, ensuring evenly distributed pressure around the sealing edge. Close the breather valve. Once all of the filters in the system have been changed, follow start-up procedures established by the site procedures.

***NOTE:** FOR OLDER HOUSINGS WITH GASKET PAD INSIDE OF THE DOOR, IT IS RECOMMENDED THAT THE GASKET BE REPLACED PRIOR TO CLOSING. TO ORDER, CALL THE BARNEBEY SUTCLIFFE SALES DEPARTMENT. BE SURE TO NOTE THE HOUSING SERIAL NUMBER AND WHICH DOOR REQUIRES THE NEW GASKET.*

Step 13 – Leak-test the system to verify filter efficiency and proper installation.

11. FILTER EXCHANGE – MULTIPLE FILTERS
Multiple filters as defined in this manual refers to systems that hold more than one filter in each door. The operator should follow the same basic procedures for multiple filters as for single-filter change-out. All contaminated filters must be removed separately before new filters are installed in the housing. This is typical for each tier and each bank. One filter or adsorber per



bag is the recommended practice. The following additional steps will need to be followed for each respective filter per opening.

Once the new filter is installed, twist the excess bag material, squeezing air out of the bag, and make two parallel seals in the gathered material between the collar and the new bag sleeve creating a diaphragm/stump. Cut between the two seals using the same steps described in Step 5 of PRELIMINARY STEPS. Place the cut-off bag with the spent filters for proper disposal.

REPEAT STEPS 7 AND 8 OF THE FILTER CHANGE PROCEDURE; HOWEVER, DO NOT INSTALL SAFETY STRAP UNTIL THE FINAL STUMP OF THE FINAL FILTER HAS BEEN REMOVED.

Repeat these steps until all filters per opening are installed and perform the above steps for each new filter bag to create a new diaphragm/stump. Once the final filter has been installed, seal filter in place following Step 9 of the filter change-out procedure. Draw the final stump into the sleeve and either seal and remove the sleeve or store inside the collar until the next filter change-out. Install the safety strap and cinch the straps.

TO REMOVE ADDITIONAL FILTERS, a filter removal rod must be used by the operator.

Horizontal airflow housing incorporates the rod in the bottom and top of the housing.

PULL THE FILTER PULL ROD TOWARD YOU. This will pull the filters toward you and make them accessible at the door for ease of removal.

Refer to FILTER/ADSORBER CHANGE-OUT BAGS chart (page 12) for the correct quantity of bags required for multiple change-outs.

12. FILTER PACKAGING – BAND SEALING

The band-sealing method is a process utilizing two stainless steel bands to cinch the change-out bag together. The banding method provides an effective method for sealing the change-out bag and protecting the environment and operator from contamination.

The operator should practice the banding process before directly working with a change-out bag. With practice, the operator will be able to perform the procedure correctly and obtain an air-tight-seal.

Banding kit consists of:

1) Stainless Steel Bands – two required for each cut
2) Banding Tool
3) Ratchet Device
4) Plastic Ties – two required for each cut
5) Cutting Tool
6) Allen Wrench

The operator should use the Banding Kit and follow the procedure listed below to ensure proper sealing:

1) Remove the filter from the housing and place into the bag. On a firm shelf, manually gather the bag in two sections between the filter and the housing.

2) At the two manually gathered sections, use two plastic ties to cinch the bag tightly in order to hold the bag in the gathered position. Recommended distance between the ties is approximately 7 to 9 inches. This space is necessary since the double metal bands will be located between the plastic ties.

3) The stainless steel bands need to be formed into the shape of a "C" and looped around the bag between the two plastic ties.

4) At one end of the band is a buckle with a threaded insert. Please note that the threaded insert will need to be on the outside of the loop.

5) Insert the end of the band through the buckle and into the hole at the front of the banding tool. The banding tool should be held so that the word “Top” is visible and the cutting handle is on the left side.

6) The ratchet device will need to be inserted into the hole on the right side of the banding tool. Push the band through until it reaches the slot in the ratchet.

7) Operate the ratchet, winding the band tighter. Continue this step until the ratchet resists further winding.

8) Use the Allen wrench to set the threaded insert in the buckle. Tighten down the threaded insert.

9) To sever the band, push the cutting handle downward and forward toward the bag. Once severed, bend the severed end back into the buckle to prevent bag damage.

10) Repeat steps 2 through 9 for the additional band that should be placed approximately ½-inch away from the first band.

11) Before cutting the bag, experiment with the knife. Open the blade to the widest position and use the successive squeezes of the handles until the blades close.

12) Open the cutting tool (blade) and position it midway between the stainless steel bands. Please note that cutting too close to the band may damage the knife. To separate the dirty filter from the system, cut between the stainless steel bands. Refer to the FILTER EXCHANGE sections of this manual for additional disposal instructions.

13. MAINTENANCE & PARTS

MODELS CM & KE CONTAINMENT HOUSINGS HAVE BEEN DESIGNED FOR MINIMAL MAINTENANCE. FILTER REMOVAL AND FILTER INSTALLATION FOR MAINTENANCE SHOULD FOLLOW THE GUIDELINES IN THIS MANUAL.

REPLACEMENT PARTS

Replacement parts are available through Barnebey Sutcliffe. Most commonly ordered replacement parts are access door knobs, change-out bags, prefilters, particulate filters, carbon adsorbers, and swing bolt assemblies.

Replacement Parts

Part Number	Description	Quantity Calculation
1033367	Access Door Hand Knobs	4 per access door
1033237	Swing Bolt Assembly	4 per access door
1033489	Prefilter Access Door Gasket	7 feet per access door
1033489	12"-Deep Access Door Gasket	9 feet per access door
1033489	16-18"-Deep Access Door Gasket	10 feet per access door
1034780	Band Sealing Kit	
Refer to table on next page for Change-out bag Part #s (P/N)	Change-Out Bag	Refer to table on next page for appropriate quantities
Refer to unit name Plate for filter P/N	Prefilter	Number of filters high X number of filters wide
Refer to unit name Plate for filter P/N	HEPA filter	Number of filters high X number of filters wide
Refer to unit name Plate for filter P/N	Carbon adsorber	Number of filters high X number of filters wide

Filter/Adsorber Change-Out Bags

Bag Part #	Filter/Adsorber (H x W x D)	Cell Type	Bag Size
SP2515	24" x 24" x 2"	Prefilters	70C x 96
	24" x 24" x 4"		
	24" x 24" x 6"		
SP2006	24" x 24" x 11 ½"	HEPA Filters	90C x 96
SP8476	24" x 24" x 16"	Adsorbers	104C x 96
	24" x 24" x 18"		

Arrangement	Number of Cells	Total Number of Cells	Number of Bags Required
1H x 1W	1	1	1
1H x 2W	2	2	3
1H x 3W	3	3	5
1H x 4W	4	4	6
1H x 5W	5	5	8
1H x 6W	6	6	10
2H x 1W	1	2	2
2H x 2W	2	4	6
2H x 3W	3	6	10
2H x 4W	4	8	12
2H x 5W	5	10	16
2H x 6W	6	12	20
3H x 1W	1	3	3
3H x 2W	2	6	9
3H x 3W	3	9	15
3H x 4W	4	12	8
3H x 5W	5	15	24
3H x 6W	6	18	30
4H x 1W	1	4	4
4H x 2W	2	8	12
4H x 3W	3	12	20
4H x 4W	4	16	24
4H x 5W	5	20	32
4H x 6W	6	24	40

Note: The above chart assumes one full bag has been installed over each opening prior to change-out process.

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APTUIT WORK INSTRUCTION	
TITLE: INCINERATOR DEMOLITION AND MATERIAL SIZING USING PLASMA/THERMAL CUTTING	**No:** Aptuit WI-010 **Date:** September 24, 2013 **Page:** 1 of 2

1. PURPOSE

This procedure describes the method that the demolition contractor will use to size reduce the incinerator and other large components including stacks, fan units, and other large components using plasma cutter.

2. APPLICABILITY

This procedure is limited to the materials and conditions specified in the attached Memo to File from the Licensee dated October 1, 2013 and the applicable Radiation Work Permit (RWP).

3. REFERENCES

3.1 Aptuit Radiation Protection Plan Manual, March 2008

4. DEFINITIONS

See attached procedure.

5. RESPONSIBILITIES

5.1 Project Health Physicist

The Project Health Physicist (PHP) is responsible for the maintenance and management of this procedure.

5.2 Site Supervisor/Survey Coordinator

The Site Supervisor (SS) will be responsible for the field oversight of the demolition contractor.

6. EQUIPMENT AND MATERIALS

6.1 Plasma cutting system

6.2 Electric shears

7. INSTRUCTIONS

Follow attached LVI procedure for equipment use, *Incinerator Demolition and Material Sizing Using Plasma/Thermal Cutting*

8. ATTACHMENTS

Memo to File from the Licensee dated October 1, 2013

9. FORMS

10. REVISION HISTORY AND APPROVAL

Rev Level	Rev Date	Rev Description	Approver
0	9/24/13	Initial Issue	Rick Greene Project Health Physicist Site Supervisor

LVI Environmental Services Inc.
5150 Fox Street
Denver, CO 80216

Phone (303) 727-9205
Fax (303) 727-9210
www.lviservices.com

Standard Operating Procedure

Aptuit Lab Partial Decommission Project

Incinerator Demolition and Material Sizing Using Plasma/Thermal Cutting

Reviewed by and date:______________________________

August 28, 2013

1. **Scope of Work and General Approach For Plasma Cutter Cutting of the Incinerator Steel and Sizing of Other Site Materials for Disposal in Sealand Containers**

1.1. Scope of work: LVI will cut the incinerator and other large components including stacks, fan units, and other large components into manageable sized pieces using a plasma cutter. The use of the plasma cutter will take place only within the incinerator room or the exterior of the building. A Hot Work Permit will be obtained on a daily basis as per Catalent Contractor Safety Procedures.

1.2. General Approach:

1. Daily Huddle Safety Meeting and Stretching
2. Job Safety Analysis (JSA) per task (Lead man/Crew)
3. The crew will have radio contact from inside the work area to the outside during all cutting and removal activities in case of an emergency.
4. LVI will have at least two employees on site and at least one employee inside the work area trained in First Aid/CPR.
5. The Hot Work Permit will be completed prior to cutting activities, and fire watch personnel will be assigned for the cutting operation and will tour the area for three hours following the cessation of cutting (tour the area at least every 30 minutes). . The Hot Work Permit will be reviewed by Catalent maintenance and Aptuit Safety Officer. The Hot Work permit will be at the work area with the JSA for review.
6. Employees will be trained in the use of fire extinguishing devices and emergency reporting procedures for this facility prior to any cutting activities.
7. Employees enter the clean room of the work area and suit up with proper PPE for the tasks they are preforming.
8. Cutter cutting crew will also wear cloth fire retardant coveralls made of "Fryban"; this includes the fire watch personnel.
9. Enter restricted work area.
10. Prior to plasma cutter cutting activities, point source air flow will be verified using smoke tubes.
11. Move negative air machines and positive air devices (box fans) as needed for air flow
12. Fire Watch will inspect the area and monitor with the four gas meter ($O_{2,}$ LEL, CO, SO_2) prior to touching activities.
13. Steel will be removed in small sections and lowered to the ground
14. Fire Watch will remain at the cutting area for one hour following cutter activity and will sign off on the Permit. The fire watch will tour the cutting area at least every 30 minutes for three hours following cutting operations.

2. **General Tasks and Methods**

1. Detailed discussion of work area activities involving all tasks that will be preformed that day with observations from the previous shifts work, including near misses during the Daily Huddle.
2. The crew will go over the Emergency Action Plan and egress routes for each work area in case of an emergency.
3. Crew to write JSA and discuss the day's activities.
4. Check negative air machines (NAM) for air flow using smoke tubes.
5. Replace pre filters on NAMs per visual inspection, check make up air filters and flaps for cutting operation.
6. Maintain housekeeping and access to work area emergency exits.
7. Inspect lighting and fire extinguisher placement in all areas

3. Personal Protection Equipment (PPE per task)

1. Outside Regulated Work area: Level "D"
2. Set up and Inspection of work area: Level "C"
3. Demolition of lab fixtures Level "C"
4. Removal of exterior parts, doors, piping: Level "C"
5. Plasma cutting of incinerator steel lid and walls: Level "C" with half face respirator with HEPA/Organic Vapor combo filters.
6. Other PPE required are hard hats, Tyvek suits, Kevlar/leather gloves, steel toed boots, leather welding clothing, fire retardant coveralls and hearing protection.

4. Equipment and Plasma Cutting Propane Oxygen Cutting: Thermadyne Cutmaster 82 Plasma System 80 (see attached specification sheets)

1. Inspect Cutmaster 82 for proper working order prior to use.
2. Hot work permits will be done daily for any thermal cutting activities and reviewed by Aptuit Safety Officer for approval.
3. Turn off power supply to plasma cutter and disconnect cord from source at lunch time and at the end of each shift.
4. LVI will train their employees in the proper use of the cutting units, fire watch and use of fire extinguishers.
5. A fire watch will be assigned for each cutting operation.
6. The air lines and electrical power will be connected and the cutting units will be inspected for proper use.
7. Place drop cloth and fire blankets under work area to control falling debris.
8. Once inspected the cutting equipment the crew will move the cutting units into the work area, using proper PPE, and placed for the day's operation.
9. Units will be placed in strategic locations, making note of air lines and electrical connections.
10. Make sure cables and hoses are hung off the floor and away from blocking egress routes.
11. The general plan is cutter from top to bottom
12. Prior to cutting, the surface of the metal will be wiped down, removing any removable soils, visible oils, and debris.

13. Install point source ventilation, making sure all air movement is away from the employees supporting the operation. Collection tube from negative air machine rated at 2,000 cubic feet per minute of air will be installed above the cutting operation, pulling cutting fumes away from the employee's breathing zone and exhausted to the outside of the containment through a HEPA filter.
14. The point source ventilation will be adjusted accordingly to recover the cutting fumes.
15. Keep point source ventilation as close to the cutting operation as possible. This will be adjusted as the cutting operation progresses to insure point source ventilation is achieved.
16. Install fire controls by placing fire extinguishers (ABC) within 5 feet of the cutting operation, and fire blankets directly under point of cutting on the floor, the fire watch will Monitor with a four gas meter prior to beginning and continually observe operation at all times during cutter operation and move the fire extinguisher and blankets as needed while the cutting progresses.
17. Fire blanket made of fire retardant material will be place under the cutting area
18. Along with fire extinguishers an active water hose will be near the area for any necessary use.
19. Employees performing the plasma cutting will be wearing a minimum number 8 shaded welding visor for eye protection in addition to PPE described above.
20. The test cutting will be performed in order to observe the point source ventilation is working correctly.
21. Cutting of steel will be done in manageable sections
22. Metal will be cooled prior to movement for wrapping with poly and placement into disposal container.
23. Fire watch will be present for one hour after any thermal cutting operation, and will verify and check for sparks and/or smoldering materials.
24. LVI employees will be trained in the use of fire extinguishers in the case of a fire event (see work plan and emergency action plan for contact numbers).

5. Air Monitoring Equipment and Use

1. RAE TN-114 four gas monitor: maintained and monitored by the assigned fire watch employee, (see attached specification sheet for the four gas monitor and will monitor for LEL, O_2, CO_2, and H_2S).
2. RAE TN-144 will be calibrated prior to use and documentation will be with the monitor.
3. LVIs Safety Officer will verify proper training and use of the air monitoring equipment.
4. Calibration of the RAE TN-114 four gas monitor will be performed daily with zero gas, multi gas and SO_2, for the days use.
5. LVI will preform OSHA sampling for lead during the first day of cutting any painted surface.
6. All air monitoring data will be submitted to Aptuit safety for review.
7. LVI will not resume work until corrections are made and approved by Aptuit Site Safety representative.

6. Engineering Controls

1. Point Source Ventilation.
2. Half face respirators with combo HEPA and OV filters.
3. RAE TN-114 four Gas Monitor.
4. Fire Extinguisher (ABC)
5. Fire blankets
6. Negative Air Machine with HEPA Filter and intake tube
7. Box Fans

7. References

Site specific health and safety plan

Reviewed and Accepted by:

LVI Safety Officer:	____________________	____________________	_______________
	Name	Signature	Date
LVI Project Manager:	____________________	____________________	_______________
	Name	Signature	Date
Aptuit Safety Manager	____________________	____________________	_______________
	Name	Signature	Date

Aptuit, LLC.
10245 Hickman Mills Drive
Kansas City, MO 64137
USA

October 1, 2013

To NRC file: Memo to File

To Whom It May Concern:

Discussions with LVI and CBI have led to further detail about the type of tools that will be utilized for decommissioning. Specifically, the Licensee has discussed and evaluated the use of a plasma cutter and does not find any concerns with its use as planned. The plasma cutter will be utilized for size reduction of the incinerator, stacks and other metal debris. These systems will be released from radiological impact before the plasma cutter is utilized on them. This will ensure that the plasma cutter does not cause contamination spread or radioactive material to become airborne. Aptuit Work Instruction WI-010 has been prepared to describe the use of the plasma cutter.

Several additional controls will also be utilized with the plasma cutter due to the amount of heat generated from its use. Workers will follow Catalent's contractor safety and hot work programs when utilizing the plasma cutter. Aptuit will apply for a hot work permit each day, station fire watches for the duration of cutting, for one following cutting, with periodic checks (at least every 30 minutes) for three hours after all cutting has ceased and any other specific requirement of the Catalent contractor guide. HEPA filtration and exhaust trunks will be utilized to ensure that harmful gases are removed from worker breathing zones.

The signatures below indicate the Licensee's approval to use a plasma cutter as outlined above and that no further actions or notifications are required.

Clint Gregg
Aptuit RSO ____
Tel: (816) 769-4382
Fax: (816) 767-7322

Marcello DiMare
Aptuit Senior Director of API ____

1. PURPOSE

This Work Instruction (WI) establishes the basis and methodology for the placement and use of air monitoring equipment, as well as the collection, analysis, and documentation of air samples. Radiological air sampling and analysis may be performed to monitor concentrations of radionuclides in the air for purposes of tracking internal radiation exposure for occupational radiation workers, determining appropriate respiratory protection devices, establishing radiological posting boundaries, verifying effluent airborne radioactivity concentrations, and providing information on radiological conditions in the work area.

2. SCOPE

This WI provides standard practices and operating procedures for performing air sampling for radioactivity during decommissioning activities at Aptuit, LLC. Air sampling may be performed during demolition, disassembly, or size reduction activities on contaminated systems. While H-3 and C-14 are the radiological contaminants of concern from routine operations at the site, the incinerator contains refractory materials that contain naturally occurring radioactive materials (NORM). Particulate forms of H-3 and C-14 are expected to be the only forms of these contaminants remaining.

3. REFERENCES

3.1 Aptuit Radiation Safety Program Manual, March 2008

3.2 Manufacturers' operating manuals

3.3 U.S. Nuclear Regulatory Commission, 2003, Consolidated NMSS Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria, NUREG 1757, Vol. 2, September

4. DEFINITIONS

TERM/ACRONYM	DEFINITION
Airborne Radioactivity	Radioactive material in any chemical or physical form that is dissolved, misted, suspended, or otherwise entrained in air.
Alpha Radiation	Alpha particles emitted by some radionuclides while undergoing radioactive decay. While Alpha radiation does not pose an external exposure threat, Alpha emitters may also emit photons (gamma or X-ray) during decay or attenuation.

TERM/ACRONYM	DEFINITION
Ambient Air	Air in the volume of interest, such as room atmosphere, as distinct from a specific stream or volume of air that may have different properties.
Annual Limit on Intake (ALI)	The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent (CEDE) of 5 rems or a committed dose equivalent (CDE) of 50 rems to any organ or tissue.
Background Radiation	Radiation that occurs naturally in the environment. Background radiation consists of cosmic radiation from outer space, or radioactive elements in geological media, building material, or other natural sources, including radon and its decay products in air and global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation and are not under the control of the licensee. “Background” radiation does not include radiation from source, byproduct, or special nuclear material regulated by the Nuclear Regulatory Commission.
Beta Radiation	Beta particles (β) emitted by some radionuclides while undergoing radioactive decay. With few exceptions, beta-emitting radionuclides also emit photons (gamma or x-ray) during decay. Beta particles cannot penetrate human skin but do pose a hazard to the skin and lenses of the eye.
Derived Air Concentration (DAC)	The concentration of a given radioactive nuclide in air which, if breathed by the reference man for a working year of 2000 hours under conditions of light work (1.2 m^3 of air per hour), would result in an intake of one (1) ALI.
Ionizing Radiation	Alpha particles, beta particles, gamma rays, neutrons, energetic electrons or protons, and other particles capable of producing ions when interacting with matter.
LSC	Liquid scintillation counter
MDC	Minimum detectable concentration.

TERM/ACRONYM	DEFINITION
NORM	Radioactive materials that are found in nature. Until recently, technologically enhanced naturally occurring radioactive materials (TENORM) was referred to simply as NORM. The words "technologically enhanced" were added to distinguish clearly between radionuclides as they occur naturally and radionuclides that human activity has concentrated or exposed to the environment.

5. RESPONSIBILITIES

5.1 Project Health Physicist

The Project Health Physicist is responsible for the maintenance and management of this procedure, including selection of appropriate instrumentation and methods to meet the data quality objectives of the project.

5.2 Site Supervisor/Survey Coordinator

The Site Supervisor (SS)/Survey Coordinator is responsible for managing the implementation of this procedure. The SS is also responsible for making sure STs are following this procedure as described herein.

5.3 Survey Technicians

The STs are responsible for compliance with this work instruction, recognizing instrumentation problems and notifying the SS or Project Health Physicist of malfunctioning instruments. The ST initiates, collects, submits, counts, and documents air samples according to the requirements of this procedure.

6. PRECAUTIONS AND LIMITATIONS

6.1 Running air samplers for extended periods may cause excessive dust loading of the filter media. The frequency of filter change-out should be increased if excessive dust loading is observed.

6.2 Air samplers shall not be used in combustible / explosive atmospheres.

6.3 Air sampling and sample counting equipment shall not be operated beyond their respective calibration periods.

6.4 Air samples shall be taken in such a manner as to not contaminate the filter with materials that were not airborne during the sample interval or by re-suspension of loose contamination from surfaces near the sampling head.

6.5 Sampler exhaust may cause the re-suspension of loose surface contamination if the sampler is positioned improperly.

6.6 Consider higher volume air samplers when covering short duration tasks.

6.7 The decision to provide individual monitoring devices to workers is influenced by the expected levels of intake, likely variations in dose among workers, and the complexity of measurement and interpretation of results.

7. PROCEDURE

7.1 Air Monitoring Methods

7.1.1 Utilize the following monitoring methods to implement the radiological air monitoring program:

(1) General Area (GA) Air Monitoring

(2) Breathing Zone (BZ) Air Monitoring

7.1.2 Air sampling equipment should be placed so as to:

(1) Not directly contact a contaminated (transferable) surface.

(2) Minimize interference with the performance of work.

(3) Be easily accessible for changing filters and servicing.

(4) Be downstream of potential release points.

7.1.3 Sampling shall be performed with instrumentation operating at volumes capable of meeting the Minimum Detectable Concentration (MDC) values established for the project.

(1) The limiting alpha emitting radionuclide is Th-232 (in the refractory). The required MDC is 25% of the Derived Air Concentration or 2.5E-13 microcurie per milliliter (µCi/ml).

(2) The required MDC for H-3 compounds is 5E-6 µCi/ml.

(3) The required MDC for C-14 compounds is 2.5E-7 µCi/ml.

7.2 General Area (GA) Air Sampling

7.2.1 GA samples are typically taken with low volume samplers such as the F&J DF-1 or equivalent.

7.2.2 GA samples should be collected during work activities as a supplement to or instead of Breathing Zone (BZ) sampling as deemed appropriate.

7.2.3 Document airflow studies, if performed, in the appropriate project logbook or as directed by the RSO.

7.2.4 Select a calibrated low volume sampler with the appropriate glass fiber air filter and place the sample head into position. The fuzzy side of the filter should face outwards.

7.2.5 Turn the sampler ON. At a minimum, document the following information on the Airborne Radioactivity Sample Log or on the filter envelope:

(1) RWP No (if applicable)

(2) Sampling ID

(3) Sample taken by

(4) Sample Description/Purpose (e.g., “GA”)

(5) Sample location

(6) Air sample model/serial number

(7) Start Date / time on

(8) Initial flow rate (typically 50 – 70 L/min for low volume samplers)

7.2.6 When air monitoring is complete, observe the sampler flow rate and turn the sampler off. At a minimum, document the following information on the Airborne Radioactivity Sample Log or on the filter envelope:

(1) Stop Date / time off

(2) Final flow rate

(3) Average flow rate (Take the average of the initial and final flow rate or use the average flow rate if measured by the flow meter).

(4) Total Run Time (if available)

(5) Total Volume Sampled (if available)

7.2.7 Remove and / or replace the sample head and filter using caution to prevent cross contamination.

7.2.8 Store the filter in a protective container to minimize the loss of collected material.

7.2.9 Submit sample and associated sample-specific information for analysis.

7.3 Breathing Zone (BZ) Air Sampling

7.3.1 Collect BZ samples during entries into posted airborne radioactivity areas and during activities which have a reasonable potential of producing airborne radioactivity (e.g., excavating contaminated soils, surface destructive activities on surfaces with fixed contamination) as determined by the RSO.

7.3.2 Position the sampler on the individual representative of the worst-case exposure for the group if a single lapel sampler is used for multiple members of a work group. Base this selection on operating experience and consultation with the RSO. A single lapel sampler should be used for a group of no more than four workers spending greater than one hour in the work.

7.3.3 Ensure the sample head is positioned as close to the breathing zone as practical without interfering with the work or the worker.

7.3.4 Operate sampler(s) according to the appropriate instrument use procedure. At a minimum, document the following information on the Airborne Radioactivity Sample Log or on the filter envelope:

(1) RWP No (if applicable)

(2) Sampling ID

(3) Sample taken by

(4) Sample Description/Purpose (e.g., “BZA”)

(5) Name of person wearing the sampler

(6) Sample location

(7) Air sample model/serial number

(8) Start Date / time on

(9) Initial flow rate (typically 2000 ml/min for BZ samplers)

7.3.5 Upon exit from the work area, note the flow rate, turn the sampler OFF and detach from the worker / object. Note that unless otherwise authorized by the RSO, BZ sampling should be

suspended / restarted during the workday to facilitate break periods when no one is in the work area. Accurate volume tracking is crucial during these periods of non-operation.

7.3.6 Perform necessary post-operation sampler checks according to the specific instrument use procedure.

7.3.7 Carefully, remove the air filter from the sample head and place in air filter envelope. Complete the pre-printed air filter envelope or sample log sheet:

(1) Stop Date / time off

(2) Final flow rate

(3) Average flow rate (Take the average of the initial and final flow rate or use the average flow rate if measured by the flow meter).

(4) Total Run Time (if available)

(5) Total Volume Sampled (if available)

7.4 Analysis of Air Samples

General Area (GA) and Breathing Zone (BZ) samples should be counted for gross alpha analysis and or H-3/C-14 analysis as directed by the RSO.

7.5 The Minimum Detectable Dose (MDD) for a single work shift is estimated as follows:

$MDD_{work\ shift} = (3.0 + 4.65(B \times t_b)^{0.5} \times 2.5 \times W)(60 \times f \times W \times E_{ff} \times SAF \times 2.22E{+}6 \times DAC \times t_s)^{-1}$

Where:

B	=	Gross background count rate (cpm)
t_b	=	Background count time (minutes)
t_s	=	Time sample is counted (minutes)
5	=	Inhalation dose conversion factor (mrem/DAC-hr)
f	=	Sample flow rate (ml/min)
60	=	60 min/h
E_{ff}	=	Detector efficiency (counts/disintegrations)
SAF	=	Self-absorption coefficient for gross alpha counting (typically 0.8)
2.22E+6	=	dpm/ µCi
W	=	Average sample collection time (hrs)
DAC	=	µCi/mL
$MDD_{work\text{-}shift}$	=	mrem

NOTE: For H-3 and C-14 analysis - If the LSC is set to give the activity in dpm for H-3 and C-14 then B will be the background count rate in dpm for the respective H-3 and C-14 channel. The efficiency and self-absorption factor will not be used.

7.6 Dose Calculated from an Individual Air Filter Analysis

To calculate the dose to assign to the worker using the gross count result:
C (µCi/mL) = (Sample – Bkg)(2.22E+6 *x* f *x* W *x* e_{ff} *x* SAF)$^{-1}$
Where:

Sample	=	Sample count rate (cpm)
Bkg	=	background count rate (cpm)
2.22E+6	=	dpm/µCi
f	=	flow rate (mL/minute)
W	=	time sampled air (minutes)
E_{ff}	=	Detector efficiency (counts/disintegrations)
SAF	=	Self-absorption coefficient for gross alpha counting (typically 0.8)

NOTE: For H-3 and C-14 analysis - If the LSC is set to give the activity in dpm for H-3 and C-14 then Sample and Bkg will be the gross sample activity and the background count rate in dpm for the respective H-3 and C-14 channels. The efficiency and self-absorption factor will not be used.

The dose to the worker exposed to this air concentration is:

Dose (mrem) = (C x T x 2.5)(DAC)$^{-1}$

Where:

C	=	air concentration(µCi/mL)
T	=	time worked exposed to airborne radioactive material (hours)
2.5	=	conversion factor (mrem/DAC-hr)
DAC	=	µCi/mL

7.7 Dose Assignment Strategy for Air Monitoring

7.7.1 Air monitoring data can be used to estimate intake and dose. The dose assignment strategy discussed in this section is one approach suitable for determining occupational exposures.

7.7.2 The assignment of an air concentration to individual workers should follow the below listed decision scheme:

(1) An individual who wears a BZ air sampler should be assigned the dose based on the air concentration resulting from the BZ sampler worn.

(2) When an individual does not wear a BZ sampler, but other workers do then consideration should be given to assigning all individuals a dose based on the highest air concentration found for the day.

(3) Because general area samples are not directly representative of breathing air, an evaluation should always be performed when using a general area sample to assign dose to an employee. Calculations of dose should be generally similar to those from BZA samples.

The evaluation should typically contain the following components:

(1) An evaluation of the sampler placement in relation to work activities and employee locations.

(2) A comparison of the results from valid BZA samples to corresponding general area samples. If a ratio is found between general area sample results and BZA sample results, it may be applied to general area sample results to estimate the activity in breathing air.

(3) An estimate of the exposure period and the calculation of individual exposures.

7.7.3 Doses will be recorded and reported in accordance with U.S. Nuclear Regulatory Commission Regulatory Guide 8.7 Revision 1, "Instructions for Recording and Reporting Occupational Radiation Exposure Data".

7.8 Air Filter Analysis

7.8.1 The analytical instrument for performing gross alpha air sample analysis should be a Ludlum 3030 or Ludlum 2929 dual phosphor or equal or superior detectors. The analytical instruments should have stable efficiencies and backgrounds. The on-site LSC or equivalent will be used for analysis of the air samples for H-3 and C-14.

7.8.2 It is necessary to minimize interference from the decay of Rn-220 progeny collected on the air sample filter paper. This can be achieved by waiting a minimum of five (5) full days after sample collection prior to performing a record count. Preliminary counts can be performed at one or two days in the event the worker exposure may be approaching a dose limit.

8. REPORTS

Maintain air monitoring instrument data, sampling data, and analysis results as a quality record.

9. ATTACHMENTS

9.1 Airborne Radioactivity Sample Log

REVISION HISTORY AND APPROVAL

Rev Level	Rev Date	Rev Description	Approver
0	10/8/2013	Initial Issue	Rick [signature] Project Health Physicist [signature] Site Supervisor

AIRBORNE RADIOACTIVITY SAMPLE LOG

Project Name: Aptuit D&D   Project No: 144040   RWP No:

RCS (or Designee)/date: Reviewed by/Date:

Sample ID No: Sample taken by:	Sample Description / Location	Air Sampler/ Serial No.	Start date & time Stop date & time	Initial Flowrate (ml/min or L/min)	Final Flowrate (ml/min or L/min)	Average Flowrate (ml/min or L/min)	Total Run Time (min)	Total Run Vol (ml or L)

RADIOLOGICAL WORK PERMIT

Project Name____________________ Project No. _____________________

RWP Title:		**RWP#:** **Rev.#:**
Initiated By:	**Date:**	**Expiration Date:**
Work Scope:		

HEAD COVERING	BODY COVERING	HANDS	FEET
☐ Hood	☐ Coveralls	☐ Surgical Gloves	☐ Shoe Covers
☐ Skull Cap	☐ Plastic Suit	☐ Rubber Gloves	☐ Rubbers
☐ Other:	☐ Other:	☐ Other:	☐ Other:
EXTERNAL DOSIMETRY	**RESPIRATOR CARTRIDGE**	**RESPIRATORY PROTECTION**	**INTERNAL DOSIMETRY**
☐ OSL/TLD personnel dosimeter	☐ Particulate	☐ Full Face	☐ Baseline Bioassay
☐ SRD/EPD	☐ Vapor	☐ Supplied Air	☐ Routine Bioassay
☐ Extremity	☐ Combination	☐ PAPR	☐ Other:
SAFETY	**SPECIAL INSTRUCTIONS**		
☐ Safety Shoes			
☐ Hard Hat			
☐ Safety Glasses			
☐ Other:	☐ See attached RWP supplemental form		

GENERAL AREA RADIATION LEVELS		RCT COVERAGE REQUIREMENTS
Average (mrem/hr)	Location:	☐ Continuous HP Coverage ☐ Intermittent HP Coverage
Maximum (mrem/hr)	Location:	☐ Other:
HOT SPOTS		**AIRBORNE SURVEY/MONITORING REQUIREMENTS**
Survey# (mrem/hr)	Location:	☐ Gen. Area Low Vol. Air Sampling ☐ Localized High Vol. Air Sampling
Survey# (mrem/hr)	Location:	☐ Personal Lapel Air Sampling ☐ Other:
LOOSE CONTAMINATION LEVELS		**ALARA REQUIREMENTS**
	$\beta\gamma$ (dpm/100cm^2) **α (dpm/100cm^2)**	■ Pre-Job Briefing
Average		☐ PHP ALARA Review/Evaluation ☐ Other:
Maximum		

Anticipated Airborne Radioactivity Levels	**BETA:**	**ALPHA:**	**Most Restrictive DAC (μCi/ml)**

Approvals

RCS:	**Date:**

Termination

RCS:	**Date:**

RWP SUPPLEMENT FORM

RWP No.

This form is to be utilized, as appropriated, to inform workers of additional, non-radiological, hazards known or expected to be present in the work area.

Atmospheric Contaminants and Conditions

Oxygen Deficient Areas:

Oxygen Concentration (%)___________ Location(s)

Areas marked and adequately controlled to preclude personnel access: YES______ NO

Explosive Atmospheres:

Contaminants (if known)

LEL (%)_________ UEL (%)________ Explosimeter Reading (%LEL)

Specific Contaminants:

Contaminant	OSHA PEL (ppm)	NIOSH TLV (ppm)	Measured Levels (ppm)	Location Measured

Area Chemical Hazards

Chemicals Present____ Location

MSDS's reviewed with personnel entering the area as part of pre-job brief? YES____ No_

Other Hazards (Specify)

Hazard Prevention Measures (Specify)

Health and Safety Supervisor Approval: ____________________________________ Date:

RADIATION WORK PERMIT SIGNATURE FORM

Project Name ___________________________ Project ___________________

RWP Title	RWP # Rev. #
My signature below certifies the following: ▪ *I have read, understand, and will comply with all requirements specified in the RWP indicated.* ▪ *To the best of my knowledge, I satisfy all applicable training and access requirements for the designated Radiologically Controlled Area.* ▪ *I will not perform work outside of the specified work scope on the RWP.*	Page ______ of ______

Date	Print Name	Signature	Badge or Social Security Number	ENTRY		EXIT	
				Time	SRD/EPD Reading	Time	SRD/EPD Reading

APPENDIX F

RESRAD-BUILD REPORTS

Input parameters for RESRAD-Build, Ver 3.5
Aptuit residual contamination in drain lines in B2-166

Use the Renovation Worker Scenario as the maximum potential dose to a member of the public.

Source term

Use maximum ^{3}H and ^{14}C values measured in remaining drain line.

Since the contamination levels are based on smears they were increased by 10x for total source term (RESRAD default is 10% removable).

The source is modeled as a rectangular volume source 10m x 0.23m x 0.15 cm for a total volume of 345,000 cm^3. This is the total volume of the drain lines in and connecting B2-166.

Total activity was obtained by using the contamination levels in dpm/100 cm^2 (increased by 10X) multiplied by the total volume of the drain lines coming from B2-166.

RESRAD-BUILD, Version 3.5 requires H-3 to be run separately. The total dose to the renovation worker is the C-14 dose plus the H-3 dose.

The default Building Renovation Scenario parameters (Table 3.1) described in the User's Manual for RESRAD-Build Version 3 were used except for the following:

Room size 115 m^2 corresponding to the floor area of B2-166.

Used a source density of 1 g/cc.

TABLE 3.1 Key Parameters Used in the Building Occupancy and Building Renovation Scenarios

		Parameter Values		
Parameter	Unit	Building Occupancy[a]	Building Renovation[b]	Remarks
Exposure duration	days (d)	365.25	179.00	To match the occupancy period of 365.25 days in NUREG/CR-5512 building occupancy scenario (Beyeler et al. 1999) and renovation period of 179 days in NUREG/CR-5512 building renovation scenario (Wernig et al. 1999).
Indoor fraction	–[c]	0.267	0.351	To match the 97.5 d/yr time in building in NUREG/CR-5512 building occupancy scenario (Beyeler et al. 1999) and 62.83 days spent in the building during renovation period in NUREG/CR-5512 building renovation scenario (Wernig et al. 1999).
Receptor location	m	0, 0, 1	0, 0, 1	At 1-m from the center of the source.
Receptor inhalation rate	m^3/d	33.6	38.4	For building occupancy scenario it matches with 1.4 m^3/h breathing rates in NUREG/CR-5512 (Beyeler et al. 1999) and for building renovation scenario it matches with 1.6 m^3/h breathing rate of moderate activity given in the EPA Exposure Factor Handbook (EPA 1997).
Receptor indirect ingestion rate	m^2/h	1.12×10^{-4}	0	Value for the building occupancy scenario is the mean value from the distribution and for the building renovation scenario it is assumed the ingestion is only from the direct contact with the source.
Source type	–	Area	Volume	For building occupancy scenario it is assumed that contamination is only on the surfaces, whereas for the building renovation scenario contamination is volumetric.

TABLE 3.1 (Cont.)

Parameter	Unit	Parameter Values: Building Occupancy[a]	Parameter Values: Building Renovation[b]	Remarks
Direct ingestion rate	1/h (area)g/h (volume)	3.06×10^{-6}	0.052	Calculated from the default ingestion rate of 1.1×10^{-4} m^2/h in NUREG/CR-5512 building occupancy scenario (Beyeler et al. 1999). The effective transfer rate from NUREG/CR-5512 building renovation scenario for ingestion of loose dust to the hands and mouth during building renovation (Wernig et al. 1999).
Air release fraction	–	0.357	0.1	For the building occupancy scenario, it is the mean value from the parameter distribution (Appendix J). For the building renovation scenario, a smaller fraction is respirable.
Removable fraction	–	0.1	NR[d]	10% of the contamination is removable (NUREG/CR-5512 building occupancy scenario default). The parameter is not required for the volume source.
Time for source removal or source lifetime	d	10,000	NR	Value for the building occupancy scenario is the most likely value from the parameter distribution (Appendix J). The parameter is not required for the volume source.
Source erosion rate	cm/d	NR	4.1×10^{-4}	For the building renovation scenario, it is assumed that the total source thickness of 15 cm can be removed in 100 years of building life.

[a] Parameter values used in the building occupancy scenario.

[b] Parameter values used in the building renovation scenario.

[c] A dash indicates that the parameter is dimensionless.

[d] NR = parameter not required for the analysis.

Title : Aptuit drain line removal H-3

Input File : C:\RESRAD Build\Aptuit drain removal h3.bld

RESRAD-BUILD Table of Contents

RESRAD-BUILD Input Parameters

Number of Sources : 1
Number of Receptors: 1
Total Time : 1.790000E+02 days
Fraction Inside : 3.510000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	0.000	0.000	1.000	1.000	3.84E+01	0.00E+00

Receptor-Source Shielding Relationship

Receptor	Source	Density [g/cm3]	Thickness [cm]	Material
1	1	1.00E+00	0.00E+00	Water

======== Building Information ========

Building Air Exchange Rate: 8.00E-01 1/hr

```
 Height[m]          Air Exchanges [m3/hr]
 Area [m2]
                   ******************************
                   *                            *
                   *                            *
                   *                          <=Q01: 2.30E+02
 H1:   2.500       *          Room  1           *      Q10 :  2.30E+02
                   *   LAMBDA: 8.00E-01         *
Area 115.000       *                            *
                   *                            *
                   ******************************
```

Deposition velocity: 1.00E-02 [m/s]   Resuspension Rate: 5.00E-07 [1/s]

Title : Aptuit drain line removal H-3

Input File : C:\RESRAD Build\Aptuit drain removal h3.bld

Source Information

Source: 1

Location:: Room : 1 x: 5.00 y: 5.00 z: 0.00[m]

Geometry:: Type: Volume Length[m]:1.00E+01 Width[m]:2.30E-01 Direction: x

Tritium Volume Parameters ::

Total Thickness:	1.500E+01 [cm]
Dry Thickness:	0.000E+00 [cm]
Volumetric Water Content:	3.000E-02
Wall Total Porosity:	1.000E-01
Volatization Fraction:	1.000E+00
Wall Density:	1.000E+00 [gm/cm3]
Humidity:	8.000E+00 [gm/m3]
Erosion rate:	4.100E-04 [cm/d]
Direct Ingestion Rate:	5.200E-02 [gm/hr]
Fraction released to air:	1.000E-01

Contamination::

Nuclide	Concentration	Dose Conversion Factor (Library: FGR 11)		
		Ingestion	Inhalation	Submersion
	[µCi/g]	[mrem/µCi]	[mrem/µCi]	[mrem/yr/ (µCi/m3)]
H-3	2.940E-05	6.400E-02	6.400E-02	3.866E-02

Title : Aptuit drain line removal H-3

Input File : C:\RESRAD Build\Aptuit drain removal h3.bld

Evaluation Time: 0.00000000E+00 years

Assessment for Time: 1

Time =0.00E+00 yr

Source Information

Source: 1

Location:: Room : 1 x: 5.00 y: 5.00 z: 0.00 [m]

Geometry:: Type: Volume Length[m]:1.00E+01 Width[m]:2.30E-01 Direction: x

Contamination ::

Total Thickness:	1.500E+01 [cm]
Dry Thickness:	0.000E+00 [cm]
Volumetric Water Content:	3.000E-02
Wall Total Porosity:	1.000E-01
Volatization Fraction:	1.000E+00
Wall Density:	1.000E+00 [gm/cm3]
Humidity:	8.000E+00 [gm/m3]
Erosion Rate:	4.100E-04 [cm/d]

Contamination:: Tritium in Volume Source

Initial Volatile Activity [µCi]	: 10.1429996
Remaining Volatization Time [yr]	: 0.938301623
Unvolatizable activity remaining [µCi]	: 0.00000000E+00

Title : Aptuit drain line removal H-3
Input File : C:\RESRAD Build\Aptuit drain removal h3.bld
Evaluation Time: 0.00000000E+00 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Total
Receptor 1	1.41E-03	1.41E-03
Total	1.41E-03	1.41E-03

Title : Aptuit drain line removal H-3

Input File : C:\RESRAD Build\Aptuit drain removal h3.bld

Evaluation Time: 0.00000000E+00 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	0.00E+00	0.00E+00	4.06E-08	1.41E-03	0.00E+00	0.00E+00
Total	0.00E+00	0.00E+00	4.06E-08	1.41E-03	0.00E+00	0.00E+00

Title : Aptuit drain line removal H-3
Input File : C:\RESRAD Build\Aptuit drain removal h3.bld
Evaluation Time: 0.00000000E+00 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
H-3	1.41E-03	1.41E-03

```
Title : Aptuit drain line removal H-3
Input File : C:\RESRAD Build\Aptuit drain removal h3.bld
Evaluation Time:  1.00000000  years
```

```
==          Assessment for Time:  2          ==
==               Time =1.00E+00 yr           ==
```

```
====== Source Information ======

Source:  1
        Location::  Room :  1  x:   5.00 y:   5.00  z:   0.00 [m]
        Geometry::  Type: Volume     Length[m]:1.00E+01  Width[m]:2.30E-01  Direction: x
        Contamination ::
             Total Thickness:           1.500E+01 [cm]
             Dry Thickness:             0.000E+00 [cm]
             Volumetric Water Content:  3.000E-02
             Wall Total Porosity:       1.000E-01
             Volatization Fraction:     1.000E+00
             Wall Density:              1.000E+00 [gm/cm3]
             Humidity:                  8.000E+00 [gm/m3]
             Erosion Rate:              4.100E-04 [cm/d]


         Contamination::     Tritium in Volume Source
            Initial Volatile Activity [µCi]        :  10.1429996
            Remaining Volatization Time [yr]       :  0.00000000E+00
            Unvolatizable activity remaining [µCi]:  0.00000000E+00
```

Title : Aptuit drain line removal H-3

Input File : C:\RESRAD Build\Aptuit drain removal h3.bld

Evaluation Time: 1.00000000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Total
Receptor 1	0.00E+00	0.00E+00
Total	0.00E+00	0.00E+00

Title : Aptuit drain line removal H-3
Input File : C:\RESRAD Build\Aptuit drain removal h3.bld
Evaluation Time: 1.00000000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Title : Aptuit drain line removal H-3

Input File : C:\RESRAD Build\Aptuit drain removal h3.bld

Evaluation Time: 1.00000000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
H-3	0.00E+00	0.00E+00

Title : Aptuit drain line removal H-3

Input File : C:\RESRAD Build\Aptuit drain removal h3.bld

Full Summary

RESRAD-BUILD Dose (Time) Tables

Receptor Dose Received for the Exposure Duration

(mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.41E-03	0.00E+00

Receptor Dose/Yr Averaged Over Exposure Duration

(mrem/yr)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	2.88E-03	0.00E+00

RESRAD-BUILD Table of Contents

RESRAD-BUILD Input Parameters

Number of Sources : 1
Number of Receptors: 1
Total Time : 1.790000E+02 days
Fraction Inside : 3.510000E-01

Receptor Information

Receptor	Room	x [m]	y [m]	z [m]	FracTime	Inhalation [m3/day]	Ingestion(Dust) [m2/hr]
1	1	0.000	0.000	1.000	1.000	3.84E+01	0.00E+00

Receptor-Source Shielding Relationship

Receptor	Source	Density [g/cm3]	Thickness [cm]	Material
1	1	1.00E+00	0.00E+00	Water

```
            =======  Building Information  =======


      Building Air Exchange Rate: 8.00E-01 1/hr


   Height[m]         Air Exchanges [m3/hr]
   Area [m2]
                    ******************************
                    *                            *
                    *                            *
                    *                          <=Q01: 2.30E+02
  H1:   2.500       *         Room  1            *      Q10 :  2.30E+02
                    *   LAMBDA: 8.00E-01         *
 Area 115.000       *                            *
                    *                            *
                    ******************************


    Deposition velocity: 1.00E-02 [m/s]   Resuspension Rate: 5.00E-07 [1/s]
```

Source Information

Source: 1

Location:: Room : 1 x: 5.00 y: 5.00 z: 0.00[m]

Geometry:: Type: Volume Length[m]:1.00E+01 Width[m]:2.30E-01 Direction: x

Pathway ::

Direct Ingestion Rate: 5.200E-02 [gm/hr]

Fraction released to air: 1.000E-01

Containment :: Number of Regions: 1 Contaminated Region: 1

Region	: 1
Thickness [cm]	:1.50E+01
Density [g/cm3]	:1.00E+00
Material	: Water
Erosion Rate [cm/day]	:4.10E-04

Contamination::

Nuclide	Concentration	Dose Conversion Factor (Library: FGR 11)		
		Ingestion	Inhalation	Submersion
	[µCi/g]	[mrem/µCi]	[mrem/µCi]	[mrem/yr/ (µCi/m3)]
C-14	1.020E-04	2.090E+00	2.090E+00	2.616E-02

Title : Aptuit drain line removal C-14

Input File : C:\RESRAD Build\Aptuit drain removal c14.bld

Evaluation Time: 0.00000000E+00 years

Assessment for Time: 1

Time =0.00E+00 yr

Source Information

Source: 1

Location:: Room : 1 x: 5.00 y: 5.00 z: 0.00 [m]

Geometry:: Type: Volume Length[m]:1.00E+01 Width[m]:2.30E-01 Direction: x

Pathway ::

Direct Ingestion Rate : 5.200E-02 [gm/hr]

Fraction released to air: 1.000E-01

Containment :: Number of Regions: 1 Contaminated Region: 1

Region	: 1
Thickness [cm]	:1.50E+01
Fraction Contaminated	:1.00E+00
Density [g/cm3]	:1.00E+00

Contamination::

Nuclide	Concentration [μCi/g]
C-14	1.020E-04

Title : Aptuit drain line removal C-14
Input File : C:\RESRAD Build\Aptuit drain removal c14.bld
Evaluation Time: 0.00000000E+00 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Total
Receptor 1	1.68E-02	1.68E-02
Total	1.68E-02	1.68E-02

Title : Aptuit drain line removal C-14

Input File : C:\RESRAD Build\Aptuit drain removal c14.bld

Evaluation Time: 0.00000000E+00 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	5.19E-06	5.24E-08	7.86E-11	8.78E-05	0.00E+00	1.67E-02
Total	5.19E-06	5.24E-08	7.86E-11	8.78E-05	0.00E+00	1.67E-02

Title : Aptuit drain line removal C-14
Input File : C:\RESRAD Build\Aptuit drain removal c14.bld
Evaluation Time: 0.00000000E+00 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
C-14	1.68E-02	1.68E-02

Title : Aptuit drain line removal C-14

Input File : C:\RESRAD Build\Aptuit drain removal c14.bld

Evaluation Time: 1.00000000 years

Assessment for Time: 2

Time =1.00E+00 yr

Source Information

Source: 1

Location:: Room : 1 x: 5.00 y: 5.00 z: 0.00 [m]

Geometry:: Type: Volume Length[m]:1.00E+01 Width[m]:2.30E-01 Direction: x

Pathway ::

Direct Ingestion Rate : 5.200E-02 [gm/hr]

Fraction released to air: 1.000E-01

Containment :: Number of Regions: 1 Contaminated Region: 1

Region	: 1
Thickness [cm]	:1.49E+01
Fraction Contaminated	:1.00E+00
Density [g/cm3]	:1.00E+00

Contamination::	Nuclide	Concentration [µCi/g]
	C-14	1.020E-04

Title : Aptuit drain line removal C-14

Input File : C:\RESRAD Build\Aptuit drain removal c14.bld

Evaluation Time: 1.00000000 years

RESRAD-BUILD Dose Tables

Source Contributions to Receptor Doses

[mrem]

	Source 1	Total
Receptor 1	1.68E-02	1.68E-02
Total	1.68E-02	1.68E-02

Title : Aptuit drain line removal C-14
Input File : C:\RESRAD Build\Aptuit drain removal c14.bld
Evaluation Time: 1.00000000 years

Pathway Detail of Doses

[mrem]

Source: 1

Receptor	External	Deposition	Immersion	Inhalation	Radon	Ingestion
1	5.18E-06	5.23E-08	7.85E-11	8.78E-05	0.00E+00	1.67E-02
Total	5.18E-06	5.23E-08	7.85E-11	8.78E-05	0.00E+00	1.67E-02

Title : Aptuit drain line removal C-14
Input File : C:\RESRAD Build\Aptuit drain removal c14.bld
Evaluation Time: 1.00000000 years

Nuclide Detail of Doses

[mrem]

Source: 1

Nuclide	Receptor 1	Total
C-14	1.68E-02	1.68E-02

RESRAD-BUILD Dose (Time) Tables

Receptor Dose Received for the Exposure Duration

(mrem)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	1.68E-02	1.68E-02

Receptor Dose/Yr Averaged Over Exposure Duration

(mrem/yr)

Evaluation Time [yr]

	0.00E+00	1.00E+00
1	3.43E-02	3.43E-02

APPENDIX G

SURFACE SOIL SAMPLING RESULTS

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

Job Number: 160-5291-1

Job Description: Rad Samples

For:
Aptuit, Inc
PO BOX 9900
Kansas City, MO 64134

Attention: Julie Dahlem

Approved for release.
Ivan H Vania
Project Manager II
2/14/2014 9:50 AM

Ivan H Vania, Project Manager II
13715 Rider Trail North, Earth City, MO, 63045
(314)298-8566
ivan.vania@testamericainc.com
02/14/2014

The test results in this report meet NELAP requirements for parameters for which accreditation is required or available. Any exceptions to the NELAP requirements are noted. Results pertain only to samples listed in this report. Pursuant to NELAP, this report shall not be reproduced, except in full, without the written approval of the laboratory. This report is confidential and is intended for the sole use of TestAmerica and its client. All questions regarding this report should be directed to the TestAmerica Project Manager.

Louisiana Lab Certification ID (Non-Potable, Solid/Haz. Material): 106151
Florida Lab Certification ID (Drinking Water): E87689.

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Qualifiers

Rad

Qualifier	Qualifier Description
H	Sample was prepped or analyzed beyond the specified holding time
U	Result is less than the sample detection limit.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

CASE NARRATIVE

Client: Aptuit, Inc

Project: Rad Samples

Report Number: 160-5291-1

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

TestAmerica St. Louis attests to the validity of the laboratory data generated by TestAmerica facilities reported herein. All analyses performed by TestAmerica facilities were done using established laboratory SOPs that incorporate QA/QC procedures described in the application methods. TestAmerica's operations groups have reviewed the data for compliance with the laboratory QA/QC plan, and data have been found to be compliant with laboratory protocols unless otherwise noted below.

The test results in this report meet all NELAP requirements for parameters for which accreditation is required or available. Any exceptions to NELAP requirements are noted in this report. Pursuant to NELAP, this report may not be reproduced, except in full, without the written approval of the laboratory.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

All solid sample results for Chemistry analyses are reported on an "as received" basis unless otherwise indicated by the presence of a % solids value in the method header. All soil/sediment sample results for radiochemistry analyses are based upon sample as dried and disaggregated with the exception of tritium, carbon-14, and iodine-129 by gamma spectroscopy unless requested as wet weight by the client."

RECEIPT
The samples were received on 01/24/2014; the samples arrived in good condition, properly preserved and on ice. The temperature of the coolers at receipt was 18.4 C.

PERCENT SOLIDS
Samples KCMSS-BKG-1 (160-5291-1), KCMSS-BKG-2 (160-5291-2), KCMSS-5 (160-5291-3), KCMSS-4 (160-5291-4), KCMSS-1 (160-5291-5), KCMSS-2 (160-5291-6), KCMSS-6 (160-5291-7), KCMSS-7 (160-5291-8), KCMSS-8 (160-5291-9) and KCMSS-3 (160-5291-10) were analyzed for percent solids in accordance with EPA Method 160.3 MOD. The samples were analyzed on 02/03/2014.

No difficulties were encountered during the % solids analysis. All quality control parameters were within the acceptance limits.

TRITIUM
Samples KCMSS-BKG-1 (160-5291-1), KCMSS-BKG-2 (160-5291-2), KCMSS-5 (160-5291-3), KCMSS-4 (160-5291-4), KCMSS-1 (160-5291-5), KCMSS-2 (160-5291-6), KCMSS-6 (160-5291-7), KCMSS-7 (160-5291-8), KCMSS-8 (160-5291-9) and KCMSS-3 (160-5291-10) were analyzed for Tritium in accordance with EPA Method 906.0. The samples were prepared on 02/11/2014 and analyzed on 02/12/2014 and 02/13/2014.

No difficulties were encountered during the Tritium analysis. All other quality control parameters were within the acceptance limits.

CARBON-14 BY LSC
Samples KCMSS-BKG-1 (160-5291-1), KCMSS-BKG-2 (160-5291-2), KCMSS-5 (160-5291-3), KCMSS-4 (160-5291-4), KCMSS-1 (160-5291-5), KCMSS-2 (160-5291-6), KCMSS-6 (160-5291-7), KCMSS-7 (160-5291-8), KCMSS-8 (160-5291-9) and KCMSS-3 (160-5291-10) were analyzed for Carbon-14 by LSC in accordance with EERF C-01. The samples were prepared on 02/07/2014 and analyzed on 02/10/2014.

No difficulties were encountered during the Carbon 14 analysis. All other quality control parameters were within the acceptance limits.

Client Sample Results

Client: Aptuit, Inc
Project/Site: Rad Samples

TestAmerica Job ID: 160-5291-1

Client Sample ID: KCMSS-BKG-1

Lab Sample ID: 160-5291-1

Date Collected: 01/22/13 10:05

Matrix: Solid

Date Received: 01/24/14 10:35

Method: 906.0 - Tritium, Total (LSC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tritium	0.320	U H	0.285	0.287	1.00	0.463	pCi/g	02/11/14 09:04	02/12/14 23:09	1

Method: C-01-1 - Carbon-14 (EERF C-01-1)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Carbon-14	-0.797	U H	0.794	0.799	5.00	1.49	pCi/g	02/07/14 06:37	02/10/14 19:51	1

Client Sample ID: KCMSS-BKG-2

Lab Sample ID: 160-5291-2

Date Collected: 01/22/13 10:15

Matrix: Solid

Date Received: 01/24/14 10:35

Method: 906.0 - Tritium, Total (LSC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tritium	0.000	U H	0.250	0.250	1.00	0.443	pCi/g	02/11/14 09:04	02/13/14 00:19	1

Method: C-01-1 - Carbon-14 (EERF C-01-1)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Carbon-14	-0.140	U H	0.824	0.824	5.00	1.45	pCi/g	02/07/14 06:37	02/10/14 20:39	1

Client Sample ID: KCMSS-5

Lab Sample ID: 160-5291-3

Date Collected: 01/22/13 10:25

Matrix: Solid

Date Received: 01/24/14 10:35

Method: 906.0 - Tritium, Total (LSC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tritium	0.120	U H	0.255	0.256	1.00	0.438	pCi/g	02/11/14 09:04	02/13/14 01:29	1

Method: C-01-1 - Carbon-14 (EERF C-01-1)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Carbon-14	-0.290	U H	0.818	0.819	5.00	1.47	pCi/g	02/07/14 06:37	02/10/14 21:03	1

Client Sample ID: KCMSS-4

Lab Sample ID: 160-5291-4

Date Collected: 01/22/13 10:50

Matrix: Solid

Date Received: 01/24/14 10:35

Method: 906.0 - Tritium, Total (LSC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tritium	0.300	U H	0.287	0.289	1.00	0.473	pCi/g	02/11/14 09:04	02/13/14 02:04	1

Client Sample ID: KCMSS-4 — **Lab Sample ID: 160-5291-4**
Date Collected: 01/22/13 10:50 — **Matrix: Solid**
Date Received: 01/24/14 10:35

Method: C-01-1 - Carbon-14 (EERF C-01-1)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Carbon-14	-0.562	U H	0.792	0.794	5.00	1.45	pCi/g	02/07/14 06:37	02/10/14 21:27	1

Client Sample ID: KCMSS-1 — **Lab Sample ID: 160-5291-5**
Date Collected: 01/22/13 10:55 — **Matrix: Solid**
Date Received: 01/24/14 10:35

Method: 906.0 - Tritium, Total (LSC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tritium	0.0417	U H	0.256	0.256	1.00	0.450	pCi/g	02/11/14 09:04	02/13/14 02:39	1

Method: C-01-1 - Carbon-14 (EERF C-01-1)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Carbon-14	0.517	U H	0.882	0.884	5.00	1.49	pCi/g	02/07/14 06:37	02/10/14 21:51	1

Client Sample ID: KCMSS-2 — **Lab Sample ID: 160-5291-6**
Date Collected: 01/22/13 11:05 — **Matrix: Solid**
Date Received: 01/24/14 10:35

Method: 906.0 - Tritium, Total (LSC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tritium	0.243	U H	0.270	0.271	1.00	0.446	pCi/g	02/11/14 09:04	02/13/14 03:14	1

Method: C-01-1 - Carbon-14 (EERF C-01-1)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Carbon-14	0.651	U H	0.882	0.885	5.00	1.47	pCi/g	02/07/14 06:37	02/10/14 22:15	1

Client Sample ID: KCMSS-6 — **Lab Sample ID: 160-5291-7**
Date Collected: 01/22/13 11:15 — **Matrix: Solid**
Date Received: 01/24/14 10:35

Method: 906.0 - Tritium, Total (LSC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tritium	0.204	U H	0.251	0.251	1.00	0.416	pCi/g	02/11/14 09:04	02/13/14 03:48	1

Method: C-01-1 - Carbon-14 (EERF C-01-1)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Carbon-14	**7.93**	**H**	1.30	1.55	5.00	1.50	pCi/g	02/07/14 06:37	02/10/14 22:39	1

Client Sample ID: KCMSS-7

Lab Sample ID: 160-5291-8

Date Collected: 01/22/13 11:20

Matrix: Solid

Date Received: 01/24/14 10:35

Method: 906.0 - Tritium, Total (LSC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tritium	0.0331	U H	0.243	0.243	1.00	0.427	pCi/g	02/11/14 09:04	02/13/14 04:24	1

Method: C-01-1 - Carbon-14 (EERF C-01-1)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Carbon-14	**3.32**	**H**	1.08	1.14	5.00	1.53	pCi/g	02/07/14 06:37	02/10/14 23:03	1

Client Sample ID: KCMSS-8

Lab Sample ID: 160-5291-9

Date Collected: 01/22/13 11:30

Matrix: Solid

Date Received: 01/24/14 10:35

Method: 906.0 - Tritium, Total (LSC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tritium	0.0342	U H	0.253	0.253	1.00	0.446	pCi/g	02/11/14 09:04	02/13/14 04:59	1

Method: C-01-1 - Carbon-14 (EERF C-01-1)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Carbon-14	**2.75**	**H**	1.03	1.07	5.00	1.50	pCi/g	02/07/14 06:37	02/10/14 23:27	1

Client Sample ID: KCMSS-3

Lab Sample ID: 160-5291-10

Date Collected: 01/22/13 10:35

Matrix: Solid

Date Received: 01/24/14 10:35

Method: 906.0 - Tritium, Total (LSC)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tritium	0.000	U H	0.277	0.277	1.00	0.493	pCi/g	02/11/14 09:04	02/13/14 05:33	1

Method: C-01-1 - Carbon-14 (EERF C-01-1)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Carbon-14	-0.406	U H	0.805	0.806	5.00	1.46	pCi/g	02/07/14 06:37	02/10/14 23:51	1

Method: 906.0 - Tritium, Total (LSC)

Lab Sample ID: MB 160-104205/1-A — **Client Sample ID: Method Blank**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 105097 — **Prep Batch: 104205**

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Tritium	-0.006006	U	0.220	0.220	1.00	0.393	pCi/g	02/11/14 09:04	02/12/14 21:59	1

Lab Sample ID: LCS 160-104205/2-A — **Client Sample ID: Lab Control Sample**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 105097 — **Prep Batch: 104205**

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits		
Tritium			12.1	11.80		1.25	1.00	0.383	pCi/g	98	80 - 114		

Lab Sample ID: 160-5291-2 MS — **Client Sample ID: KCMSS-BKG-2**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 105097 — **Prep Batch: 104205**

Analyte	Sample Result	Sample Qual	Spike Added	MS Result	MS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits		
Tritium	0.000	U H	12.0	11.45		1.25	1.00	0.450	pCi/g	96	78 - 122		

Lab Sample ID: 160-5291-1 DU — **Client Sample ID: KCMSS-BKG-1**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 105097 — **Prep Batch: 104205**

Analyte	Sample Result	Sample Qual		DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit			RER	RER Limit
Tritium	0.320	U H		0.1925	U	0.271	1.00	0.456	pCi/g			0.23	1

Method: C-01-1 - Carbon-14 (EERF C-01-1)

Lab Sample ID: MB 160-103612/1-A — **Client Sample ID: Method Blank**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 104204 — **Prep Batch: 103612**

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Carbon-14	-0.4550	U	0.811	0.812	5.00	1.47	pCi/g	02/07/14 06:37	02/10/14 18:15	1

Lab Sample ID: LCS 160-103612/2-A — **Client Sample ID: Lab Control Sample**
Matrix: Solid — **Prep Type: Total/NA**
Analysis Batch: 104204 — **Prep Batch: 103612**

Analyte			Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits		
Carbon-14			84.4	75.36		8.72	5.00	1.50	pCi/g	89	67 - 124		

Method: C-01-1 - Carbon-14 (EERF C-01-1) (Continued)

Lab Sample ID: 160-5291-1 MS
Matrix: Solid
Analysis Batch: 104204

Client Sample ID: KCMSS-BKG-1
Prep Type: Total/NA
Prep Batch: 103612

Analyte	Sample Result	Sample Qual	Spike Added	MS Result	MS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec. Limits		
Carbon-14	-0.797	U H	82.8	63.28		7.40	5.00	1.45	pCi/g	76	29 - 128		

Lab Sample ID: 160-5337-A-1-G DU
Matrix: Solid
Analysis Batch: 104204

Client Sample ID: Duplicate
Prep Type: Total/NA
Prep Batch: 103612

Analyte	Sample Result	Sample Qual		DU Result	DU Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit			RER	RER Limit
Carbon-14	-0.460			0.2275	U	0.855	5.00	1.47	pCi/g			0.41	1

QC Association Summary

Client: Aptuit, Inc
Project/Site: Rad Samples

TestAmerica Job ID: 160-5291-1

General Chemistry

Analysis Batch: 102663

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-5291-1	KCMSS-BKG-1	Total/NA	Solid	Moisture	
160-5291-1 DU	KCMSS-BKG-1	Total/NA	Solid	Moisture	
160-5291-2	KCMSS-BKG-2	Total/NA	Solid	Moisture	
160-5291-3	KCMSS-5	Total/NA	Solid	Moisture	
160-5291-4	KCMSS-4	Total/NA	Solid	Moisture	
160-5291-5	KCMSS-1	Total/NA	Solid	Moisture	
160-5291-6	KCMSS-2	Total/NA	Solid	Moisture	
160-5291-7	KCMSS-6	Total/NA	Solid	Moisture	
160-5291-8	KCMSS-7	Total/NA	Solid	Moisture	
160-5291-9	KCMSS-8	Total/NA	Solid	Moisture	
160-5291-10	KCMSS-3	Total/NA	Solid	Moisture	

Rad

Prep Batch: 103612

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-5291-1	KCMSS-BKG-1	Total/NA	Solid	LSC_Dist_Susp	
160-5291-1 MS	KCMSS-BKG-1	Total/NA	Solid	LSC_Dist_Susp	
160-5291-2	KCMSS-BKG-2	Total/NA	Solid	LSC_Dist_Susp	
160-5291-3	KCMSS-5	Total/NA	Solid	LSC_Dist_Susp	
160-5291-4	KCMSS-4	Total/NA	Solid	LSC_Dist_Susp	
160-5291-5	KCMSS-1	Total/NA	Solid	LSC_Dist_Susp	
160-5291-6	KCMSS-2	Total/NA	Solid	LSC_Dist_Susp	
160-5291-7	KCMSS-6	Total/NA	Solid	LSC_Dist_Susp	
160-5291-8	KCMSS-7	Total/NA	Solid	LSC_Dist_Susp	
160-5291-9	KCMSS-8	Total/NA	Solid	LSC_Dist_Susp	
160-5291-10	KCMSS-3	Total/NA	Solid	LSC_Dist_Susp	
160-5337-A-1-G DU	Duplicate	Total/NA	Solid	LSC_Dist_Susp	
LCS 160-103612/2-A	Lab Control Sample	Total/NA	Solid	LSC_Dist_Susp	
MB 160-103612/1-A	Method Blank	Total/NA	Solid	LSC_Dist_Susp	

Prep Batch: 104205

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-5291-1	KCMSS-BKG-1	Total/NA	Solid	LSC_Dist_Susp	
160-5291-1 DU	KCMSS-BKG-1	Total/NA	Solid	LSC_Dist_Susp	
160-5291-2	KCMSS-BKG-2	Total/NA	Solid	LSC_Dist_Susp	
160-5291-2 MS	KCMSS-BKG-2	Total/NA	Solid	LSC_Dist_Susp	
160-5291-3	KCMSS-5	Total/NA	Solid	LSC_Dist_Susp	
160-5291-4	KCMSS-4	Total/NA	Solid	LSC_Dist_Susp	
160-5291-5	KCMSS-1	Total/NA	Solid	LSC_Dist_Susp	
160-5291-6	KCMSS-2	Total/NA	Solid	LSC_Dist_Susp	
160-5291-7	KCMSS-6	Total/NA	Solid	LSC_Dist_Susp	
160-5291-8	KCMSS-7	Total/NA	Solid	LSC_Dist_Susp	
160-5291-9	KCMSS-8	Total/NA	Solid	LSC_Dist_Susp	
160-5291-10	KCMSS-3	Total/NA	Solid	LSC_Dist_Susp	
LCS 160-104205/2-A	Lab Control Sample	Total/NA	Solid	LSC_Dist_Susp	
MB 160-104205/1-A	Method Blank	Total/NA	Solid	LSC_Dist_Susp	

Client Sample ID: KCMSS-BKG-1

Lab Sample ID: 160-5291-1

Date Collected: 01/22/13 10:05

Matrix: Solid

Date Received: 01/24/14 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	102663	02/03/14 05:24	SDB	TAL SL
Total/NA	Prep	LSC_Dist_Susp			103612	02/07/14 06:37	LEM	TAL SL
Total/NA	Analysis	C-01-1		1	104204	02/10/14 19:51	MLK	TAL SL
Total/NA	Prep	LSC_Dist_Susp			104205	02/11/14 09:04	NMN	TAL SL
Total/NA	Analysis	906.0		1	105097	02/12/14 23:09	MLK	TAL SL

Client Sample ID: KCMSS-BKG-2

Lab Sample ID: 160-5291-2

Date Collected: 01/22/13 10:15

Matrix: Solid

Date Received: 01/24/14 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	102663	02/03/14 05:24	SDB	TAL SL
Total/NA	Prep	LSC_Dist_Susp			103612	02/07/14 06:37	LEM	TAL SL
Total/NA	Analysis	C-01-1		1	104204	02/10/14 20:39	MLK	TAL SL
Total/NA	Prep	LSC_Dist_Susp			104205	02/11/14 09:04	NMN	TAL SL
Total/NA	Analysis	906.0		1	105097	02/13/14 00:19	MLK	TAL SL

Client Sample ID: KCMSS-5

Lab Sample ID: 160-5291-3

Date Collected: 01/22/13 10:25

Matrix: Solid

Date Received: 01/24/14 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	102663	02/03/14 05:24	SDB	TAL SL
Total/NA	Prep	LSC_Dist_Susp			103612	02/07/14 06:37	LEM	TAL SL
Total/NA	Analysis	C-01-1		1	104204	02/10/14 21:03	MLK	TAL SL
Total/NA	Prep	LSC_Dist_Susp			104205	02/11/14 09:04	NMN	TAL SL
Total/NA	Analysis	906.0		1	105097	02/13/14 01:29	MLK	TAL SL

Client Sample ID: KCMSS-4

Lab Sample ID: 160-5291-4

Date Collected: 01/22/13 10:50

Matrix: Solid

Date Received: 01/24/14 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	102663	02/03/14 05:24	SDB	TAL SL
Total/NA	Prep	LSC_Dist_Susp			103612	02/07/14 06:37	LEM	TAL SL
Total/NA	Analysis	C-01-1		1	104204	02/10/14 21:27	MLK	TAL SL
Total/NA	Prep	LSC_Dist_Susp			104205	02/11/14 09:04	NMN	TAL SL
Total/NA	Analysis	906.0		1	105097	02/13/14 02:04	MLK	TAL SL

Client Sample ID: KCMSS-1 Lab Sample ID: 160-5291-5
Date Collected: 01/22/13 10:55 **Matrix: Solid**
Date Received: 01/24/14 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	102663	02/03/14 05:24	SDB	TAL SL
Total/NA	Prep	LSC_Dist_Susp			103612	02/07/14 06:37	LEM	TAL SL
Total/NA	Analysis	C-01-1		1	104204	02/10/14 21:51	MLK	TAL SL
Total/NA	Prep	LSC_Dist_Susp			104205	02/11/14 09:04	NMN	TAL SL
Total/NA	Analysis	906.0		1	105097	02/13/14 02:39	MLK	TAL SL

Client Sample ID: KCMSS-2 Lab Sample ID: 160-5291-6
Date Collected: 01/22/13 11:05 **Matrix: Solid**
Date Received: 01/24/14 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	102663	02/03/14 05:24	SDB	TAL SL
Total/NA	Prep	LSC_Dist_Susp			103612	02/07/14 06:37	LEM	TAL SL
Total/NA	Analysis	C-01-1		1	104204	02/10/14 22:15	MLK	TAL SL
Total/NA	Prep	LSC_Dist_Susp			104205	02/11/14 09:04	NMN	TAL SL
Total/NA	Analysis	906.0		1	105097	02/13/14 03:14	MLK	TAL SL

Client Sample ID: KCMSS-6 Lab Sample ID: 160-5291-7
Date Collected: 01/22/13 11:15 **Matrix: Solid**
Date Received: 01/24/14 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	102663	02/03/14 05:24	SDB	TAL SL
Total/NA	Prep	LSC_Dist_Susp			103612	02/07/14 06:37	LEM	TAL SL
Total/NA	Analysis	C-01-1		1	104204	02/10/14 22:39	MLK	TAL SL
Total/NA	Prep	LSC_Dist_Susp			104205	02/11/14 09:04	NMN	TAL SL
Total/NA	Analysis	906.0		1	105097	02/13/14 03:48	MLK	TAL SL

Client Sample ID: KCMSS-7 Lab Sample ID: 160-5291-8
Date Collected: 01/22/13 11:20 **Matrix: Solid**
Date Received: 01/24/14 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	102663	02/03/14 05:24	SDB	TAL SL
Total/NA	Prep	LSC_Dist_Susp			103612	02/07/14 06:37	LEM	TAL SL
Total/NA	Analysis	C-01-1		1	104204	02/10/14 23:03	MLK	TAL SL
Total/NA	Prep	LSC_Dist_Susp			104205	02/11/14 09:04	NMN	TAL SL
Total/NA	Analysis	906.0		1	105097	02/13/14 04:24	MLK	TAL SL

Client Sample ID: KCMSS-8

Lab Sample ID: 160-5291-9

Date Collected: 01/22/13 11:30

Matrix: Solid

Date Received: 01/24/14 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	102663	02/03/14 05:24	SDB	TAL SL
Total/NA	Prep	LSC_Dist_Susp			103612	02/07/14 06:37	LEM	TAL SL
Total/NA	Analysis	C-01-1		1	104204	02/10/14 23:27	MLK	TAL SL
Total/NA	Prep	LSC_Dist_Susp			104205	02/11/14 09:04	NMN	TAL SL
Total/NA	Analysis	906.0		1	105097	02/13/14 04:59	MLK	TAL SL

Client Sample ID: KCMSS-3

Lab Sample ID: 160-5291-10

Date Collected: 01/22/13 10:35

Matrix: Solid

Date Received: 01/24/14 10:35

Prep Type	Batch Type	Batch Method	Run	Dilution Factor	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1	102663	02/03/14 05:24	SDB	TAL SL
Total/NA	Prep	LSC_Dist_Susp			103612	02/07/14 06:37	LEM	TAL SL
Total/NA	Analysis	C-01-1		1	104204	02/10/14 23:51	MLK	TAL SL
Total/NA	Prep	LSC_Dist_Susp			104205	02/11/14 09:04	NMN	TAL SL
Total/NA	Analysis	906.0		1	105097	02/13/14 05:33	MLK	TAL SL

Laboratory References:

TAL SL = TestAmerica St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Laboratory: TestAmerica St. Louis

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Alaska	State Program	10	MO00054	06-30-14
California	NELAP	9	09266CA	03-31-14
Connecticut	State Program	1	PH-0241	03-31-15
Florida	NELAP	4	E87689	06-30-14
Illinois	NELAP	5	200023	11-30-14
Iowa	State Program	7	373	12-01-14
Kansas	NELAP	7	E-10236	10-31-14
Kentucky (DW)	State Program	4	90125	12-31-14
L-A-B	DoD ELAP		L2305	01-10-16
Louisiana	NELAP	6	LA140007	12-31-14
Maryland	State Program	3	310	09-30-14
Missouri	State Program	7	780	06-30-14
Nevada	State Program	9	MO000542013-1	07-31-14
New Jersey	NELAP	2	MO002	06-30-14
New Mexico	State Program	6		06-30-10 *
New York	NELAP	2	11616	04-01-14
North Dakota	State Program	8	R207	06-30-14
NRC	NRC		24-24817-01	12-31-22
Oklahoma	State Program	6	2013-049	08-31-14
Pennsylvania	NELAP	3	68-00540	02-28-14
South Carolina	State Program	4	85002001	06-30-14
Texas	NELAP	6	T104704193-13-6	07-31-14
USDA	Federal		P330-07-00122	01-09-17
USEPA Reg V SDWA	Federal	1	WG-15J	08-30-14
Utah	NELAP	8	MO000542013-5	07-31-14
Virginia	NELAP	3	2236	06-14-14
Washington	State Program	10	C592	08-30-14
West Virginia DEP	State Program	3	381	02-28-14 *

* Expired certification is currently pending renewal and is considered valid.

Method Summary

Client: Aptuit, Inc
Project/Site: Rad Samples

TestAmerica Job ID: 160-5291-1

Method	Method Description	Protocol	Laboratory
Moisture	Percent Moisture	EPA	TAL SL
906.0	Tritium, Total (LSC)	EPA	TAL SL
C-01-1	Carbon-14 (EERF C-01-1)	EERF	TAL SL

Protocol References:

EERF = EERF

EPA = US Environmental Protection Agency

Laboratory References:

TAL SL = TestAmerica St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
160-5291-1	KCMSS-BKG-1	Solid	01/22/13 10:05	01/24/14 10:35
160-5291-2	KCMSS-BKG-2	Solid	01/22/13 10:15	01/24/14 10:35
160-5291-3	KCMSS-5	Solid	01/22/13 10:25	01/24/14 10:35
160-5291-4	KCMSS-4	Solid	01/22/13 10:50	01/24/14 10:35
160-5291-5	KCMSS-1	Solid	01/22/13 10:55	01/24/14 10:35
160-5291-6	KCMSS-2	Solid	01/22/13 11:05	01/24/14 10:35
160-5291-7	KCMSS-6	Solid	01/22/13 11:15	01/24/14 10:35
160-5291-8	KCMSS-7	Solid	01/22/13 11:20	01/24/14 10:35
160-5291-9	KCMSS-8	Solid	01/22/13 11:30	01/24/14 10:35
160-5291-10	KCMSS-3	Solid	01/22/13 10:35	01/24/14 10:35

REAGENT TRACEABILITY SUMMARY

Lab Name: TestAmerica St. Louis Job No.: 160-5291-1

SDG No.:

Reagent ID	Exp Date	Prep Date	Dilutant Used	Reagent Final Volume	Parent Reagent: Reagent ID	Parent Reagent: Volume Added	Analyte	Concentration
C-14_00005	03/21/61	03/24/11	0.1M NaOH, Lot 0	100 mL	C-14_00002	4.9809 g	Carbon-14	23556.7 dpm/mL
.C-14_00002	03/21/61	Eckert & Ziegler, Lot 84129-334			(Purchased Reagent)		Carbon-14	7882.35 Bq/g
C-14_00006	12/17/13	12/02/11	0.1M NaOH, Lot 0	500 mL	C-14_00003	4 mL	Carbon-14	187.528 dpm/mL
.C-14_00003	03/21/61	03/24/11	0.1M NaOH, Lot 0	100 mL	C-14_00001	4.9594 mL	Carbon-14	23441 dpm/mL
..C-14_00001	03/21/61	Eckert & Ziegler, Lot 84130-334			(Purchased Reagent)		Carbon-14	7877.65 Bq/g
C-14_00008	12/06/14	12/02/11	0.1M NaOH, Lot 0	500 mL	C-14_00003	4 mL	Carbon-14	187.528 dpm/mL
.C-14_00003	03/21/61	03/24/11	0.1M NaOH, Lot 0	100 mL	C-14_00001	4.9594 mL	Carbon-14	23441 dpm/mL
..C-14_00001	03/21/61	Eckert & Ziegler, Lot 84130-334			(Purchased Reagent)		Carbon-14	7877.65 Bq/g
H-3_00013	09/12/14	09/11/13	DI Water, Lot n/a	250 mL	H-3_00005	5 mL	Tritium	2233.66 dpm/mL
.H-3_00005	04/15/58	04/15/08	DI Water, Lot 0	100 mL	H-3_00003	4.9508 g	Tritium	111683 dpm/mL
..H-3_00003	04/15/58	Eckert & Ziegler, Lot 1280-60-1			(Purchased Reagent)		Tritium	37.56 kBq/g
LSC Brown_00001	12/18/15	Perkin Elmer, Lot 13			(Purchased Reagent)		Background	0 dpm
							Carbon-14	132400 dpm
							Tritium	264200 dpm
LSC Teal_00001	12/18/15	Perkin Elmer, Lot 78			(Purchased Reagent)		Background	0 dpm
							Carbon-14	132400 dpm
							Tritium	264200 dpm

Reagent

C-14_00001

Eckert & Ziegler
Analytics

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318
Tel 404·352·8677
Fax 404·352·2837
www.analyticsinc.com

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

84130-334

C-14 5 mL Liquid in Flame Sealed Vial

Customer: Test America St. Louis
P.O. No.: 2409507, Item 1

This standard radionuclide source was prepared gravimetrically from a master solution, calibrated by Eckert & Ziegler Analytics. The master solution was calibrated by liquid scintillation counting. Radionuclide purity and calibration were checked by germanium gamma-ray spectrometry and liquid scintillation counting. The nuclear decay rate and reference date for this source are given below. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty*, % Type u_A	u_B	U	Reference Date (12:00 PM EST)
C-14	2.082E+06	3.965E+04	0.2	2.0	4.0	03/21/2011

***Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

Comments:
Impurities: γ-impurities < 0.1 %. 5.03323 g of solution 50 µg/g glucose + 1 mg/g formaldehyde in H2O.

Source Prepared by: ____________
W. Mao, Radiochemist

QA Approved: ____________ Date: 3/21/11
J. D. McCorvey, QA Manager Alternate

ACCREDITED SOURCE CALIBRATION LABORATORY HEALTH PHYSICS SOCIETY FOUNDED 1956

Corporate Office Laboratory

Reagent

C-14_00002

Eckert & Ziegler
Analytics

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318
Tel 404•352•8677
Fax 404•352•2837
www.analyticsinc.com

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

84129-334

C-14 5 mL Liquid in Flame Sealed Vial

Customer: Test America St. Louis
P.O. No.: 2409507, Item 1

This standard radionuclide source was prepared gravimetrically from a master solution, calibrated by Eckert & Ziegler Analytics. The master solution was calibrated by liquid scintillation counting. Radionuclide purity and calibration were checked by germanium gamma-ray spectrometry and liquid scintillation counting. The nuclear decay rate and reference date for this source are given below. Eckert & Ziegler Analytics (EZA) maintains traceability to the National Institute of Standards and Technology through a Measurements Assurance Program as described in USNRC Regulatory Guide 4.15, Revision 1, February, 1979, and compliance with ANSI N42.22-1995, "Traceability of Radioactive Sources to NIST." EZA is accredited by the Health Physics Society (HPS) for the production of NIST-traceable sources, and this source was produced in accordance with the HPS accreditation requirements. Customers may report any concerns with the accreditation program to the HPS Secretariat, 1313 Dolley Madison Blvd., Ste. 402, McLean, VA 22101.

Isotope	Half-Life, Days	Activity (Bq)	Uncertainty*, % Type u_A	u_B	U	Reference Date (12:00 PM EST)
C-14	2.082E+06	3.961E+04	0.2	2.0	4.0	03/21/2011

***Uncertainty:** U - Relative expanded uncertainty, k = 2. See NIST Technical Note 1297, "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results."

Comments:
Impurities: γ-impurities < 0.1 %. 5.02515 g of solution 50 µg/g glucose + 1 mg/g formaldehyde in H2O.

Source Prepared by: WM
W. Mao, Radiochemist

QA Approved: [signature]
J. D. McCorvey, QA Manager Alternate

Date: 3/21/11

ANA Form005 Rev. —

ACCREDITED SOURCE CALIBRATION LABORATORY HEALTH PHYSICS SOCIETY FOUNDED 1956

Single Isotope Certificate, Rev 1 9/28/2009

Corporate Office
24937 Avenue Tibbitts Valencia, California 91355

Laboratory
1380 Seaboard Industrial Blvd. Atlanta, Georgia, 30318

Reagent

C-14_00008

St. Louis Radiological Standard Reverification Form

Standard ID Number:	C-14_00008		Radionuclide:
True Value =	187.4666	DPM/L or g	Carbon-14
Date Analyzed:	12/6/2013		

	Replicates	
#1	199.19	DPM/L or g
#2	193.19	DPM/L or g
#3	189.19	DPM/L or g

Mean = 193.8567

1 sigma = 5.033223 1.96 sigma = 9.865117

True Value minus 5% = 178.0932 (True Value - 5%)
True Value plus 5% = 196.8399 (True Value + 5%)

Accuracy:
Mean value within 5% of Certified (True) Value? **Yes** **(Acceptance Criteria)**

Precision:
1.96 sigma Value Within 10% of Mean Value? **Yes** **(Acceptance Criteria)**

Standard Reverification Acceptable? **Yes**

Note: Criteria for reverification of radiological standards is taken from the DOE QSAS and LANL Statements of Work

Reviewed By/Date: Micha Korrinhizer 12/9/2013

SOP Reference: STL-QA-0002, Current Revision

Assay Definition

Assay Description:

Assay Type: DPM (Single)
Report Name: C14_Protocol 22
Output Data Path: \Slsvr01\RAD\Upload\PACK_LSC_Pink
Raw Results Path: C:\Packard\Tricarb\Results\Default\C14_2013 Protocol 22\20131206_0844\20131206_0844.results
Assay File Name: C:\Packard\TriCarb\Assays\C14_2013 Protocol 22.lsa

Additional Data Files Generated with this Protocol:
22C14
[Auto] 22C14.001

Count Conditions

Nuclide: C14_2013
Quench Indicator: tSIE
External Std Terminator (sec): 15 sec
Pre-Count Delay (min): 0.00
Quench Set:
Low Energy: C14_2013
Count Time (min): 30.00
Count Mode: Low Level
Assay Count Cycles: 1 Repeat Sample Count: 1
#Vials/Sample: 1 Calculate % Reference: Off

Background Subtract

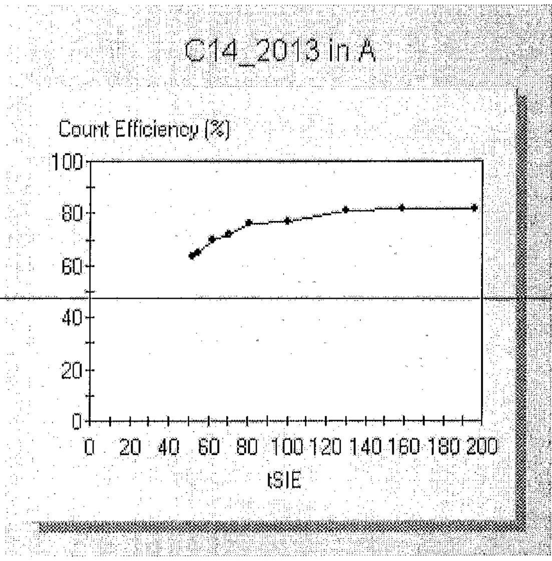
Background Subtract: Off
Low CPM Threshold: Off
2 Sigma % Terminator: On - Any Region

Regions	LL	UL	2Sigma % Terminator
A	0.0	156.0	1.50
B	2.0	156.0	0.00
C	156.1	300.0	0.00

Count Corrections

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

Cycle 1 Results
Quench Curve Block Data

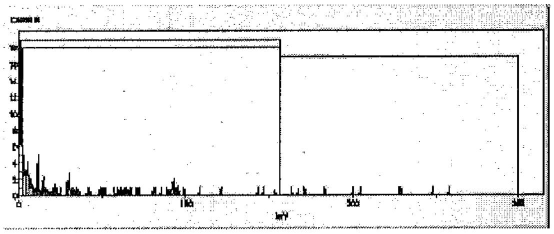


Date Acquired: 08/07/2013
Date Modified:
C14_2013 in A

tSIE	Count Efficiency (%)
196.62	81.60
158.93	81.93
130.49	80.94
100.88	76.70
80.59	75.82
70.92	72.00
62.10	69.99
54.43	64.85
51.69	63.68

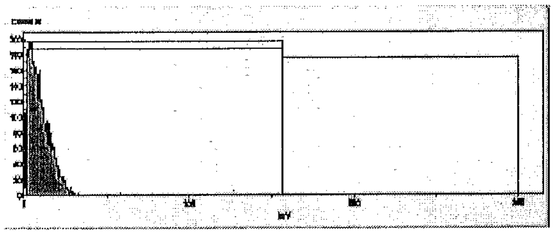
S#			SMPL ID	Count Time	CPMA	DPM1	TIME
DATE	EFF	tSIE	LUM	CPMC MESSAGES		CPMB	
1			BKG	30.00	5.17e+000	6.81e+000	8:46:29 AM
12/6/2013	0.759	82.05	28	3.21e-001		3.60e+000	

SpectraView Block Data



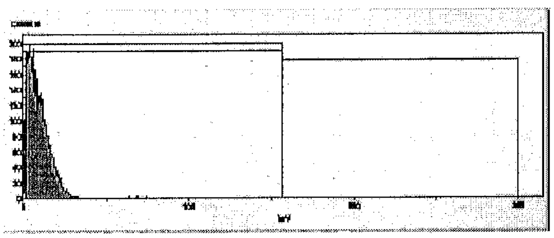
2			Ver 1	30.00	1.64e+002	2.06e+002	9:21:26 AM
12/6/2013	0.798	122.48	0	4.83e-001		1.56e+002	

SpectraView Block Data



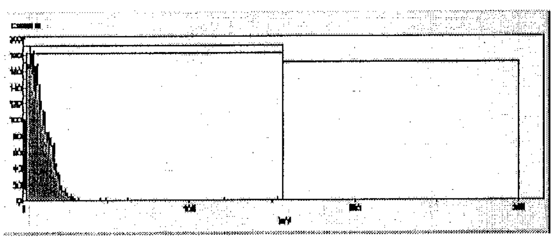
3			Ver 2	30.00	1.60e+002	2.00e+002	9:56:16 AM
12/6/2013	0.801	124.69	0	4.42e-001		1.53e+002	

SpectraView Block Data



4			Ver 3	30.00	1.57e+002	1.96e+002	10:31:06 AM
12/6/2013	0.802	124.98	0	3.33e-001		1.49e+002	

SpectraView Block Data



TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Prep Report Carbon-14 by LSC

Batch: M132786 **Prep Analyst:** 201

SampID	WRKNO	Aliquot		Volume Counted	
Verification 1	NA	1.0000	sample	10.0000	mL
2					
Verification 2	NA	1.0000	sample	10.0000	mL
3					
Verification 3	NA	1.0000	sample	10.0000	mL
4					

Spike Information

Sample ID	Standard ID	Analyte	Std Conc	Aliquot	Ref Date	StdAdded

LM
Spiked By

Spike Verified By

12-5-13
Spike Date

Standard Operating Procedures

SOPNumber	Title	Revision
☐		

Reviewed By

Review Date

LM
Analyst/Relenquished By

12-5-13
Release Date

MK
Received By

12/5/13
Receipt Date

Balance ID / Initials / Date

PINK
prot.
30mins.

Carbon 14

Initial Activity:	187.5281	dpm		
Reference Date:	3/21/2011			
Current Date:	12/6/2013		(or date at which you wish to determine activity)	
Elapsed Time:	991	days		
Half Life:	2092882.5	days		
Exponential Term:	0.999671842			
Corrected Activity:	187.4665612	dpm	84.44439692	pCi

Reagent

H-3_00003

Eckert & Ziegler
Isotope Products

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661•309•1010
Fax 661•257•8303

CERTIFICATE OF CALIBRATION
BETA STANDARD SOLUTION

Radionuclide:	H-3	**Customer:**	TEST AMERICA
Half-life:	12.35 ± 0.01 years	**P.O. No.:**	345287
Catalog No.:	7003	**Reference Date:**	15-Apr-08 12:00 PST
Source No.:	1280-60-1	**Contained Radioactivity:**	5.075 **µCi** 187.8 **kBq**

Physical Description:

A. Mass of solution: 5.00089 g in 5 mL flame-sealed ampoule
B. Chemical form: T_2O in H_2O
C. Carrier content: None
D. Density: 0.9982 g/mL @ 20°C

Radioimpurities:

None detected

Radionuclide Concentration: 1.015 µCi/g, 37.56 kBq/g

Method of Calibration:

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

Uncertainty of Measurement:

A. Type A (random) uncertainty:	±	1.3	%
B. Type B (systematic) uncertainty:	±	3.3	%
C. Uncertainty in aliquot weighing:	±	0.0	%
D. Total uncertainty at the 99% confidence level:	±	3.5	%

Notes:

- See reverse side for leak test(s) performed on this source.
- EZIP participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from NCRP Report No. 58, 1985.
- This solution has a working life of 5 years.

Daniel James Van Dalsem
Quality Control

3-Apr-08
Date

EZIP Ref. No.: 1280-60

Reagent

H-3_00013

TestAmerica St. Louis

Standards Preparation Logbook Record

Sep-13-2013

Logbook: \\Qstlmo01\Stdslog\RAD_STD.std

RAD08-0037, H-3 Ampuole

Analyst: ridenhowerr

Vendor: Isotope Products   Lot No.: 1280-60-1
Solvent: Water
Date Prep./Opened: 04-15-2008   Date Consumed: 04-15-2008
Date Expires(1): 04-15-2058 (50 Years)
Date Expires(2): 04-15-2058 (50 Years)
H-3 Ampuole, reference date 4/15/08

Component	Initial Conc (dpm/mL)	Final Conc (dpm/mL)
H-3	2,253,300	2,253,300

RAD08-0039, H-3 Parent

Analyst: ridenhowerr

Solvent: Water   Volume (ml): 100.00
Date Prep./Opened: 04-15-2008
Date Expires(1): 04-15-2058 (50 Years)
Date Expires(2): 04-15-2058 (50 Years)
H-3 Primary dilution, reference date 4/15/08

Parent Std No.: RAD08-0037, H-3 Ampuole   Aliquot Amount (ml): 4.9508
Parent Date Expires(1): 04-15-2058   Parent Date Expires(2): 04-15-2058

Component	Initial Conc (dpm/mL)	Final Conc (dpm/mL)
H-3	2,253,300	111,556

H-3_00013
#200476

RAD13-0033, H-3 Spike

Analyst: marrss

Solvent: Water   Volume (ml): 250.00
Date Prep./Opened: 09-11-2013
Date Expires(1): 09-12-2014 (1 Year)
Date Expires(2): 09-12-2014 (1 Year)

Parent Std No.: RAD08-0039, H-3 Parent   Aliquot Amount (ml): 5.0000
Parent Date Expires(1): 04-15-2058   Parent Date Expires(2): 04-15-2058

Component	Initial Conc (dpm/mL)	Final Conc (dpm/mL)
H-3	111,556	2,231.1

Reviewed By: SUB

Page 1 of 1

H-3 Spike

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

H-3_00013

Reagent ID: H-3_00013

Description:	H-3 Spike
No. of Bottles:	1
Storage Location:	RAD Actinide STDs
Reagent Volume:	250.000 mL
Creation Date:	09/11/2013
Container(s):	200476
Comment:	
Expiration Date:	09/12/2014
Laboratory:	TestAmerica St. Louis
Prepared By:	Bernsen, Sarah C
Solvent:	DI Water
Solvent Lot:	n/a

Reagent Analyte Information

Analyte	Source ID	Source Expiration Date	Source Conc.	Source Conc. Units	Final Conc.	Final Conc. Units
Tritium	H-3_00005	04/15/2058	111682.8	dpm/mL	2233.65600	dpm/mL

Source Reagents

Reagent	Description	Type	Expiration	Vendor	Vendor Lot #	Vendor Cat Lot #	Volume Used	Volume Units
H-3_00005	H-3 Parent		04/15/58				5.00000	mL

St. Louis Radiological Standard Reverification Form

Standard ID Number:	Rad13-0033 / 200476		Radionuclide:
True Value =	822.81	DPM/L or g	Tritium
Date Analyzed:	9/12/2013		

	Replicates	
#1	830.18	DPM/L or g
#2	844.18	DPM/L or g
#3	805.18	DPM/L or g

Mean = 826.5133

1 sigma = 19.75686

1.96 sigma = 38.72344

True Value minus 5% = 781.6695 (True Value - 5%)

True Value plus 5% = 863.9505 (True Value + 5%)

Accuracy:

Mean value within 5% of Certified (True) Value? **Yes** **(Acceptance Criteria)**

Precision:

1.96 sigma Value Within 10% of Mean Value? **Yes** **(Acceptance Criteria)**

Standard Reverification Acceptable? **Yes**

Note: Criteria for reverification of radiological standards is taken from the DOE QSAS and LANL Statements of Work

Reviewed By/Date: Micha Korrinhizer 9/13/2013

SOP Reference: STL-QA-0002, Current Revision

Cocktail 97.13171 Rad 13-0033 Spike Verification

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Prep Report for Tritium in Water by LSC

Batch: M132750 **Prep Analyst:** 166

Bkg Water Batch: m132721

SampID	WRKNO	Aliquot	Volume Used		pH Checked
verification 1	NA	10.0000 mL	10.0000 mL	2	☑
verification 2	NA	10.0000 mL	10.0000 mL	3	☑
veririfcation 3	NA	10.0000 mL	10.0000 mL	4	☑

Spike Information

Sample ID	Standard ID	Analyte	Std Conc	Aliquot	Ref Date	StdAdded

NN — Spiked By

SUB — Spike Verified By

9.12.13 — Spike Date

Standard Operating Procedures

SOPNumber	Title	Revision
☑ ST-RC-0036		

MK — Reviewed By

9/13/13 — Review Date

NN — Analyst/Relenquished By

9.12.13 — Release Date

MK — Received By

9/12/13 — Receipt Date

1129111054 NN 9.12.13

Balance ID / Initials / Date

Prot.

3180
30min.
Prot. 16

TestAmerica St. Louis

Standards Preparation Logbook Record

Sep-11-2013

Logbook: \\Qstlmo01\Stdslog\RAD_STD.std

RAD08-0037, H-3 Ampuole

Analyst: ridenhowerr

Vendor: Isotope Products   Lot No.: 1280-60-1
Solvent: Water
Date Prep./Opened: 04-15-2008   Date Consumed: 04-15-2008
Date Expires(1): 04-15-2058 (50 Years)
Date Expires(2): 04-15-2058 (50 Years)
H-3 Ampuole, reference date 4/15/08

Component	Initial Conc (dpm/mL)	Final Conc (dpm/mL)
H-3	2,253,300	2,253,300

RAD08-0039, H-3 Parent

Analyst: ridenhowerr

Solvent: Water   Volume (ml): 100.00
Date Prep./Opened: 04-15-2008
Date Expires(1): 04-15-2058 (50 Years)
Date Expires(2): 04-15-2058 (50 Years)
H-3 Primary dilution, reference date 4/15/08

Parent Std No.: RAD08-0037, H-3 Ampuole   Aliquot Amount (ml): 4.9508
Parent Date Expires(1): 04-15-2058   Parent Date Expires(2): 04-15-2058

Component	Initial Conc (dpm/mL)	Final Conc (dpm/mL)
H-3	2,253,300	111,556

RAD13-0033, H-3 Spike

Analyst: marrss

Solvent: Water   Volume (ml): 250.00
Date Prep./Opened: 09-11-2013
Date Expires(1): 09-11-2014 (1 Year)
Date Expires(2): 09-11-2014 (1 Year)

Parent Std No.: RAD08-0039, H-3 Parent   Aliquot Amount (ml): 5.0000
Parent Date Expires(1): 04-15-2058   Parent Date Expires(2): 04-15-2058

Component	Initial Conc (dpm/mL)	Final Conc (dpm/mL)
H-3	111,556	2,231.1

Reviewed By: ______________________________

Page 1 of 1

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

H-3_00013

Reagent ID: H-3_00013

		Expiration Date:	09/11/2014
Description:	H-3 Spike	Laboratory:	TestAmerica St. Louis
No. of Bottles:	1	Prepared By:	Bernsen, Sarah C
Storage Location:	RAD Actinide STDs	Solvent:	DI Water
Reagent Volume:	250.000 mL	Solvent Lot:	n/a
Creation Date:	09/11/2013		
Container(s):	200476		
Comment:			

Reagent Analyte Information

Analyte	Source ID	Source Expiration Date	Source Conc.	Source Conc. Units	Final Conc.	Final Conc. Units
Tritium	H-3_00005	04/15/2058	111682.8	dpm/mL	2233.65600	dpm/mL

Source Reagents

Reagent	Description	Type	Expiration	Vendor	Vendor Lot #	Vendor Cat Lot #	Volume Used	Volume Units
H-3_00005	H-3 Parent		04/15/58				5.00000	mL

Tritium						
Initial Activity:	2231.1	dpm				
Reference Date:	4/15/2008					
Current Date:	9/12/2013		(or date at which you wish to determine activity)			
Elapsed Time:	1976	days				
Half Life:	4500	days	108000			
Exponential Term:	0.73758892					
Corrected Activity:	1645.634639	dpm/mL	3653.31	pCi/mL		
@ 0.5mL:	822.81	dpm/mL				

LLH3_2012 Protocol 16

Assay Definition

Assay Description:

Assay Type: DPM (Single)
Report Name: LLH3_Protocol 16
Output Data Path: \Slsvr01\rad\Upload\PACK_LSC_3180
Raw Results Path: C:\Packard\Tricarb\Results\Default\LLH3_2012 Protocol 16\20130912_1645
\20130912_1645.results
Assay File Name: C:\Packard\TriCarb\Assays\LLH3_2012 Protocol 16.lsa

Additional Data Files Generated with this Protocol:
16LLH3
[Auto] 16LLH3.001

Count Conditions

Nuclide: LLH3_2012
Quench Indicator: tSIE
External Std Terminator (sec): 15 sec
Pre-Count Delay (min): 0.00
Quench Set:
Low Energy: LLH3_2012
Count Time (min): 30.00
Count Mode: Low Level
Assay Count Cycles: 1 Repeat Sample Count: 1
#Vials/Sample: 1 Calculate % Reference: Off

Background Subtract

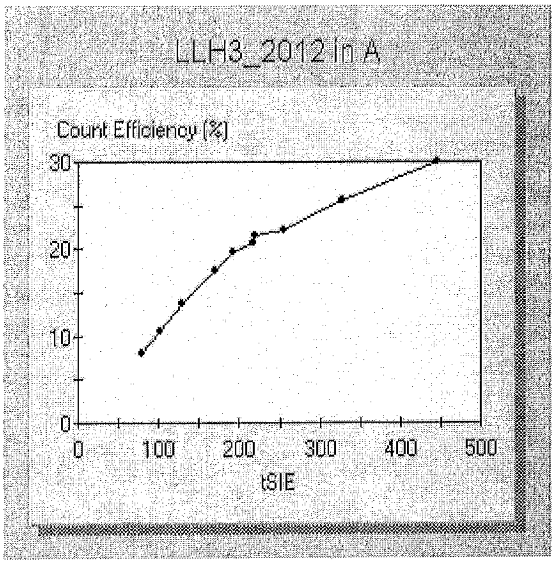
Background Subtract: Off
Low CPM Threshold: Off
2 Sigma % Terminator: On - Any Region

Regions	LL	UL	2Sigma % Terminator
A	0.0	18.6	1.50
B	2.0	18.6	0.00
C	18.7	100.0	0.00

Count Corrections

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

Cycle 1 Results
Quench Curve Block Data

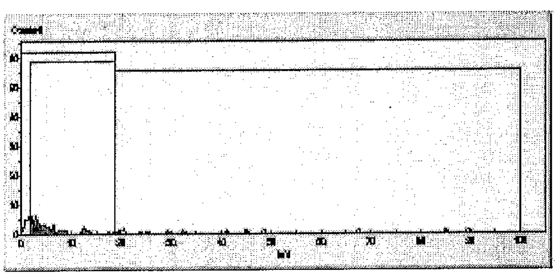


Date Acquired: 10/17/2012
Date Modified: 10/17/2012
LLH3_2012 in A

tSIE	Count Efficiency (%)
446.22	29.91
328.40	25.59
256.60	22.25
219.88	21.55
217.13	20.65
191.52	19.69
168.64	17.53
129.59	13.71
101.40	10.52
78.66	8.07

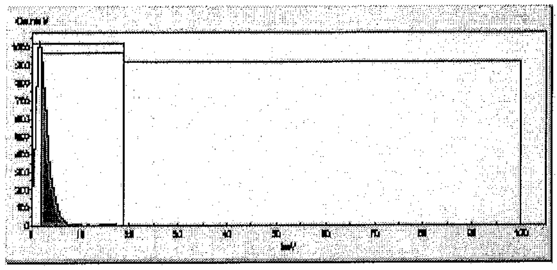
S#	Count Time	CPMA	CPMB	DPM1	tSIE	MESSAGES	EFF
CPMC	LUM	DATE	TIME	SMPL_ID			
1	30.00	1.74e+000	1.38e+000	7.82e+000	257.87		0.223
3.91e-001	100	9/12/2013	4:46:49 PM		BKG		

SpectraView Block Data



S#	Count Time	CPMA	CPMB	DPM1	tSIE	MESSAGES	EFF
2	30.00	1.91e+002	1.21e+002	8.38e+002	268.16		0.228
4.45e-001	100	9/12/2013	5:20:50 PM	verification 1			

SpectraView Block Data



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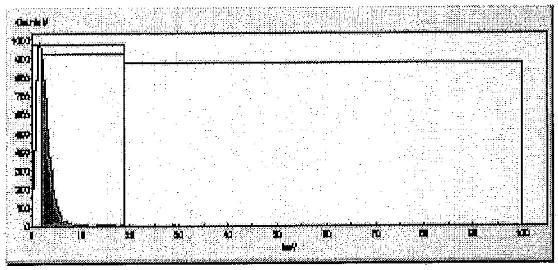
3 30.00 1.91e+002 1.22e+002 8.52e+002 261.16 0.225
2.42e-001 100 9/12/2013 5:54:50 PM verification 2

SpectraView Block Data



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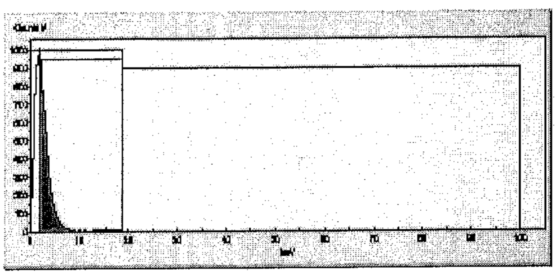
4 30.00 1.92e+002 1.26e+002 8.13e+002 285.60 0.236
2.27e-001 100 9/12/2013 6:28:51 PM veririfcation 3

SpectraView Block Data



TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Radiochemistry Data Review Checklist

Batch: M132750 **Analysis:** Tritium in Liquid by LSC

Lot Number	**Analytical Due Date**

	Review Item	Yes	No	N/A	2 Rvw
Rad Prep					
1	Are all samples on batch sheet present or removed from batch?	☑	☐	☐	☐
2	Are all samples, QC and methods in compliance with client requirements? (List Clients in COMMENTS section below)	☑	☐	☐	☐
3	Were forms checked for transcription errors?	☑	☐	☐	☐
4	Are al LIMS entries complete?	☑	☐	☐	☐
5	Is all prep sheet and logbook documentation included?	☑	☐	☐	☐
6	Is a copy of the pulverizer sequence log included?	☐	☐	☑	☐
7	Are all problems and deviations documented?	☐	☐	☑	☐
8	Does this batch contain re-extracts?	☐	☑	☐	☐
Sample Analysis					
1	Are carrier/tracer yields within acceptance limits?	☐	☐	☐	☐
2	Were all sample holding times met?	☐	☐	☐	☐
3	Were samples analyzed using normal ROI's?	☐	☐	☐	☐
4	Are all required forms complete and reviewed?	☐	☐	☐	☐
QC Samples					
1	Is the blank activity </= MDA and </= CRDL?	☐	☐	☐	☐
2	Is the blank activity </= client CRDL?	☐	☐	☐	☐
3	If blank activity exceeds limit, is sample activity >/= 10X blank activity?	☐	☐	☐	☐
4	Is LCS recovery within acceptance limits?	☐	☐	☐	☐
5	Is duplicate RPD/RER within acceptance limits?	☐	☐	☐	☐
6	Is MS/MSD recovery within acceptance limits?	☐	☐	☐	☐
7	Do samples meet CRDL?	☐	☐	☐	☐
Other					
1	Are all nonconformances documented and noted?	☐	☐	☐	☐
2	Were LIMS data entries checked at the required frequency?	☐	☐	☐	☐
3	Were manual calculations checked at the required frequency?	☐	☐	☐	☐
4	Were forms checked for transcription errors?	☐	☐	☐	☐
5	Are reporting units correct?	☐	☐	☐	☐
Data Packaging					
1	Run logs included?	☐	☐	☐	☐
2	Daily checks included?	☐	☐	☐	☐
3	Backgrounds included?	☐	☐	☐	☐
4	Calibrations included?	☐	☐	☐	☐

Batch: M132750 **Analysis:** Tritium in Liquid by LSC

Comments:

Prep Analyst: NW Date: 9.12.13

Analyst: Date:

Second Level Reviewer Date:

Date Uploaded:

Date Verified:

Date Review Released:

GENERAL CHEMISTRY

COVER PAGE
GENERAL CHEMISTRY

Lab Name: TestAmerica St. Louis   Job Number: 160-5291-1

SDG No.:

Project: Rad Samples

Client Sample ID	Lab Sample ID
KCMSS-BKG-1	160-5291-1
KCMSS-BKG-2	160-5291-2
KCMSS-5	160-5291-3
KCMSS-4	160-5291-4
KCMSS-1	160-5291-5
KCMSS-2	160-5291-6
KCMSS-6	160-5291-7
KCMSS-7	160-5291-8
KCMSS-8	160-5291-9
KCMSS-3	160-5291-10

Comments:

9-IN
DETECTION LIMITS
GENERAL CHEMISTRY

Lab Name: TestAmerica St. Louis   Job Number: 160-5291-1

SDG Number:

Matrix: Solid   Instrument ID: NOEQUIP

Method: Moisture   RL Date: 01/28/2011 14:43

Analyte	Wavelength/ Mass	RL (%)	
Percent Moisture		0.1	
Percent Solids		0.1	

FORM IX - IN

9-IN
CALIBRATION BLANK DETECTION LIMITS
GENERAL CHEMISTRY

Lab Name: TestAmerica St. Louis   Job Number: 160-5291-1

SDG Number:

Matrix: Solid   Instrument ID: NOEQUIP

Method: Moisture   XRL Date: 01/28/2011 14:42

Analyte	Wavelength/ Mass	XRL (%)	
Percent Moisture		0.1	
Percent Solids		0.1	

FORM IX - IN

ANALYSIS RUN LOG

GENERAL CHEMISTRY

Lab Name: TestAmerica St. Louis Job No.: 160-5291-1

SDG No.:

Instrument ID: NOEQUIP Analysis Method: Moisture

Start Date: 02/03/2014 05:24 End Date: 02/03/2014 05:24

Lab Sample Id	D/F	Type	Time	Analytes: %Sol	Moist
160-5291-1	1	T	05:24	X	X
160-5291-1 DU	1	T	05:24	X	X
160-5291-2	1	T	05:24	X	X
160-5291-3	1	T	05:24	X	X
160-5291-4	1	T	05:24	X	X
160-5291-5	1	T	05:24	X	X
160-5291-6	1	T	05:24	X	X
160-5291-7	1	T	05:24	X	X
160-5291-8	1	T	05:24	X	X
160-5291-9	1	T	05:24	X	X
160-5291-10	1	T	05:24	X	X
ZZZZZZ			05:24		
ZZZZZZ			05:24		
ZZZZZZ			05:24		
ZZZZZZ			05:24		
ZZZZZZ			05:24		
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FORM XIII-IN

13-IN
ANALYSIS RUN LOG
GENERAL CHEMISTRY

Lab Name: TestAmerica St. Louis Job No.: 160-5291-1

SDG No.:

Instrument ID: NOEQUIP Analysis Method: Moisture

Start Date: 02/03/2014 05:24 End Date: 02/03/2014 05:24

Lab Sample Id	D/F	Type	Time	Analytes	
				%Sol	Moist
ZZZZZZ			05:24		
ZZZZZZ			05:24		
ZZZZZZ			05:24		

Prep Types:
T = Total/NA

FORM XIII-IN

GENERAL CHEMISTRY BATCH WORKSHEET

Lab Name: TestAmerica St. Louis   Job No.: 160-5291-1

SDG No.:

Batch Number: 102663   Batch Start Date: 02/03/14 07:00   Batch Analyst: Braatz, Steve D

Batch Method: Moisture   Batch End Date: 02/04/14 00:55

Lab Sample ID	Client Sample ID	Method Chain	Basis	DISH#	DishWeight	SampleMassWet	SampleMassDry		
160-5291-A-1	KCMSS-BKG-1	Moisture	T	1	1.3325 g	10.2050 g	8.3376 g		
160-5291-A-1 DU	KCMSS-BKG-1	Moisture	T	2	1.3168 g	9.2761 g	7.6080 g		
160-5291-A-2	KCMSS-BKG-2	Moisture	T	3	1.3222 g	9.3099 g	7.6514 g		
160-5291-A-3	KCMSS-5	Moisture	T	4	1.3233 g	12.4623 g	10.6756 g		
160-5291-A-4	KCMSS-4	Moisture	T	5	1.3166 g	15.1784 g	12.2136 g		
160-5291-A-5	KCMSS-1	Moisture	T	6	1.3313 g	11.9771 g	9.5226 g		
160-5291-A-6	KCMSS-2	Moisture	T	7	1.3180 g	13.1846 g	11.1977 g		
160-5291-A-7	KCMSS-6	Moisture	T	8	1.3337 g	9.9289 g	9.0496 g		
160-5291-A-8	KCMSS-7	Moisture	T	9	1.3299 g	8.0485 g	7.0945 g		
160-5291-A-9	KCMSS-8	Moisture	T	10	1.3329 g	13.1695 g	10.7961 g		
160-5291-A-10	KCMSS-3	Moisture	T	11	1.3229 g	7.5325 g	5.3315 g		

Batch Notes	
Balance ID	27050421 No Unit
Batch Comment	TRAY A
Date samples were placed in the oven	1-3-14
Oven Temp when samples are put in oven	103 Degrees C
Time samples were place in the oven	07:00
Date samples were removed from oven	1-4-14
Oven Temp when samples removed from oven	103 Degrees C
Time Samples were removed from oven	00:55
Oven ID	OA

Basis	Basis Description
T	Total/NA

The pound sign (#) in the amount added field denotes that the reagent was used undiluted. All calculations are performed using the stated concentration for this reagent.

LIQUID SCINTILLATION COUNTER

Method 906.0

Tritium (LSC) by Method 906.0

LIQUID SCINTILLATION COUNTER BATCH WORKSHEET

Lab Name: TestAmerica St. Louis   Job No.: 160-5291-1

SDG No.:

Batch Number: 104205   Batch Start Date: 02/11/14 09:04   Batch Analyst: Nwosu, Ndidi M

Batch Method: LSC_Dist_Susp   Batch End Date: 02/11/14 09:18

Lab Sample ID	Client Sample ID	Method Chain	Basis	InitialAmount	DiluentAdded	VolumeCounted	H-3 00013		
MB 160-104205/1		LSC_Dist_Susp, 906.0		30 g	40 mL	10 mL			
LCS 160-104205/2		LSC_Dist_Susp, 906.0		30 g	40 mL	10 mL	0.5 mL		
160-5291-A-1	KCMSS-BKG-1	LSC_Dist_Susp, 906.0	T	30 g	40 mL	10 mL			
160-5291-A-1 DU	KCMSS-BKG-1	LSC_Dist_Susp, 906.0	T	30.4 g	40 mL	10 mL			
160-5291-A-2	KCMSS-BKG-2	LSC_Dist_Susp, 906.0	T	30.3 g	40 mL	10 mL			
160-5291-A-2 MS	KCMSS-BKG-2	LSC_Dist_Susp, 906.0	T	30.3 g	40 mL	10 mL	0.5 mL		
160-5291-A-3	KCMSS-5	LSC_Dist_Susp, 906.0	T	30.3 g	40 mL	10 mL			
160-5291-A-4	KCMSS-4	LSC_Dist_Susp, 906.0	T	30 g	40 mL	10 mL			
160-5291-A-5	KCMSS-1	LSC_Dist_Susp, 906.0	T	30.5 g	40 mL	10 mL			
160-5291-A-6	KCMSS-2	LSC_Dist_Susp, 906.0	T	30 g	40 mL	10 mL			
160-5291-A-7	KCMSS-6	LSC_Dist_Susp, 906.0	T	30.4 g	40 mL	10 mL			
160-5291-A-8	KCMSS-7	LSC_Dist_Susp, 906.0	T	30.1 g	40 mL	10 mL			
160-5291-A-9	KCMSS-8	LSC_Dist_Susp, 906.0	T	30.3 g	40 mL	10 mL			
160-5291-A-10	KCMSS-3	LSC_Dist_Susp, 906.0	T	30.1 g	40 mL	10 mL			

Batch Notes	
Balance ID	1129111054
Background Water Batch	293022
Person's name who witnessed reagent drop	sb
Analyst who added reagent	nn
SOP Number	st rc 0030

Basis	Basis Description
T	Total/NA

The pound sign (#) in the amount added field denotes that the reagent was used undiluted. All calculations are performed using the stated concentration for this reagent.

Prep Batch: 104205

Distillation and Suspension (LSC)

Liquid Scintillation Counter Analysis Detail Report
Prep Batch: 104205

Lab ID: MB 160-104205/1-A | Analyzed: 02/12/14 21:59 | Sigma: 2 | Decay Corrected: No | Ts: 30
Client ID: | Detector: LSCBrown | Dil Fac: 1 | Yield Truncated: No | Tb: 30

Analyte	MB Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	-0.006006	0.220	0.220	U	pCi/g	1.00	0.393	66.6	68.7	2.220	2.290	0.21200	0.21600	105097

Lab ID: LCS 160-104205/2-A | Analyzed: 02/12/14 22:34 | Sigma: 2 | Decay Corrected: No | Ts: 30
Client ID: | Detector: LSCBrown | Dil Fac: 1 | Yield Truncated: No | Tb: 30

Analyte	LCS Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	11.80	0.694	1.25		pCi/g	1.00	0.383	1347	68.7	44.900	2.290	0.21700	0.21600	105097

Lab ID: 160-5291-1 | Analyzed: 02/12/14 23:09 | Sigma: 2 | Decay Corrected: No | Ts: 30
Client ID: KCMSS-BKG-1 | Detector: LSCBrown | Dil Fac: 1 | Yield Truncated: No | Tb: 30

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	0.320	0.285	0.287	U H	pCi/g	1.00	0.463	95.1	68.7	3.170	2.290	0.20800	0.21600	105097

Lab ID: 160-5291-1 DU | Analyzed: 02/12/14 23:44 | Sigma: 2 | Decay Corrected: No | Ts: 30
Client ID: KCMSS-BKG-1 | Detector: LSCBrown | Dil Fac: 1 | Yield Truncated: No | Tb: 30

Analyte	DU Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	0.1925	0.271	0.271	U	pCi/g	1.00	0.456	83.7	68.7	2.790	2.290	0.20900	0.21600	105097

Lab ID: 160-5291-2 | Analyzed: 02/13/14 00:19 | Sigma: 2 | Decay Corrected: No | Ts: 30
Client ID: KCMSS-BKG-2 | Detector: LSCBrown | Dil Fac: 1 | Yield Truncated: No | Tb: 30

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	0.000	0.250	0.250	U H	pCi/g	1.00	0.443	68.1	68.7	2.270	2.290	0.21500	0.21600	105097

Lab ID: 160-5291-2 MS | Analyzed: 02/13/14 00:54 | Sigma: 2 | Decay Corrected: No | Ts: 30
Client ID: KCMSS-BKG-2 | Detector: LSCBrown | Dil Fac: 1 | Yield Truncated: No | Tb: 30

Analyte	MS Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	11.45	0.747	1.25		pCi/g	1.00	0.450	1122	68.7	37.400	2.290	0.21200	0.21600	105097

Liquid Scintillation Counter Analysis Detail Report

Prep Batch: 104205

Lab ID: 160-5291-3 | Analyzed: 02/13/14 01:29 | Sigma: 2 | Decay Corrected: No | Ts: 30
Client ID: KCMSS-5 | Detector: LSCBrown | Dil Fac: 1 | Yield Truncated: No | Tb: 30

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	0.120	0.255	0.256	U H	pCi/g	1.00	0.438	78.3	68.7	2.610	2.290	0.21100	0.21600	105097

Lab ID: 160-5291-4 | Analyzed: 02/13/14 02:04 | Sigma: 2 | Decay Corrected: No | Ts: 30
Client ID: KCMSS-4 | Detector: LSCBrown | Dil Fac: 1 | Yield Truncated: No | Tb: 30

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	0.300	0.287	0.289	U H	pCi/g	1.00	0.473	90.6	68.7	3.020	2.290	0.20400	0.21600	105097

Lab ID: 160-5291-5 | Analyzed: 02/13/14 02:39 | Sigma: 2 | Decay Corrected: No | Ts: 30
Client ID: KCMSS-1 | Detector: LSCBrown | Dil Fac: 1 | Yield Truncated: No | Tb: 30

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	0.0417	0.256	0.256	U H	pCi/g	1.00	0.450	71.7	68.7	2.390	2.290	0.21400	0.21600	105097

Lab ID: 160-5291-6 | Analyzed: 02/13/14 03:14 | Sigma: 2 | Decay Corrected: No | Ts: 30
Client ID: KCMSS-2 | Detector: LSCBrown | Dil Fac: 1 | Yield Truncated: No | Tb: 30

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	0.243	0.270	0.271	U H	pCi/g	1.00	0.446	89.4	68.7	2.980	2.290	0.21000	0.21600	105097

Lab ID: 160-5291-7 | Analyzed: 02/13/14 03:48 | Sigma: 2 | Decay Corrected: No | Ts: 30
Client ID: KCMSS-6 | Detector: LSCBrown | Dil Fac: 1 | Yield Truncated: No | Tb: 30

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	0.204	0.251	0.251	U H	pCi/g	1.00	0.416	88.5	68.7	2.950	2.290	0.21300	0.21600	105097

Lab ID: 160-5291-8 | Analyzed: 02/13/14 04:24 | Sigma: 2 | Decay Corrected: No | Ts: 30
Client ID: KCMSS-7 | Detector: LSCBrown | Dil Fac: 1 | Yield Truncated: No | Tb: 30

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	0.0331	0.243	0.243	U H	pCi/g	1.00	0.427	71.7	68.7	2.390	2.290	0.21500	0.21600	105097

Liquid Scintillation Counter Analysis Detail Report

Prep Batch: 104205

Lab ID:	160-5291-9	Analyzed:	02/13/14 04:59	Sigma:	2	Decay Corrected:	No	Ts:	30
Client ID:	KCMSS-8	Detector:	LSCBrown	Dil Fac:	1	Yield Truncated:	No	Tb:	30

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	0.0342	0.253	0.253	U H	pCi/g	1.00	0.446	70.8	68.7	2.360	2.290	0.21300	0.21600	105097

Lab ID:	160-5291-10	Analyzed:	02/13/14 05:33	Sigma:	2	Decay Corrected:	No	Ts:	30
Client ID:	KCMSS-3	Detector:	LSCBrown	Dil Fac:	1	Yield Truncated:	No	Tb:	30

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Tritium	0.000	0.277	0.277	U H	pCi/g	1.00	0.493	67.5	68.7	2.250	2.290	0.21300	0.21600	105097

Quality Control Summary

Method Blank ID:	Analyte	Parent Result	Spike Added	MB Result	Qualifier	Unit	% Rec	% Rec Limits	RPD	RER	DER	RER Limit	Z Factor
MB 160-104205/1-A	Tritium			-0.006006	U	pCi/g							

Lab Control Sample ID:	Analyte	Parent Result	Spike Added	LCS Result	Qualifier	Unit	% Rec	% Rec Limits	RPD	RER	DER	RER Limit	Z Factor
LCS 160-104205/2-A	Tritium		12.1	11.80		pCi/g	98	80 - 114					

Matrix Spike ID:	Analyte	Parent Result	Spike Added	MS Result	Qualifier	Unit	% Rec	% Rec Limits	RPD	RER	DER	RER Limit	Z Factor
160-5291-2	Tritium	0.000	12.0	11.45		pCi/g	96	78 - 122					

Duplicate ID:	Analyte	Parent Result	Spike Added	DU Result	Qualifier	Unit	% Rec	% Rec Limits	RPD	RER	DER	RER Limit	Z Factor
160-5291-1	Tritium	0.320		0.1925	U	pCi/g			50	0.23	0.65	1	

Glossary:

- Ts = Count Duration, Sample
- Tb = Count Duration, Background
- Cs = Total Counts, Sample
- Cb = Total Counts, Background
- CPMs = Counts Per Minute, Sample
- CPMb = Counts Per Minute, Background
- EFFs = Efficiency, Sample
- EFFb = Efficiency, Background

LIQUID SCINTILLATION COUNTER BATCH WORKSHEET

Lab Name: TestAmerica St. Louis Job No.: 160-5291-1

SDG No.:

Batch Number: 104205 Batch Start Date: 02/11/14 09:04 Batch Analyst: Nwosu, Ndidi M

Batch Method: LSC_Dist_Susp Batch End Date: 02/11/14 09:18

Lab Sample ID	Client Sample ID	Method Chain	Basis	InitialAmount	DiluentAdded	VolumeCounted	H-3 00013		
MB 160-104205/1		LSC_Dist_Susp, 906.0		30 g	40 mL	10 mL			
LCS 160-104205/2		LSC_Dist_Susp, 906.0		30 g	40 mL	10 mL	0.5 mL		
160-5291-A-1	KCMSS-BKG-1	LSC_Dist_Susp, 906.0	T	30 g	40 mL	10 mL			
160-5291-A-1 DU	KCMSS-BKG-1	LSC_Dist_Susp, 906.0	T	30.4 g	40 mL	10 mL			
160-5291-A-2	KCMSS-BKG-2	LSC_Dist_Susp, 906.0	T	30.3 g	40 mL	10 mL			
160-5291-A-2 MS	KCMSS-BKG-2	LSC_Dist_Susp, 906.0	T	30.3 g	40 mL	10 mL	0.5 mL		
160-5291-A-3	KCMSS-5	LSC_Dist_Susp, 906.0	T	30.3 g	40 mL	10 mL			
160-5291-A-4	KCMSS-4	LSC_Dist_Susp, 906.0	T	30 g	40 mL	10 mL			
160-5291-A-5	KCMSS-1	LSC_Dist_Susp, 906.0	T	30.5 g	40 mL	10 mL			
160-5291-A-6	KCMSS-2	LSC_Dist_Susp, 906.0	T	30 g	40 mL	10 mL			
160-5291-A-7	KCMSS-6	LSC_Dist_Susp, 906.0	T	30.4 g	40 mL	10 mL			
160-5291-A-8	KCMSS-7	LSC_Dist_Susp, 906.0	T	30.1 g	40 mL	10 mL			
160-5291-A-9	KCMSS-8	LSC_Dist_Susp, 906.0	T	30.3 g	40 mL	10 mL			
160-5291-A-10	KCMSS-3	LSC_Dist_Susp, 906.0	T	30.1 g	40 mL	10 mL			

Batch Notes	
Balance ID	1129111054
Background Water Batch	293022
Person's name who witnessed reagent drop	sb
Analyst who added reagent	nn
SOP Number	st rc 0030

Basis	Basis Description
T	Total/NA

The pound sign (#) in the amount added field denotes that the reagent was used undiluted. All calculations are performed using the stated concentration for this reagent.

H3_2013 Protocol 4

Assay Definition

Assay Description:

Assay Type: DPM (Single)
Report Name: H3_Protocol 4
Output Data Path: \Slsvr01\RAD\Upload\PACK_LSC_Brown
Raw Results Path: C:\Packard\Tricarb\Results\Default\H3_2013 Protocol 4\20140212_2122
\20140212_2122.results
Assay File Name: C:\Packard\TriCarb\Assays\H3_2013 Protocol 4.lsa

Additional Data Files Generated with this Protocol:
4H3
[Auto] 4H3.001

Count Conditions

Nuclide: H3_2013
Quench Indicator: tSIE
External Std Terminator (sec): 15 sec
Pre-Count Delay (min): 0.00
Quench Set:
Low Energy: H3_2013
Count Time (min): 30.00
Count Mode: Low Level
Assay Count Cycles: 1 Repeat Sample Count: 1
#Vials/Sample: 1 Calculate % Reference: Off

Background Subtract

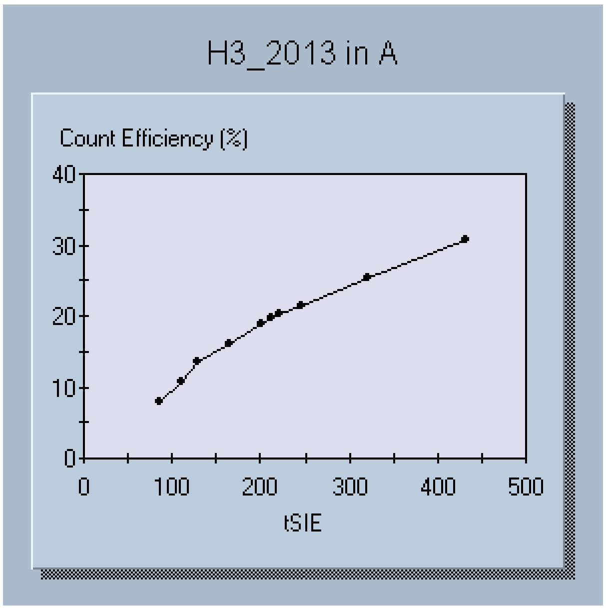
Background Subtract: Off
Low CPM Threshold: Off
2 Sigma % Terminator: On - Any Region

Regions	LL	UL	2Sigma % Terminator
A	0.0	18.6	1.50
B	2.0	18.6	0.00
C	18.7	100.0	0.00

Count Corrections

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

Cycle 1 Results
Quench Curve Block Data

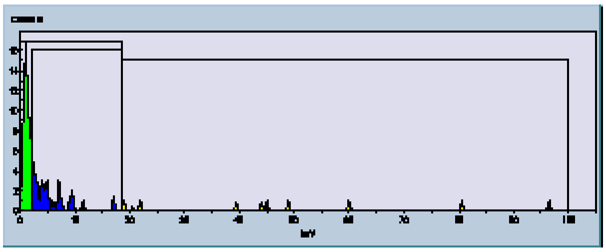


Date Acquired: 05/07/2013
Date Modified:
H3_2013 in A

tSIE	Count Efficiency (%)
432.28	30.67
321.50	25.32
246.44	21.41
221.17	20.32
213.39	19.82
200.66	18.87
164.59	16.05
130.02	13.62
110.36	10.62
86.74	8.02

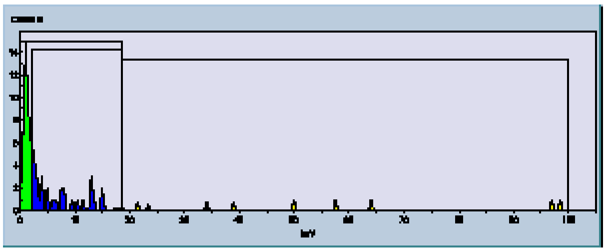
S#	Count Time	CPMA	CPMB	DPM1	tSIE	MESSAGES	EFF
CPMC	**LUM**	**DATE**	**TIME**	**SMPL_ID**			
1	30.00	2.29e+000	1.12e+000	1.06e+001	249.68		0.216
3.00e-001	97	2/12/2014	9:24:24 PM		BKG		

SpectraView Block Data



2	30.00	2.22e+000	1.18e+000	1.05e+001	241.40		0.212
2.66e-001	94	2/12/2014	9:59:23 PM	MB 160-104205/1-A			

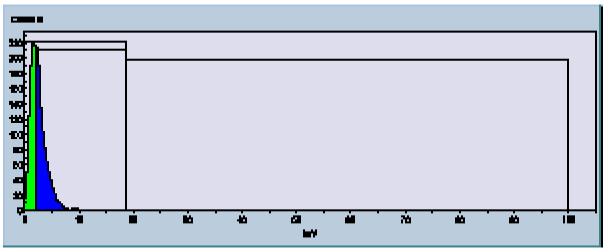
SpectraView Block Data



---

3 30.00 4.49e+001 2.95e+001 2.07e+002 252.77 0.217
1.38e-001 6 2/12/2014 10:34:21 PM LCS 160-104205/2-A

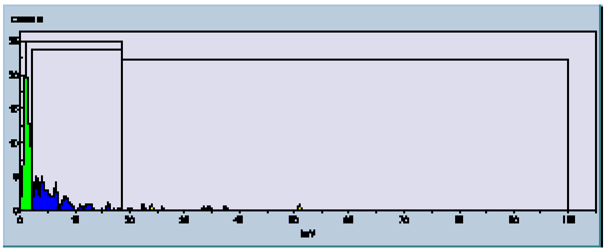
SpectraView Block Data



---

4 30.00 3.17e+000 1.67e+000 1.52e+001 232.62 0.208
2.00e-001 76 2/12/2014 11:09:18 PM 160-5291-A-1-C

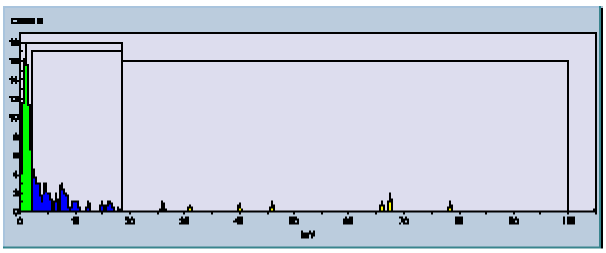
SpectraView Block Data



---

5 30.00 2.79e+000 1.36e+000 1.34e+001 234.25 0.209
2.50e-001 85 2/12/2014 11:44:18 PM 160-5291-A-1-D DU

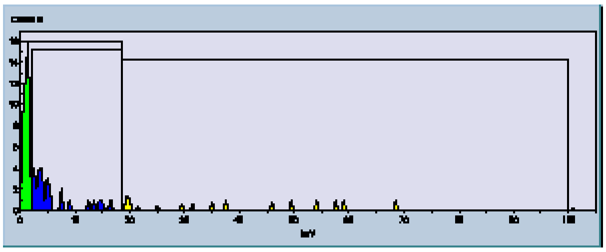
SpectraView Block Data



---

6 30.00 2.27e+000 1.01e+000 1.06e+001 248.60 0.215
4.17e-001 80 2/13/2014 12:19:15 AM 160-5291-A-2-B

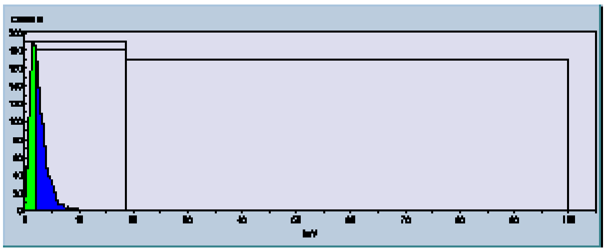
SpectraView Block Data



---

7 30.00 3.74e+001 2.42e+001 1.77e+002 240.97 0.212
2.70e-001 7 2/13/2014 12:54:15 AM 160-5291-A-2-C MS

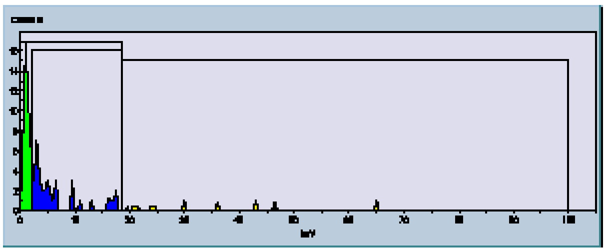
SpectraView Block Data



---

8 30.00 2.61e+000 1.44e+000 1.24e+001 239.27 0.211
2.42e-001 80 2/13/2014 1:29:10 AM 160-5291-A-3-B

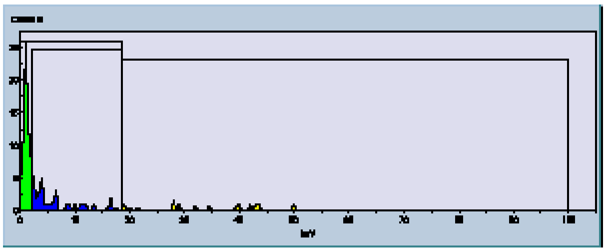
SpectraView Block Data



---

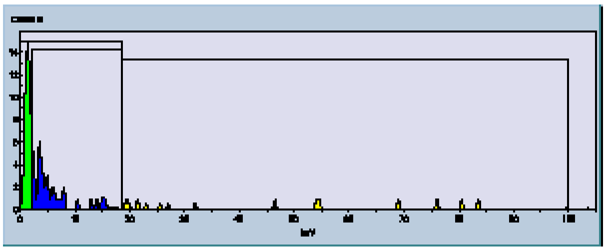
9 30.00 3.02e+000 1.29e+000 1.49e+001 222.30 0.204
3.88e-001 81 2/13/2014 2:04:07 AM 160-5291-A-4-B

SpectraView Block Data



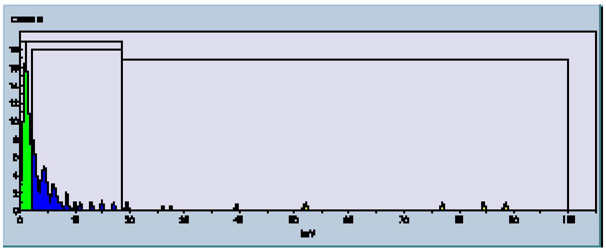
10	30.00	2.39e+000	1.39e+000	1.12e+001	246.06		0.214
3.96e-001	82	2/13/2014	2:39:05 AM			160-5291-A-5-B	

SpectraView Block Data



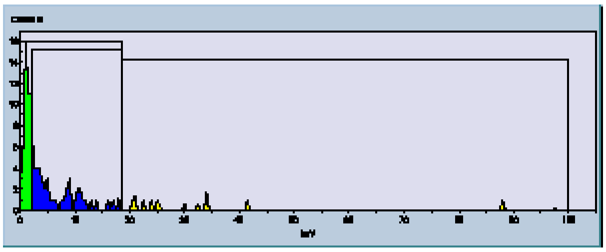
11	30.00	2.98e+000	1.61e+000	1.42e+001	238.00		0.210
2.25e-001	79	2/13/2014	3:14:01 AM			160-5291-A-6-B	

SpectraView Block Data



12	30.00	2.95e+000	1.78e+000	1.38e+001	243.87		0.213
3.67e-001	73	2/13/2014	3:48:57 AM			160-5291-A-7-B	

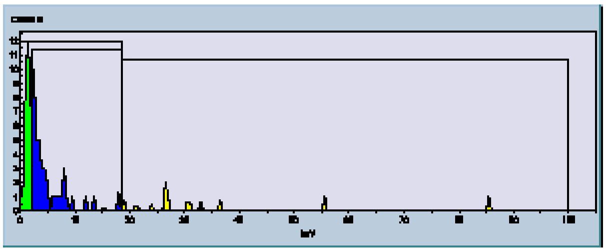
SpectraView Block Data



13	30.00	2.39e+000	1.59e+000	1.11e+001	248.14	0.215

3.21e-001 86 2/13/2014 4:24:04 AM 160-5291-A-8-B

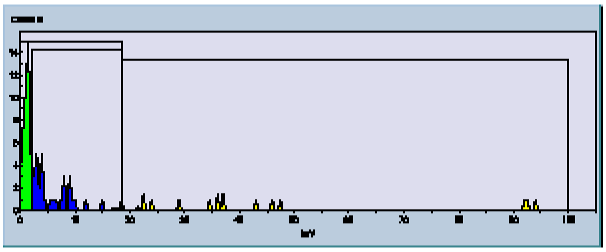
SpectraView Block Data



14	30.00	2.36e+000	1.16e+000	1.11e+001	242.89	0.213

4.74e-001 79 2/13/2014 4:59:00 AM 160-5291-A-9-B

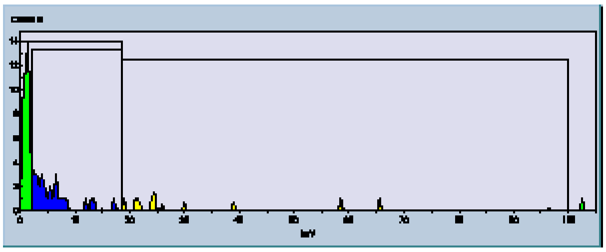
SpectraView Block Data



15	30.00	2.25e+000	1.08e+000	1.06e+001	243.04	0.213

3.33e-001 97 2/13/2014 5:33:56 AM 160-5291-A-10-B

SpectraView Block Data



Method C-01-1

Carbon-14 (LSC) by Method C-01-1

Prep Batch: 103612

Distillation and Suspension (LSC)

Liquid Scintillation Counter Analysis Detail Report
Prep Batch: 103612

Lab ID: MB 160-103612/1-A | Analyzed: 02/10/14 18:15 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	MB Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	-0.4550	0.811	0.812	U	pCi/g	5.00	1.47	86.6	101.6	4.330	5.080	0.76200	0.75800	104204

Lab ID: LCS 160-103612/2-A | Analyzed: 02/10/14 18:39 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	LCS Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	75.36	3.12	8.72		pCi/g	5.00	1.50	2600	101.6	130.000	5.080	0.75000	0.75800	104204

Lab ID: 160-5337-A-1-G DU | Analyzed: 02/10/14 19:27 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	DU Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	0.2275	0.854	0.855	U	pCi/g	5.00	1.47	109.2	101.6	5.460	5.080	0.75800	0.75800	104204

Lab ID: 160-5291-1 | Analyzed: 02/10/14 19:51 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: KCMSS-BKG-1 | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	-0.797	0.794	0.799	U H	pCi/g	5.00	1.49	74.2	101.6	3.710	5.080	0.75200	0.75800	104204

Lab ID: 160-5291-1 MS | Analyzed: 02/10/14 20:15 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: KCMSS-BKG-1 | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	MS Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	63.28	2.84	7.40		pCi/g	5.00	1.45	2280	101.6	114.000	5.080	0.75800	0.75800	104204

Lab ID: 160-5291-2 | Analyzed: 02/10/14 20:39 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: KCMSS-BKG-2 | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	-0.140	0.824	0.824	U H	pCi/g	5.00	1.45	98.8	101.6	4.940	5.080	0.77400	0.75800	104204

Liquid Scintillation Counter Analysis Detail Report
Prep Batch: 103612

Lab ID: 160-5291-3 | Analyzed: 02/10/14 21:03 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: KCMSS-5 | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	-0.290	0.818	0.819	U H	pCi/g	5.00	1.47	91.8	101.6	4.590	5.080	0.75800	0.75800	104204

Lab ID: 160-5291-4 | Analyzed: 02/10/14 21:27 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: KCMSS-4 | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	-0.562	0.792	0.794	U H	pCi/g	5.00	1.45	83.4	101.6	4.170	5.080	0.76600	0.75800	104204

Lab ID: 160-5291-5 | Analyzed: 02/10/14 21:51 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: KCMSS-1 | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	0.517	0.882	0.884	U H	pCi/g	5.00	1.49	117.8	101.6	5.890	5.080	0.74900	0.75800	104204

Lab ID: 160-5291-6 | Analyzed: 02/10/14 22:15 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: KCMSS-2 | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	0.651	0.882	0.885	U H	pCi/g	5.00	1.47	123.8	101.6	6.190	5.080	0.75900	0.75800	104204

Lab ID: 160-5291-7 | Analyzed: 02/10/14 22:39 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: KCMSS-6 | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	7.93	1.30	1.55	H	pCi/g	5.00	1.50	366	101.6	18.300	5.080	0.75100	0.75800	104204

Lab ID: 160-5291-8 | Analyzed: 02/10/14 23:03 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: KCMSS-7 | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	3.32	1.08	1.14	H	pCi/g	5.00	1.53	208	101.6	10.400	5.080	0.74200	0.75800	104204

Liquid Scintillation Counter Analysis Detail Report
Prep Batch: 103612

Lab ID: 160-5291-9 | Analyzed: 02/10/14 23:27 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: KCMSS-8 | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	2.75	1.03	1.07	H	pCi/g	5.00	1.50	192.4	101.6	9.620	5.080	0.74900	0.75800	104204

Lab ID: 160-5291-10 | Analyzed: 02/10/14 23:51 | Sigma: 2 | Decay Corrected: No | Ts: 20
Client ID: KCMSS-3 | Detector: LSCTeal | Dil Fac: 1 | Yield Truncated: No | Tb: 20

Analyte	Result	Count Unc	Total Unc	Qualifier	Unit	RL	MDC	Cs	Cb	CPMs	CPMb	EFFs	EFFb	Anly Batch
Carbon-14	-0.406	0.805	0.806	U H	pCi/g	5.00	1.46	88.4	101.6	4.420	5.080	0.76400	0.75800	104204

Quality Control Summary

Method Blank ID:	Analyte	Parent Result	Spike Added	MB Result	Qualifier	Unit	% Rec	% Rec Limits	RPD	RER	DER	RER Limit	Z Factor
MB 160-103612/1-A	Carbon-14			-0.4550	U	pCi/g							

Lab Control Sample ID:	Analyte	Parent Result	Spike Added	LCS Result	Qualifier	Unit	% Rec	% Rec Limits	RPD	RER	DER	RER Limit	Z Factor
LCS 160-103612/2-A	Carbon-14		84.4	75.36		pCi/g	89	67 - 124					

Matrix Spike ID:	Analyte	Parent Result	Spike Added	MS Result	Qualifier	Unit	% Rec	% Rec Limits	RPD	RER	DER	RER Limit	Z Factor
160-5291-1	Carbon-14	-0.797	82.8	63.28		pCi/g	76	29 - 128					

Duplicate ID:	Analyte	Parent Result	Spike Added	DU Result	Qualifier	Unit	% Rec	% Rec Limits	RPD	RER	DER	RER Limit	Z Factor
160-5337-A-1-G DU	Carbon-14	-0.460		0.2275	U	pCi/g			592	0.41	1.16	1	

Glossary:

- Ts = Count Duration, Sample
- Tb = Count Duration, Background
- Cs = Total Counts, Sample
- Cb = Total Counts, Background
- CPMs = Counts Per Minute, Sample
- CPMb = Counts Per Minute, Background
- EFFs = Efficiency, Sample
- EFFb = Efficiency, Background

LIQUID SCINTILLATION COUNTER BATCH WORKSHEET

Lab Name: TestAmerica St. Louis   Job No.: 160-5291-1

SDG No.:

Batch Number: 103612   Batch Start Date: 02/07/14 06:37   Batch Analyst: Mewes, Leah E

Batch Method: LSC_Dist_Susp   Batch End Date: 02/07/14 15:02

Lab Sample ID	Client Sample ID	Method Chain	Basis	InitialAmount	C-14 00008				
MB 160-103612/1		LSC_Dist_Susp, C-01-1		1.0 g					
LCS 160-103612/2		LSC_Dist_Susp, C-01-1		1.0 g	1 mL				
160-5337-A-1 DU		LSC_Dist_Susp, C-01-1	T	1.01 g					
160-5291-A-1	KCMSS-BKG-1	LSC_Dist_Susp, C-01-1	T	1.00 g					
160-5291-A-1 MS	KCMSS-BKG-1	LSC_Dist_Susp, C-01-1	T	1.02 g	1 mL				
160-5291-A-2	KCMSS-BKG-2	LSC_Dist_Susp, C-01-1	T	1.00 g					
160-5291-A-3	KCMSS-5	LSC_Dist_Susp, C-01-1	T	1.01 g					
160-5291-A-4	KCMSS-4	LSC_Dist_Susp, C-01-1	T	1.01 g					
160-5291-A-5	KCMSS-1	LSC_Dist_Susp, C-01-1	T	1.01 g					
160-5291-A-6	KCMSS-2	LSC_Dist_Susp, C-01-1	T	1.01 g					
160-5291-A-7	KCMSS-6	LSC_Dist_Susp, C-01-1	T	1.00 g					
160-5291-A-8	KCMSS-7	LSC_Dist_Susp, C-01-1	T	0.99 g					
160-5291-A-9	KCMSS-8	LSC_Dist_Susp, C-01-1	T	1.00 g					
160-5291-A-10	KCMSS-3	LSC_Dist_Susp, C-01-1	T	1.01 g					

Batch Notes	
Balance ID	1122021820
Person's name who witnessed reagent drop	RS
Analyst who added reagent	LM
SOP Number	ST-RC-0057

Basis	Basis Description
T	Total/NA

The pound sign (#) in the amount added field denotes that the reagent was used undiluted. All calculations are performed using the stated concentration for this reagent.

Assay Definition

Assay Description:

Assay Type: DPM (Single)
Report Name: C14_Protocol 22
Output Data Path: \Slsvr01\RAD\Upload\PACK_LSC_Teal
Raw Results Path: C:\Packard\Tricarb\Results\Default\C14_2013 Protocol 22\20140210_1749\20140210_1749.results
Assay File Name: C:\Packard\TriCarb\Assays\C14_2013 Protocol 22.lsa

Additional Data Files Generated with this Protocol:
22C14
[Auto] 22C14.001

Count Conditions

Nuclide: C14_2013
Quench Indicator: tSIE
External Std Terminator (sec): 15 sec
Pre-Count Delay (min): 0.00
Quench Set:
Low Energy: C14_2013
Count Time (min): 20.00
Count Mode: Low Level
Assay Count Cycles: 1 Repeat Sample Count: 1
#Vials/Sample: 1 Calculate % Reference: Off

Background Subtract

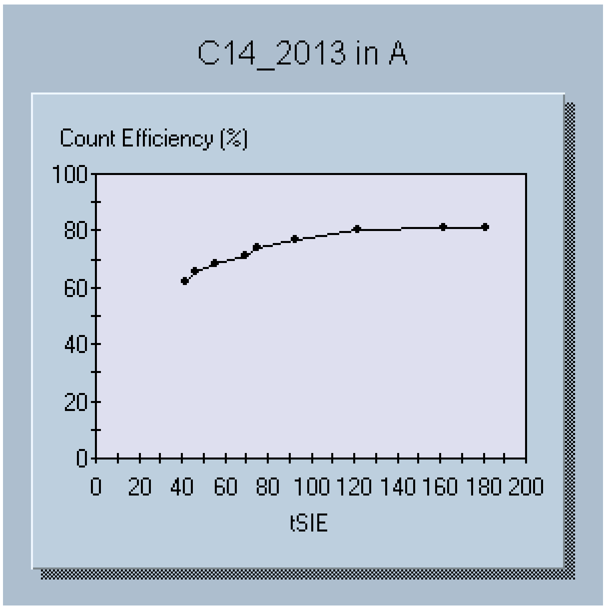
Background Subtract: Off
Low CPM Threshold: Off
2 Sigma % Terminator: On - Any Region

Regions	LL	UL	2Sigma % Terminator
A	0.0	156.0	1.50
B	2.0	156.0	0.00
C	156.1	300.0	0.00

Count Corrections

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

Cycle 1 Results
Quench Curve Block Data

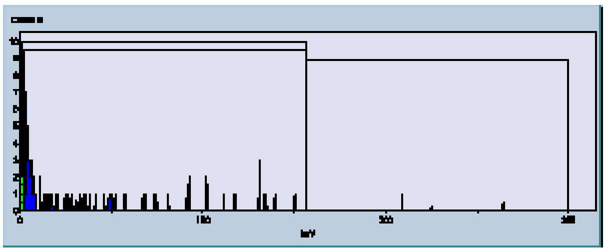


Date Acquired: 08/07/2013
Date Modified:
C14_2013 in A

tSIE	Count Efficiency (%)
181.24	80.94
161.89	80.76
121.66	80.42
93.01	76.48
74.97	73.87
70.08	71.40
55.47	68.38
46.44	65.51
41.89	62.31

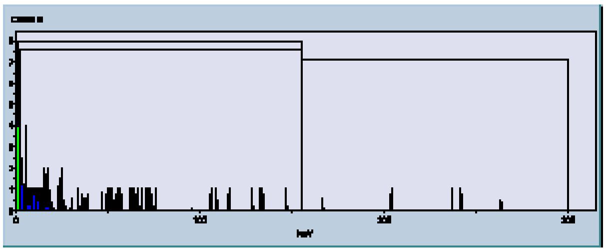
S#				**SMPL_ID**	**Count Time**	**CPMA**	**DPM1**	**TIME**
DATE	**EFF**	**tSIE**	**LUM**		**CPMC**	**MESSAGES**	**CPMB**	
1				BKG	20.00	5.08e+000	6.70e+000	5:51:24 PM
2/10/2014	0.758	88.26	34		8.75e-002		4.22e+000	

SpectraView Block Data



2				MB 160-103612/1-A	20.00	4.33e+000	5.69e+000	6:15:30 PM
2/10/2014	0.762	90.84	36		2.06e-001		3.33e+000	

SpectraView Block Data



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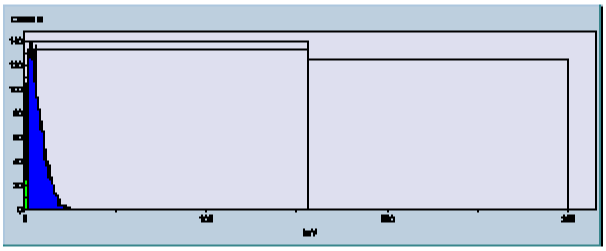
3 LCS 160-103612/2-A 20.00 1.30e+002 1.74e+002 6:39:29 PM
2/10/2014 0.750 82.61 1 2.50e-001 1.16e+002

SpectraView Block Data



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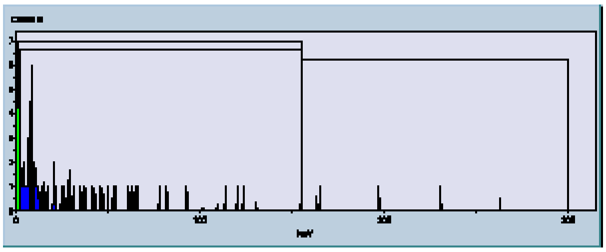
4 160-5337-A-1-F 20.00 4.30e+000 5.69e+000 7:03:35 PM
2/10/2014 0.756 86.93 35 2.06e-001 3.40e+000

SpectraView Block Data



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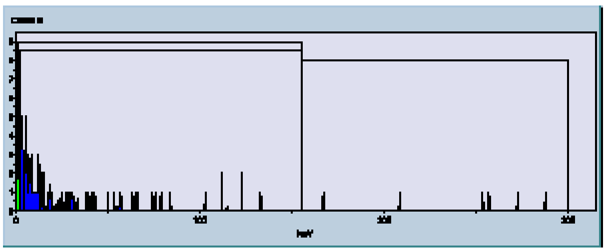
5 160-5337-A-1-G DU 20.00 5.46e+000 7.21e+000 7:27:34 PM
2/10/2014 0.758 88.31 24 3.31e-001 4.41e+000

SpectraView Block Data



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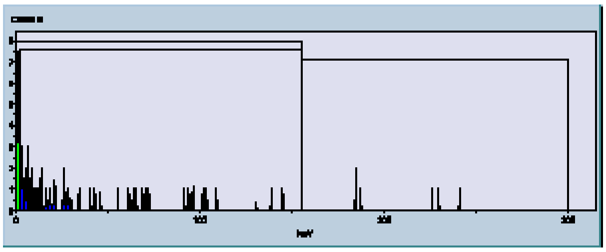
6 160-5291-A-1-A 20.00 3.71e+000 4.93e+000 7:51:31 PM

2/10/2014 0.752 83.85 43 3.00e-001 2.76e+000

SpectraView Block Data



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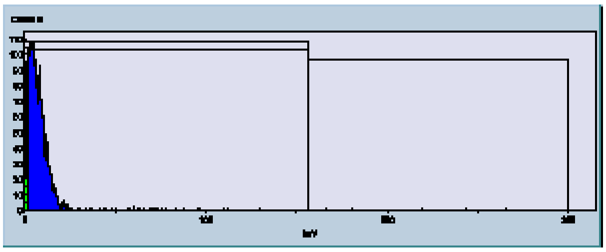
7 160-5291-A-1-B MS 20.00 1.14e+002 1.50e+002 8:15:29 PM
2/10/2014 0.758 88.31 2 3.06e-001 1.01e+002

SpectraView Block Data



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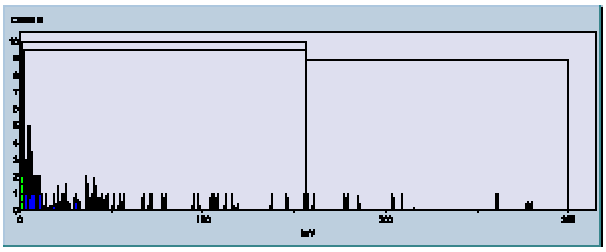
8 160-5291-A-2-A 20.00 4.94e+000 6.39e+000 8:39:27 PM
2/10/2014 0.774 99.53 27 5.00e-001 3.84e+000

SpectraView Block Data



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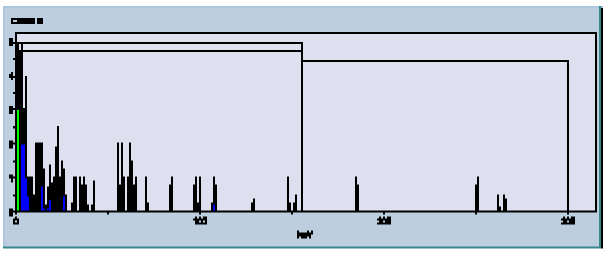
9 160-5291-A-3-A 20.00 4.59e+000 6.05e+000 9:03:25 PM
2/10/2014 0.758 88.60 34 1.50e-001 3.84e+000

SpectraView Block Data



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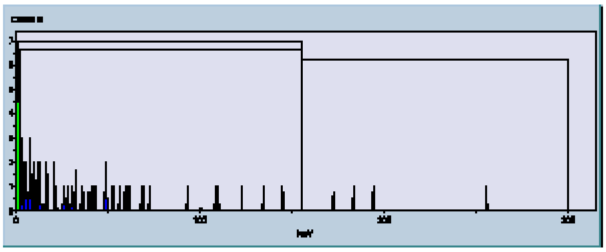
10 160-5291-A-4-A 20.00 4.17e+000 5.44e+000 9:27:23 PM
2/10/2014 0.766 94.08 32 1.88e-001 3.12e+000

SpectraView Block Data



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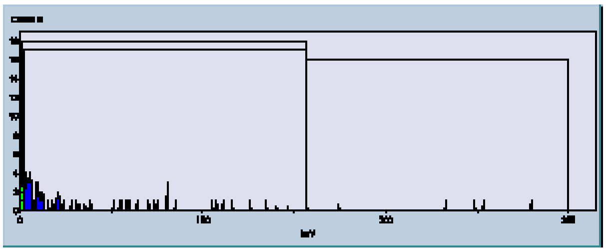
11 160-5291-A-5-A 20.00 5.89e+000 7.86e+000 9:51:20 PM
2/10/2014 0.749 82.04 35 2.87e-001 4.04e+000

SpectraView Block Data



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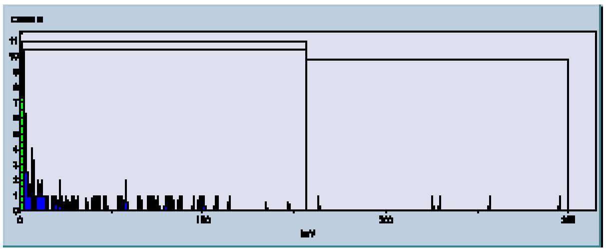
12 160-5291-A-6-A 20.00 6.19e+000 8.16e+000 10:15:18 PM
2/10/2014 0.759 89.12 31 2.50e-001 4.74e+000

SpectraView Block Data



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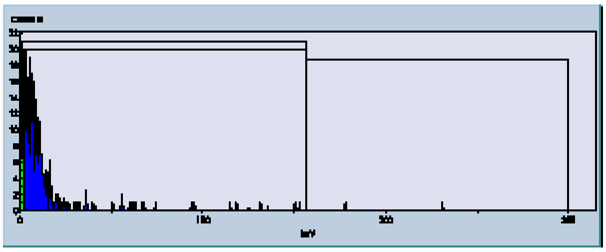
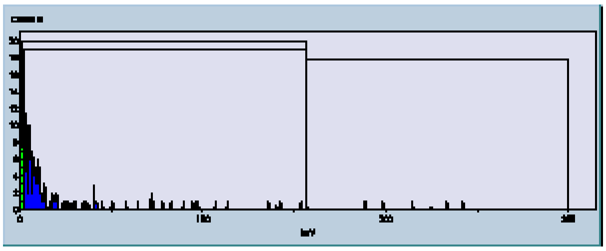
13 160-5291-A-7-A 20.00 1.83e+001 2.43e+001 10:39:27 PM
2/10/2014 0.751 83.15 10 1.00e-001 1.61e+001

SpectraView Block Data



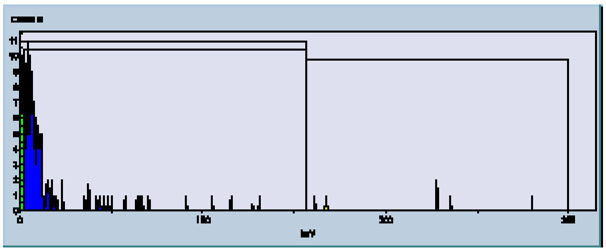
14		160-5291-A-8-A		20.00	1.04e+001	1.40e+001	11:03:31 PM
2/10/2014	0.742	77.58	15	3.56e-001		8.28e+000	

SpectraView Block Data



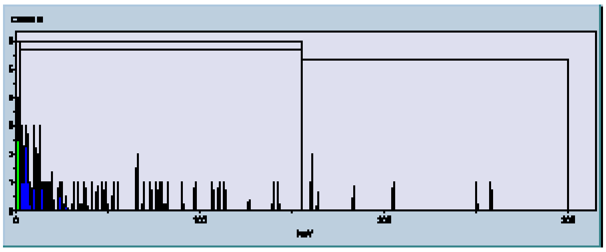
15		160-5291-A-9-A		20.00	9.62e+000	1.28e+001	11:27:27 PM
2/10/2014	0.749	82.43	16	3.31e-001		8.22e+000	

SpectraView Block Data



16		160-5291-A-10-A		20.00	4.42e+000	5.79e+000	11:51:25 PM
2/10/2014	0.764	92.14	27	3.25e-001		3.72e+000	

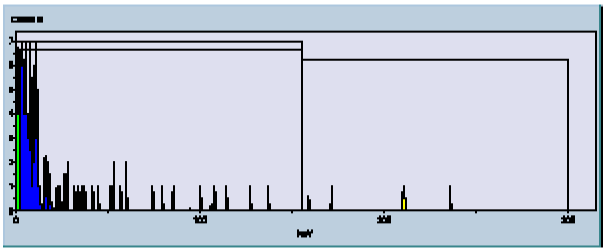
SpectraView Block Data



17		160-5356-C-1-A		20.00	7.98e+000	1.05e+001	12:15:18 AM

2/11/2014	0.761	90.65	17	2.31e-001	7.13e+000

SpectraView Block Data



LIQUID SCINTILLATION COUNTER BATCH WORKSHEET

Lab Name: TestAmerica St. Louis Job No.: 160-5291-1

SDG No.:

Batch Number: 103612 Batch Start Date: 02/07/14 06:37 Batch Analyst: Mewes, Leah E

Batch Method: LSC_Dist_Susp Batch End Date: 02/07/14 15:02

Lab Sample ID	Client Sample ID	Method Chain	Basis	InitialAmount	C-14 00008				
MB 160-103612/1		LSC_Dist_Susp, C-01-1		1.0 g					
LCS 160-103612/2		LSC_Dist_Susp, C-01-1		1.0 g	1 mL				
160-5337-A-1 DU		LSC_Dist_Susp, C-01-1	T	1.01 g					
160-5291-A-1	KCMSS-BKG-1	LSC_Dist_Susp, C-01-1	T	1.00 g					
160-5291-A-1 MS	KCMSS-BKG-1	LSC_Dist_Susp, C-01-1	T	1.02 g	1 mL				
160-5291-A-2	KCMSS-BKG-2	LSC_Dist_Susp, C-01-1	T	1.00 g					
160-5291-A-3	KCMSS-5	LSC_Dist_Susp, C-01-1	T	1.01 g					
160-5291-A-4	KCMSS-4	LSC_Dist_Susp, C-01-1	T	1.01 g					
160-5291-A-5	KCMSS-1	LSC_Dist_Susp, C-01-1	T	1.01 g					
160-5291-A-6	KCMSS-2	LSC_Dist_Susp, C-01-1	T	1.01 g					
160-5291-A-7	KCMSS-6	LSC_Dist_Susp, C-01-1	T	1.00 g					
160-5291-A-8	KCMSS-7	LSC_Dist_Susp, C-01-1	T	0.99 g					
160-5291-A-9	KCMSS-8	LSC_Dist_Susp, C-01-1	T	1.00 g					
160-5291-A-10	KCMSS-3	LSC_Dist_Susp, C-01-1	T	1.01 g					

Batch Notes	
Balance ID	1122021820
Person's name who witnessed reagent drop	RS
Analyst who added reagent	LM
SOP Number	ST-RC-0057

Basis	Basis Description
T	Total/NA

The pound sign (#) in the amount added field denotes that the reagent was used undiluted. All calculations are performed using the stated concentration for this reagent.

Daily Checks

SNC Protocol

Calibration Information
Software Version IC: 3.02
Software Version EC: 4.00
Instrument Model: Tri-Carb 3180TR/SL
Instrument Serial Number: 117382
3H Chi Square: 16.26 Date Processed: 2/12/2014 9:22:22 PM
14C Chi Square: 13.32 Date Processed: 2/12/2014 9:22:22 PM
3H E^2/B (1-18.6 keV): 1504.52 Date Processed: 2/12/2014 9:22:22 PM
14C E^2/B (4-156 keV): 8146.35 Date Processed: 2/12/2014 9:22:22 PM
3H Efficiency (1-18.6 keV): 61.69 Date Processed: 2/12/2014 9:22:22 PM
14C Efficiency (4-156 keV): 93.31 Date Processed: 2/12/2014 9:22:22 PM
IPA Background Date Processed: 2/12/2014 9:22:22 PM
3H Background CPM (1-18.6 keV): 2.53 Date Processed: 2/12/2014 9:22:22 PM
14C Background CPM (4-156 keV): 1.07 Date Processed: 2/12/2014 9:22:22 PM
3H Calibration DPM: 264200
3H Reference Date: 12/18/2010
14C Calibration DPM: 132400

SNC Protocol

Calibration Information
Software Version IC: 3.02
Software Version EC: 4.00
Instrument Model: Tri-Carb 3180TR/SL
Instrument Serial Number: 117384
3H Chi Square: 15.48   Date Processed: 2/10/2014 4:08:45 PM
14C Chi Square: 19.60   Date Processed: 2/10/2014 4:08:45 PM
3H E^2/B (1-18.6 keV): 2815.75 Date Processed: 2/10/2014 4:08:45 PM
14C E^2/B (4-156 keV): 13387.43   Date Processed: 2/10/2014 4:08:45 PM
3H Efficiency (1-18.6 keV): 60.16 Date Processed: 2/10/2014 4:08:45 PM
14C Efficiency (4-156 keV): 92.98 Date Processed: 2/10/2014 4:08:45 PM
IPA Background Date Processed: 2/10/2014 4:08:45 PM
3H Background CPM (1-18.6 keV): 1.29 Date Processed: 2/10/2014 4:08:45 PM
14C Background CPM (4-156 keV): 0.65 Date Processed: 2/10/2014 4:08:45 PM
3H Calibration DPM: 264200
3H Reference Date: 12/18/2010
14C Calibration DPM: 132400

Initial Calibrations

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Carbon-14 Quench Curve
2013
LSC Teal

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

C-14 Quench Curve

STD used: Rad11-0038 / 6460
Activity: 23557dpm/mL
Amount used: 0.1mL
Reference date: 3/21/2011

STD #	mL CarbosorbE	mL Permafluor E	uL Nitromethane
1	7.9	12	0
2	8.9	11	0
3	9.9	10	0
4	9.9	10	10
5	9.9	10	20
6	9.9	10	30
7	9.9	10	40
8	9.9	10	50
9	9.9	10	60

Prepared by: Micha Korrinhizer
Date: 8/6/2013

Carbon 14						
Initial Activity:	23557	dpm				
Reference Date:	3/21/2011					
Current Date:	8/7/2013		(or date at which you wish to determine activity)			
Elapsed Time:	870	days				
Half Life:	2092882.5	days				
Exponential Term:	0.999711904					
Corrected Activity:	23550.21332	dpm	10608.2042	pCi		

Carbon-14 quench curve validation 2013, LSC Teal

STD #	source activity, dpm	cpm	count time	total counts	Calculated efficiency	TSIE	quench curve efficiency	curve projected efficiency	decimal discrepancy
1	2355	1900	9.37	17803.00	0.8068	181.24	0.8068	0.8010	-0.0058
2	2355	1900	9.37	17803.00	0.8068	161.89	0.8067	0.8142	0.0075
3	2355	1891	9.41	17794.31	0.8030	121.66	0.8029	0.8041	0.0012
4	2355	1798	9.89	17782.22	0.7635	93.01	0.7635	0.7660	0.0025
5	2355	1738	10.23	17779.74	0.7380	74.97	0.7381	0.7288	-0.0093
6	2355	1680	10.59	17791.20	0.7134	70.08	0.7132	0.7170	0.0038
7	2355	1609	11.06	17795.54	0.6832	55.47	0.6832	0.6772	-0.0060
8	2355	1542	11.54	17794.68	0.6548	46.44	0.6547	0.6493	-0.0054
9	2355	1466	12.13	17782.58	0.6225	41.89	0.6227	0.6342	0.0115

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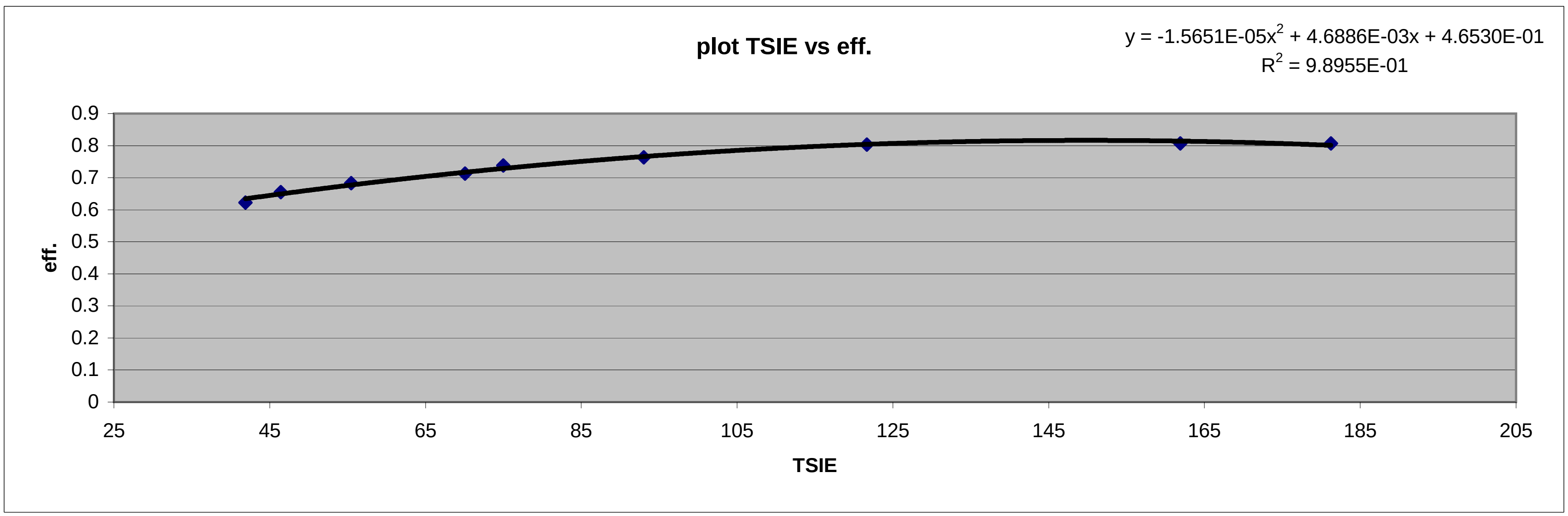


C14_2013 Quench Curve

Assay Definition

Assay Description:

Assay Type: Quench Standards
Report Name: Report1
Output Data Path: \Slsvr01\RAD\Upload\PACK_LSC_Teal
Raw Results Path: C:\Packard\Tricarb\Results\Default\C14_2013 Quench Curve\20130807_1543\20130807_1543.results
Assay File Name: C:\Packard\TriCarb\Assays\C14_2013 Quench Curve.lsa

Count Conditions

Nuclide: C14_2013
   Quench Indicator: tSIE/AEC
   External Std Terminator (sec): 15 sec
   Pre-Count Delay (min): 0.00
Quench Set: n/a
Count Time (min): 30.00
Count Mode: Low Level
Assay Count Cycles: 1   Repeat Sample Count: n/a
#Vials/Sample: n/a   Calculate % Reference: n/a

Background Subtract

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

Regions	LL	UL	2Sigma % Terminator
A	0.0	156.0	1.50

Count Corrections

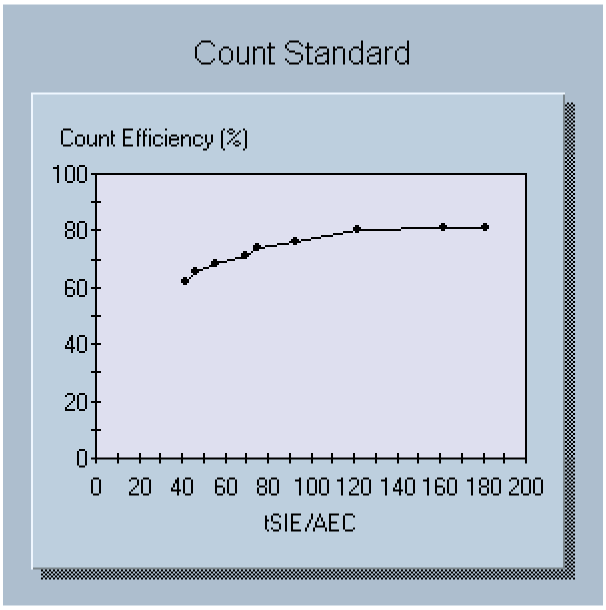
Static Controller: On   Luminescence Correction: n/a
Colored Samples: On   Heterogeneity Monitor: n/a
Coincidence Time (nsec): 18   Delay Before Burst (nsec): 75

Cycle 1 Results

S#	Count Time	CPMA	SIS	tSIE	MESSAGES
1	9.37	1900	44.15	181.24	S
2	9.37	1900	37.35	161.89	S
3	9.41	1891	33.35	121.66	S
4	9.89	1798	26.95	93.01	S
5	10.23	1738	22.94	74.97	S
6	10.59	1680	19.92	70.08	S
7	11.06	1609	18.10	55.47	S
8	11.54	1542	16.78	46.44	S
9	12.13	1466	15.24	41.89	S

Quench Curve Block Data

C14_2013 Quench Curve



Date Acquired: 8/7/2013
Date Modified:
Count Standard

tSIE/AEC	Count Efficiency (%)
181.24	80.68
161.89	80.67
121.66	80.29
93.01	76.35
74.97	73.81
70.08	71.32
55.47	68.32
46.44	65.47
41.89	62.27

THE LEADER IN ENVIRONMENTAL TESTING

Tritium Quench Curve
2013
LSC Brown

H3 Quench Curve

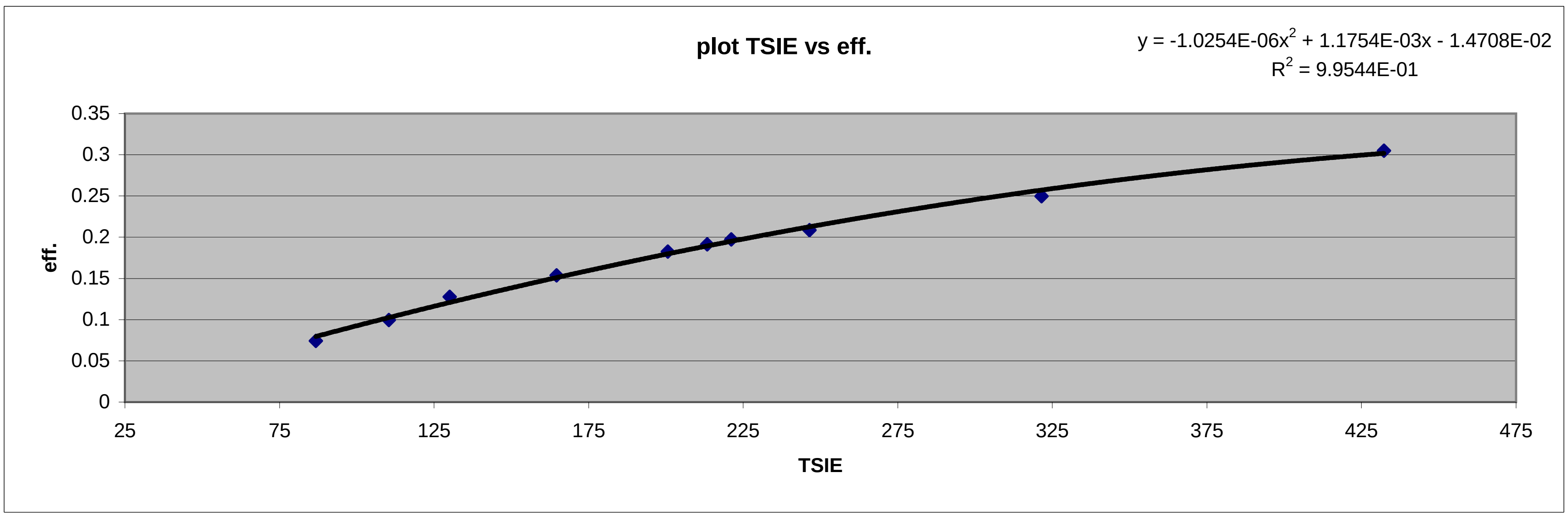
STD used: 6349
Activity: 1,873,787dpm/mL
Reference date: 09/03/1998

STD #	mL H20	mL Rad04-0016	mL UGLLT	uL Nitromethane
1	4.9	0.1	15	0
2	7.9	0.1	12	0
3	9.9	0.1	10	0
4	9.9	0.1	10	5
5	9.9	0.1	10	10
6	9.9	0.1	10	15
7	9.9	0.1	10	25
8	9.9	0.1	10	50
9	9.9	0.1	10	75
10	9.9	0.1	10	100

Prepared by: Micha Korrinhizer
Date: 03/07/2013

ritium quench curve validation 2013, LSC Brown

STD #	source activity, dpm	cpm	count time	total counts	Calculated efficiency	TSIE	quench curve efficiency	curve projected efficiency	decimal discrepancy
1	82065	25034	0.72	18024.48	0.3051	432.28	0.305	0.3018	-0.0032
2	82065	20485	0.88	18026.80	0.2496	321.5	0.2496	0.2572	0.0076
3	82065	17116	1.05	17971.80	0.2086	246.44	0.2086	0.2127	0.0041
4	82065	16204	1.11	17986.44	0.1975	221.17	0.1975	0.1951	-0.0024
5	82065	15710	1.14	17909.40	0.1914	213.39	0.1914	0.1894	-0.0020
6	82065	14973	1.2	17967.60	0.1825	200.66	0.1825	0.1799	-0.0026
7	82065	12603	1.42	17896.26	0.1536	164.59	0.1536	0.1510	-0.0026
8	82065	10485	1.7	17824.50	0.1278	130.02	0.1278	0.1208	-0.0070
9	82065	8183	2.18	17838.94	0.0997	110.36	0.0997	0.1025	0.0028
10	82065	6078	2.94	17869.32	0.0741	86.74	0.0741	0.0795	0.0054



H3_2013 Quench Curve

Assay Definition

Assay Description:

Assay Type: Quench Standards
Report Name: Report1
Output Data Path: C:\Packard\Tricarb\Results\
Raw Results Path: C:\Packard\Tricarb\Results\Default\H3_2013 Quench Curve\20130507_1452
\20130507_1452.results
Assay File Name: C:\Packard\TriCarb\Assays\H3_2013 Quench Curve.lsa

Count Conditions

Nuclide: H3_2013
 Quench Indicator: tSIE/AEC
 External Std Terminator (sec): 15 sec
 Pre-Count Delay (min): 0.00
Quench Set: n/a
Count Time (min): 30.00
Count Mode: Low Level
Assay Count Cycles: 1 Repeat Sample Count: n/a
#Vials/Sample: n/a Calculate % Reference: n/a

Background Subtract

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

Regions	LL	UL	2Sigma % Terminator
A	0.0	18.6	1.50

Count Corrections

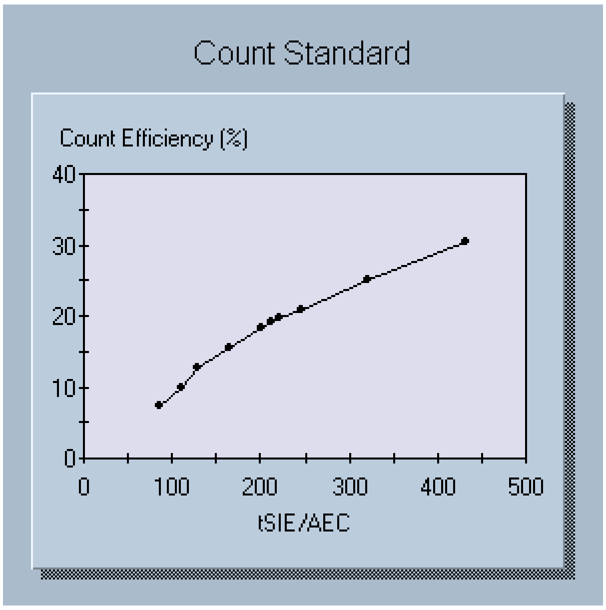
Static Controller: On Luminescence Correction: n/a
Colored Samples: On Heterogeneity Monitor: n/a
Coincidence Time (nsec): 18 Delay Before Burst (nsec): 75

Cycle 1 Results

S#	Count Time	CPMA	SIS	tSIE	MESSAGES
1	0.72	25034	10.29	432.28	S
2	0.88	20485	9.44	321.50	S
3	1.05	17116	8.59	246.44	S
4	1.11	16204	8.47	221.17	S
5	1.14	15710	8.29	213.39	S
6	1.20	14973	8.23	200.66	S
7	1.42	12603	8.08	164.59	S
8	1.70	10485	7.30	130.02	S
9	2.18	8183	6.52	110.36	S
10	2.94	6078	6.17	86.74	S

Quench Curve Block Data

H3_2013 Quench Curve



Date Acquired: 5/8/2013
Date Modified:
Count Standard

tSIE/AEC	Count Efficiency (%)
432.28	30.50
321.50	24.96
246.44	20.86
221.17	19.75
213.39	19.14
200.66	18.25
164.59	15.36
130.02	12.78
110.36	9.97
86.74	7.41

Initial Calibration Verifications

THE LEADER IN ENVIRONMENTAL TESTING

Carbon-14 Quench Curve Verification
2013
LSC Teal

C-14 Quench Curve Verification:

STD used: Rad11-0124 / 6459
Activity: 187.53dpm/mL
Amount used: 1mL
Reference date: 03/21/2011

STD #	Carbosorb E mL	Permafluor E mL	STD mL	Nitromethane uL
1	8	11	1	0
2	9	10	1	0
3	9	10	1	20

Prepared by: Micha Korrinhizer
Date: 8/9/2013

C14 Quench Curve 2013, LSC Teal
Second Source Verification
Rad11-0124 / 6459
Activity: 187.53 dpm/mL
Reference date: 3/21/2011

Carbon 14

Initial Activity:	187.53 dpm		
Reference Date:	3/21/2011		
Current Date:	8/13/2013	(or date at which you wish to determine activity)	
Elapsed Time:	876 days		
Half Life:	2092883 days		
Exponential Term:	0.99971		
Corrected Activity:	187.4756 dpm	84.44846883 pCi	

Std #	DPM Measured	BKG	Corrected I	True Value	% Recovery
STD 1	199	11.2	187.8	187.4756	100.17%
STD 2	199	11.2	187.8	187.4756	100.17%
STD 3	195	11.2	183.8	187.4756	98.04%
				Mean =	99.46%

Assay Definition

Assay Description:

Assay Type: DPM (Single)
Report Name: C14_Protocol 22
Output Data Path: \Slsvr01\RAD\Upload\PACK_LSC_Teal
Raw Results Path: C:\Packard\Tricarb\Results\Default\C14_2013 Protocol 22\20130813_1125\20130813_1125.results
Assay File Name: C:\Packard\TriCarb\Assays\C14_2013 Protocol 22.lsa

Additional Data Files Generated with this Protocol:
22C14
[Auto] 22C14.001

Count Conditions

Nuclide: C14_2013
Quench Indicator: tSIE
External Std Terminator (sec): 15 sec
Pre-Count Delay (min): 0.00
Quench Set:
Low Energy: C14_2013
Count Time (min): 30.00
Count Mode: Low Level
Assay Count Cycles: 1 Repeat Sample Count: 1
#Vials/Sample: 1 Calculate % Reference: Off

Background Subtract

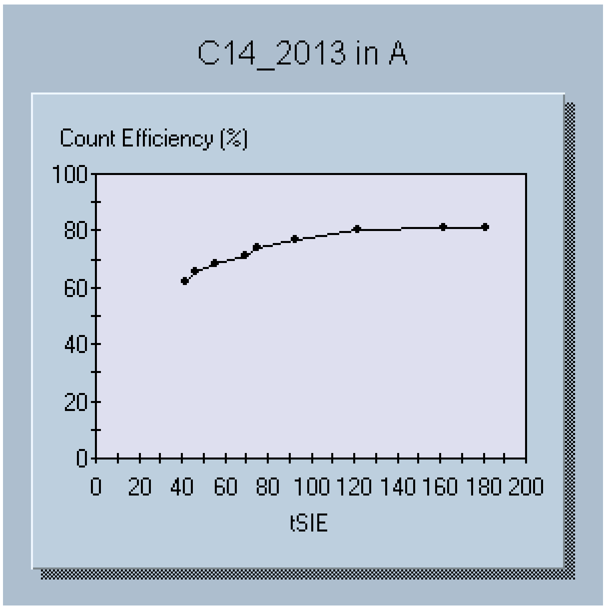
Background Subtract: Off
Low CPM Threshold: Off
2 Sigma % Terminator: On - Any Region

Regions	LL	UL	2Sigma % Terminator
A	0.0	156.0	1.50
B	2.0	156.0	0.00
C	156.1	300.0	0.00

Count Corrections

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

Cycle 1 Results
Quench Curve Block Data

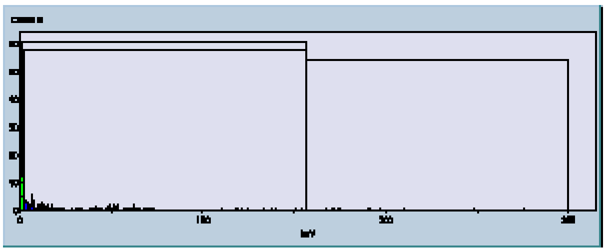


Date Acquired: 08/07/2013
Date Modified:
C14_2013 in A

tSIE	Count Efficiency (%)
181.24	80.94
161.89	80.76
121.66	80.42
93.01	76.48
74.97	73.87
70.08	71.40
55.47	68.38
46.44	65.51
41.89	62.31

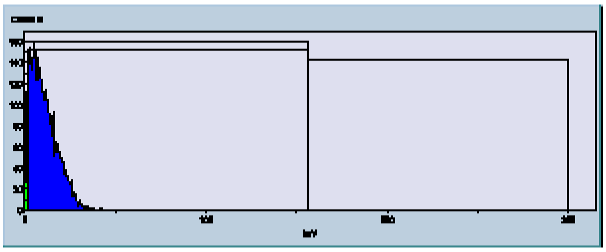
S# / DATE	EFF	tSIE	SMPL_ID / LUM	Count Time / CPMC	MESSAGES	CPMA	DPM1 / CPMB	TIME
1			BKG	30.00		8.35e+000	1.12e+001	11:27:06 AM
8/13/2013	0.747	81.05	64	2.79e-001			3.51e+000	

SpectraView Block Data



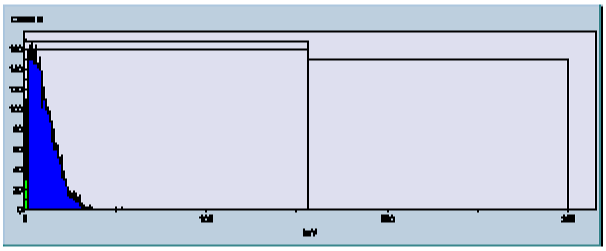
S# / DATE	EFF	tSIE	SMPL_ID / LUM	Count Time / CPMC	MESSAGES	CPMA	DPM1 / CPMB	TIME
2			Ver 1	30.00		1.61e+002	1.99e+002	12:02:08 PM
8/13/2013	0.807	160.39	1	3.81e-001			1.51e+002	

SpectraView Block Data



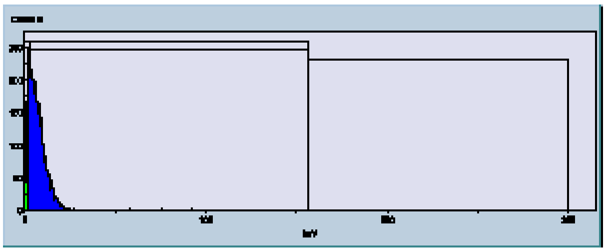
3			Ver 2	30.00	1.61e+002	1.99e+002	12:37:05 PM
8/13/2013	0.806	141.72	1	2.96e-001		1.51e+002	

SpectraView Block Data



4			Ver 3	30.00	1.47e+002	1.95e+002	1:12:02 PM
8/13/2013	0.752	84.13	1	3.42e-001		1.32e+002	

SpectraView Block Data



THE LEADER IN ENVIRONMENTAL TESTING

Tritium Quench Curve Verification
2013
LSC Brown

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

H-3 Quench Curve Verification

Std #: 6474
Activity: 2231.1 dpm/mL
Reference Date: 4/15/2008

Vial #	mL H2O	STD mL	mL UGLLT	uL Nitromethane
1	9	1	10	0
2	9	1	10	25
3	9	1	10	40

Prepared by: Michaela Korrinhizer
Date: 03/07/2013

H3 Quench Curve 2013, LSC Brown
Second Source Verification
Rad12-0025 / 6474 2231.1 dpm/mL

Tritium

Initial Activity:	2231.1	dpm	
Reference Date:	4/15/2008		
Current Date:	5/8/2013		(or date at which you wish to determine activity)
Elapsed Time:	1849	days	
Half Life:	4500	days	108000
Exponential Term:	0.75216		
Corrected Activity:	1678.144	dpm	

Std #	DPM Measured	BKG	Corrected I	True Value	% Recovery
STD 1	1840	6.2	1833.8	1678.144	109.28%
STD 2	1860	6.2	1853.8	1678.144	110.47%
STD 3	1810	6.2	1803.8	1678.144	107.49%
				Mean =	109.08%

Assay Definition

Assay Description:

Assay Type: DPM (Single)
Report Name: H3_Protocol 2
Output Data Path: \Slsvr01\RAD\Upload\PACK_LSC_Brown
Raw Results Path: C:\Packard\Tricarb\Results\Default\H3_2013 Protocol 2\20130508_1157\20130508_1157.results
Assay File Name: C:\Packard\TriCarb\Assays\H3_2013 Protocol 2.lsa

Additional Data Files Generated with this Protocol:
2H3
[Auto] 2H3.001

Count Conditions

Nuclide: H3_2013
Quench Indicator: tSIE
External Std Terminator (sec): 15 sec
Pre-Count Delay (min): 0.00
Quench Set:
Low Energy: H3_2013
Count Time (min): 20.00
Count Mode: Low Level
Assay Count Cycles: 1 Repeat Sample Count: 1
#Vials/Sample: 1 Calculate % Reference: Off

Background Subtract

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

Regions	LL	UL	2Sigma % Terminator
A	0.0	18.6	1.50
B	2.0	18.6	0.00
C	18.7	2000.0	0.00

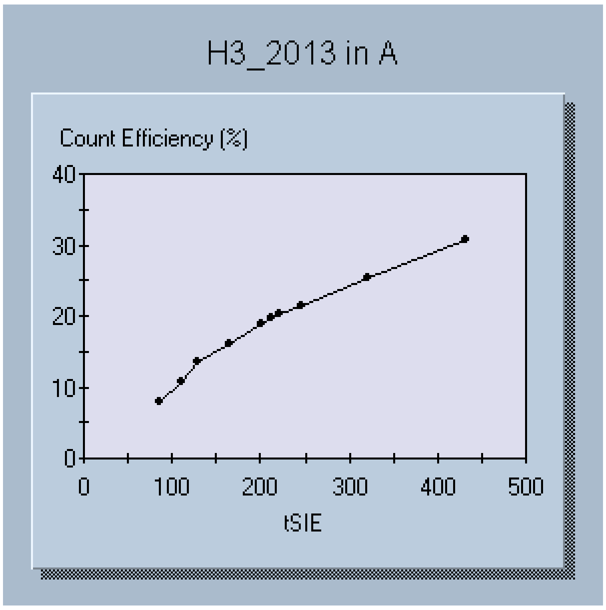
Count Corrections

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

Cycle 1 Results

Quench Curve Block Data

H3_2013 Protocol 2

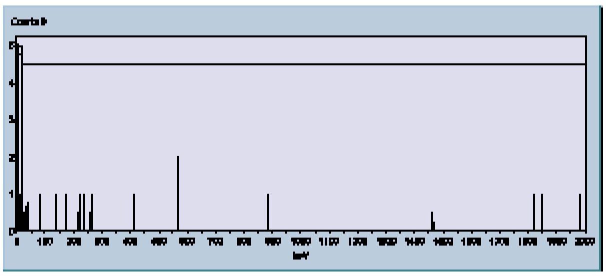


Date Acquired: 05/07/2013
Date Modified:
H3_2013 in A

tSIE	Count Efficiency (%)
432.28	30.67
321.50	25.32
246.44	21.41
221.17	20.32
213.39	19.82
200.66	18.87
164.59	16.05
130.02	13.62
110.36	10.62
86.74	8.02

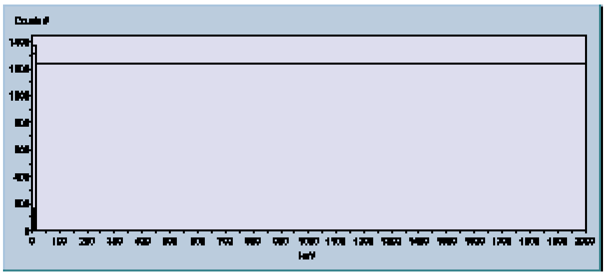
S#	Count Time	CPMA	CPMB	DPM1	tSIE	MESSAGES	EFF
CPMC	**LUM**	**DATE**	**TIME**	**SMPL_ID**			
1	20.00	1.33e+000	1.13e+000	6.20e+000	247.73		0.215
8.75e-001	93	5/8/2013	11:59:01 AM		BKG		

SpectraView Block Data



2	20.00	4.01e+002	2.64e+002	1.84e+003	253.73		0.218
9.56e-001	1	5/8/2013	12:22:54 PM	Ver 1			

SpectraView Block Data



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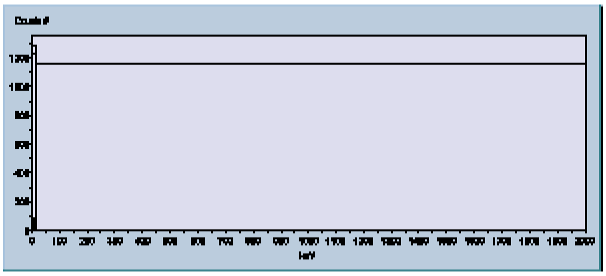
3 20.00 3.08e+002 1.74e+002 1.86e+003 170.78 0.165
1.45e+000 1 5/8/2013 12:46:47 PM Ver 2

SpectraView Block Data



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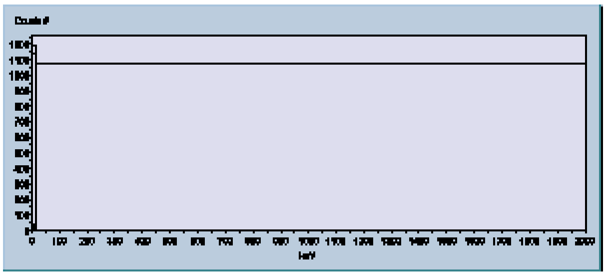
4 20.00 2.67e+002 1.41e+002 1.81e+003 146.45 0.148
1.07e+000 1 5/8/2013 1:10:39 PM Ver 3

SpectraView Block Data



Run Logs

Liquid Scintillation Counter Run Log

Detector: LSCBrown **Serial Number: 117382**

Analysis Date	Count Minutes	Lab Sample ID	Client Sample ID	Analysis Batch	Prep Batch	Method	Analyst Initials
05/07/13 14:52		IC 160-51140/1		51140			MLK
05/08/13 11:57		ICV 160-51140/2		51140			MLK
02/12/14 21:22		CCV 160-105112/1		105112			MLK
02/12/14 21:24		BBKG 160-105097/1		105097			
02/12/14 21:59	30	MB 160-104205/1-A		105097	104205	906.0	MLK
02/12/14 22:34	30	LCS 160-104205/2-A		105097	104205	906.0	MLK
02/12/14 23:09	30	160-5291-1	KCMSS-BKG-1	105097	104205	906.0	MLK
02/12/14 23:44	30	160-5291-1 DU	KCMSS-BKG-1 DU	105097	104205	906.0	MLK
02/13/14 00:19	30	160-5291-2	KCMSS-BKG-2	105097	104205	906.0	MLK
02/13/14 00:54	30	160-5291-2 MS	KCMSS-BKG-2 MS	105097	104205	906.0	MLK
02/13/14 01:29	30	160-5291-3	KCMSS-5	105097	104205	906.0	MLK
02/13/14 02:04	30	160-5291-4	KCMSS-4	105097	104205	906.0	MLK
02/13/14 02:39	30	160-5291-5	KCMSS-1	105097	104205	906.0	MLK
02/13/14 03:14	30	160-5291-6	KCMSS-2	105097	104205	906.0	MLK
02/13/14 03:48	30	160-5291-7	KCMSS-6	105097	104205	906.0	MLK
02/13/14 04:24	30	160-5291-8	KCMSS-7	105097	104205	906.0	MLK
02/13/14 04:59	30	160-5291-9	KCMSS-8	105097	104205	906.0	MLK
02/13/14 05:33	30	160-5291-10	KCMSS-3	105097	104205	906.0	MLK

Detector: LSCTeal **Serial Number: 117384**

Analysis Date	Count Minutes	Lab Sample ID	Client Sample ID	Analysis Batch	Prep Batch	Method	Analyst Initials
08/07/13 15:43		IC 160-66918/1		66918			MLK
08/13/13 11:25		ICV 160-66918/2		66918			MLK
02/10/14 16:09		CCV 160-104241/1		104241			MLK
02/10/14 17:51		BBKG 160-104204/1		104204			
02/10/14 18:15	20	MB 160-103612/1-A		104204	103612	C-01-1	MLK
02/10/14 18:39	20	LCS 160-103612/2-A		104204	103612	C-01-1	MLK
02/10/14 19:03	20	ZZZZZ		104204			
02/10/14 19:27	20	160-5337-A-1-G DU		104204	103612	C-01-1	MLK
02/10/14 19:51	20	160-5291-1	KCMSS-BKG-1	104204	103612	C-01-1	MLK
02/10/14 20:15	20	160-5291-1 MS	KCMSS-BKG-1 MS	104204	103612	C-01-1	MLK
02/10/14 20:39	20	160-5291-2	KCMSS-BKG-2	104204	103612	C-01-1	MLK
02/10/14 21:03	20	160-5291-3	KCMSS-5	104204	103612	C-01-1	MLK
02/10/14 21:27	20	160-5291-4	KCMSS-4	104204	103612	C-01-1	MLK
02/10/14 21:51	20	160-5291-5	KCMSS-1	104204	103612	C-01-1	MLK
02/10/14 22:15	20	160-5291-6	KCMSS-2	104204	103612	C-01-1	MLK
02/10/14 22:39	20	160-5291-7	KCMSS-6	104204	103612	C-01-1	MLK
02/10/14 23:03	20	160-5291-8	KCMSS-7	104204	103612	C-01-1	MLK
02/10/14 23:27	20	160-5291-9	KCMSS-8	104204	103612	C-01-1	MLK
02/10/14 23:51	20	160-5291-10	KCMSS-3	104204	103612	C-01-1	MLK
02/11/14 00:15	20	ZZZZZ		104204			

Shipping and Receiving Documents

TestAmerica St. Louis
13715 Rider Trail North

Earth City, MO 63045
phone 314.298.8566 fax

Chain of Custody Record

ok 271

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

5291

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☑ Other: USNRC

TestAmerica Laboratories, Inc.

Client Contact	Project Manager: Clint Gregg	Site Contact: Clint Gregg	Date: 01/22/14	COC No: 20140122
Aptuit, Kansas City	Tel/Fax: (816) 769-4382	Lab Contact: Mike Franks	Carrier: Fed Ex	1 of 1 COCs
1701 Vine	Analysis Turnaround Time			Sampler: Shane Brungardt
Harrisonville / MO / 64701	☐ CALENDAR DAYS ☑ WORKING DAYS			For Lab Use Only:
(816) 769-4382 Phone	TAT if different from Below ____			Walk-in Client:
(xxx) xxx-xxxx FAX	☑ 2 weeks			Lab Sampling:
Project Name: Aptuit, KCM	☐ 1 week			
Site: Aptuit, KCM	☐ 2 days			Job / SDG No.:
P O # : EDPUS-41341	☐ 1 day			

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y/N)	Perform MS / MSD (Y/N)	H3 DOE H3-04-RC MOD	C14 ERF C-01-1	Sample Specific Notes:
KCMSS-BKG-1	1/22/2013	1005	C	Soil	1	N		X	X	
KCMSS-BKG-2	1/22/2013	1015	C	Soil	1	N				
KCMSS-5	1/22/2013	1025	C	Soil	1	N				
KCMSS-4	1/22/2013	1050	C	Soil	1	N				
KCMSS-1	1/22/2013	1055	C	Soil	1	N				
KCMSS-2	1/22/2013	1105	C	Soil	1	N				
KCMSS-6	1/22/2013	1115	C	Soil	1	N				
KCMSS-7	1/22/2013	1120	C	Soil	1	N				
KCMSS-8	1/22/2013	1130	C	Soil	1	N				
KCMSS-3	1/22/2013	1035	C	Soil	1	N				

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ___None___

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☑ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☑ Disposal by Lab ☐ Archive for ____ Months

Special Instructions/QC Requirements & Comments:
Fed Ex 2 day Tracking # 7976 9873 8880

Custody Seals Intact: ☐ Yes ☐ No	Custody Seal No.:		Cooler Temp. (°C): Obs'd: ____ Corr'd: ____		Therm ID No.: ____
Relinquished by: Clint Gregg	Company: Aptuit	Date/Time: 1/22/14 1506	Received by: Jill Clark	Company: TA STL	Date/Time: 1.24.14 1035
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Form No. CA-C-WI-002, Rev. 4.3, dated 12/05/2013

Login Sample Receipt Checklist

Client: Aptuit, Inc

Job Number: 160-5291-1

Login Number: 5291

List Source: TestAmerica St. Louis

List Number: 1

Creator: Clarke, Jill C

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	False	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	Thermal preservation not required.
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time.	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	