Environmental Health & Safety Policy Manual		
Issue Date: 02/03/2011	Updated: 02/23/2024	Policy # EHS-100.08
Radiation Safety - Liquid Scintillation Counter Use Procedures		

1.0 PURPOSE:

To provide operating instructions for scintillation machine use at LSUHSC to detect the activity of particulate emitting beta *(ß)* radioactive samples and auger electrons emitted from gamma particles. The following common use isotopes with their emission type may be analyzed:

- Beta emission: C-14, H-3 (tritium), P-32, P-33, S-35
- Gamma emission: (auger electrons): Cr-51, Cs-137, I-125

2.0 SCOPE:

The Radiation Safety Officer (RSO) utilizes the scintillation machine for wipe tests taken during quarterly lab inspections and potential release events. Lab employees using H-3 (tritium), C-14 or S-35 use the scintillation machine to analyze after wipe test surveys (see the Appendix for Wipe Test Procedures) post use of applicable radioactive materials.

3.0 EQUIPMENT DESCRIPTION:

Two scintillation systems are used at LSUHSC: 1) Beckman Coulter, Inc. model # LS 6500, and 2) Perkin Elmer Liquid Scintillation Detectors, Tri-Carb LSC 4810TR110 V. All information presented is based on the Perkin Elmer model but may be generically used for other machines. Consult your device's user manual for specific instructions and programing requirements.

2022 Perkin Elmer Liquid Scintillation Detector

3.1 Instrument Specs (Perking Elmer)

Manufacturer:	Perkin Elmer
Model:	Tri-Carb LSC 4810TR110 V
Sample Vial Capability:	336 Standard vials
	648 Miniature vials
Calculation types:	Counts per minute (CPM)
	Disintegrations per minute (DPM)

Scintillation Efficiencies:

Isotope	LSC efficiency
C-14	96 %
H-3	65 %
P-32 & P-33	100 %
S-35	97 %
Cr-51	35 %
Cs-137	100 %
I-125	78 %

Small check source:	Cs-137 @ 30 *u*ci (microcuries)
Printer:	Brothers
CRT:	Color, Black and Off White
Reference samples:	Background Standard (BKG)
	H3 standard and C14 standard
Product Dimensions:	Width: 103 cm
	Height: 47 cm
	Depth: 81 cm
	Weight: 480 lbs
Minimum Power Requirements:	120 V 3.0 A
	240 V 1.5 A

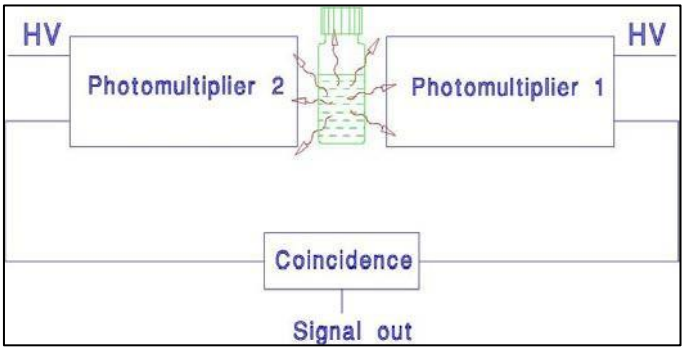
3.2 Scintillation Machine Operation Overview

Liquid scintillation counting (LSC) is the standard laboratory method to quantify the radioactivity of low energy radioisotopes, mostly beta-emitting isotopes. Liquid Scintillation Counters detect and measure radiation by means of tiny visible flashes of light created when radiation emissions from a wipe sample react with a scintillation fluid.

The scintillation fluid, typically made up of aromatic compounds such as toluene or xylene, is mixed with a solvent and a fluor (such as a phosphor or a dye). The wipe sample, which may contain radioactive materials, is then introduced into the scintillation fluid. When radiation interacts with the scintillation fluid, it ionizes the atoms or molecules present. The ionization causes energy to be transferred to the fluor molecules, exciting them to a higher energy state. As the fluor molecules relax back to their ground state, they emit photons of light in the visible spectrum.

These emitted photons of light can be detected by photomultiplier tubes (PMTs) or other light sensors. PMTs are commonly used in liquid scintillation counters due to their high sensitivity and ability to amplify weak signals. The PMTs convert the photons of light into electrical signals, which are then measured and recorded by the counter's electronics.

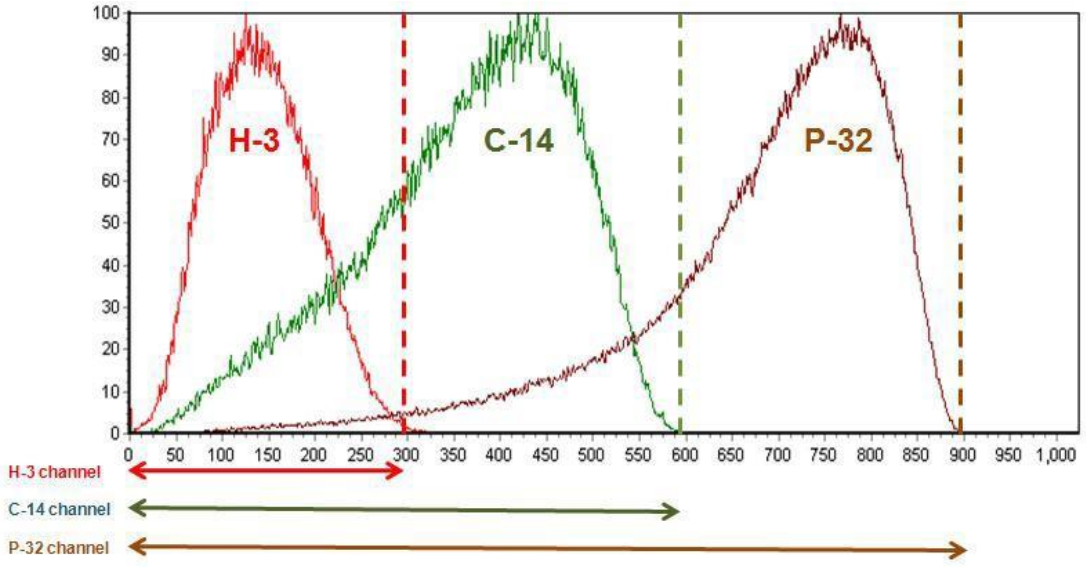
The number and intensity of the light flashes detected by the PMTs are directly proportional to the amount of radiation present in the sample. The counter's electronics analyze the signals from the PMTs to determine the energy and type of radiation emitted by the radioactive material. This information can be used to quantify the radioactive contamination in the sample.



The scintillation counter further classifies each pulse of photons based on the energy of the radiation event. These pulses are then grouped into different channels, each corresponding to a specific range of energies. The instrument records the counts per minute in each channel, excluding counts with energies outside the set limits.

If the scintillation counter is not configured to detect and record the correct

channel, the results obtained will be inaccurate. This means that the measurements may include counts with energies that should be excluded from a particular channel, leading to incorrect data and potentially misleading conclusions. It is therefore important to properly set up the scintillation counter to ensure accurate and reliable results. For example, if the LSC is set to read only the low energy channel of H-3 and your sample includes P-32, detection of P-32 will not be indicated.

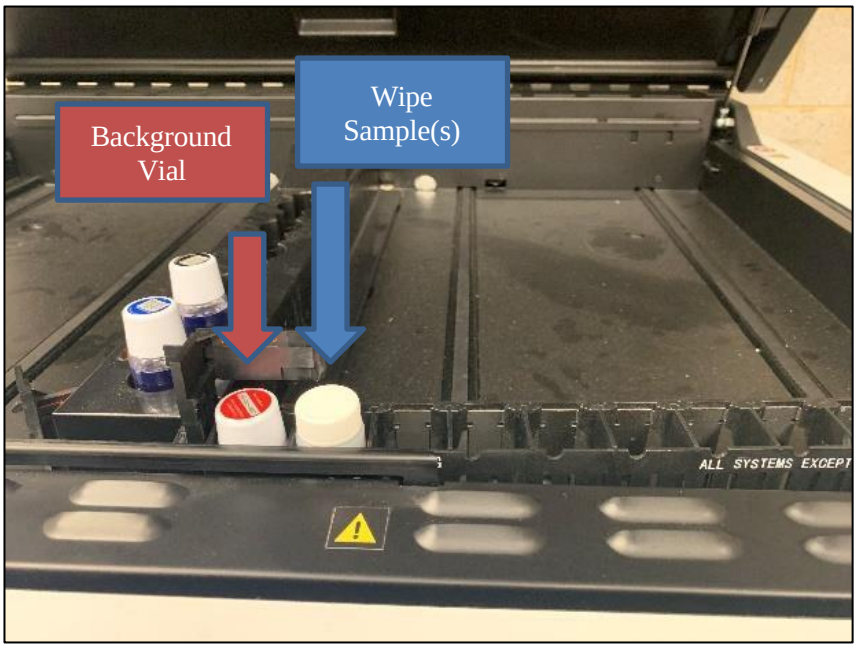


3.3 Operating Instructions (Perkin Elmer)

1. **Prep Samples**: Obtain and prep samples as directed in Appendix A, Radiation Survey Wipe Test Policy and Procedure.

2. **Load Samples into LSC:** Load samples into rack in the following order:

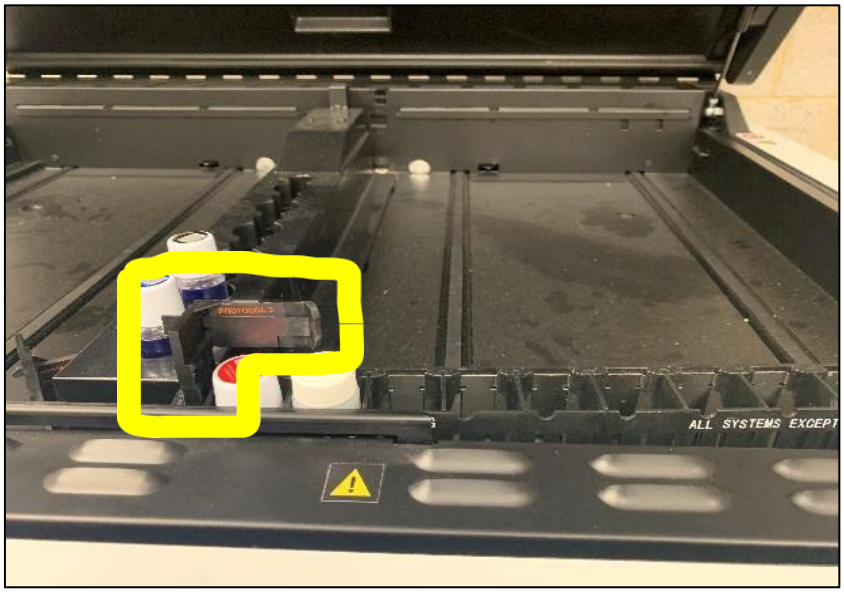
background sample followed by wipe test loaded samples.



3. **Place Isotope Flag Marker on Vial Rack:** Insert the correct isotope identifier flag in the front slot of the rack with the background and sample(s) vials. Each flag is labeled with the isotopes programmed in to the LSC equipment.

Container of isotope identifier flags.

Placement location of isotope identifier flag on sample rack.



4. **Select Isotope within LSC Menu Screen to Begin Analysis:** Once the proper isotope is loaded in the rack with the proper isotope flag selected, highlight the User Program number with corresponding isotope on the LSC computer screen. Close the sample area cover. Click the green flag at the top left-hand corner of the screen to begin analysis.

LSC Programming Screen

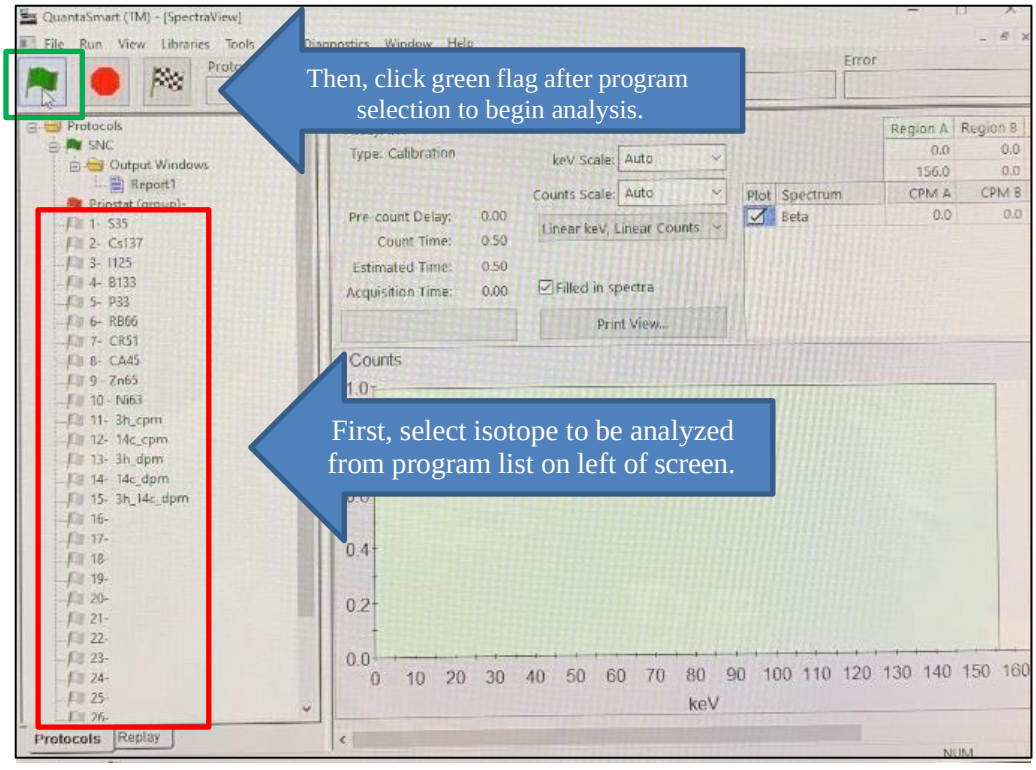
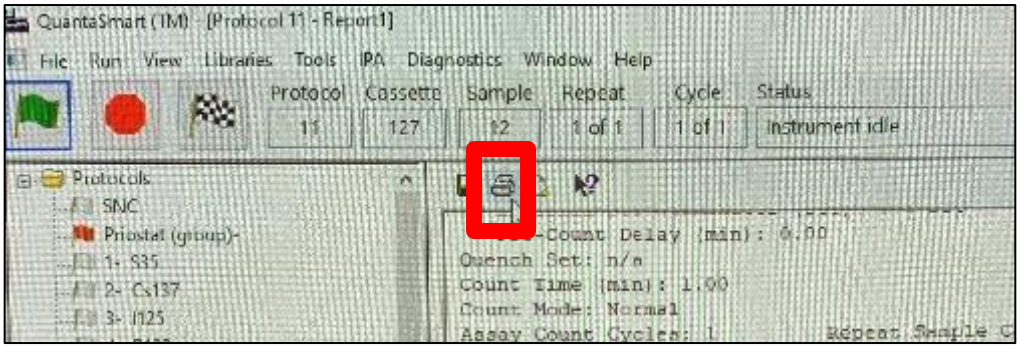


Table: List of LSC Isotope User Program Selections

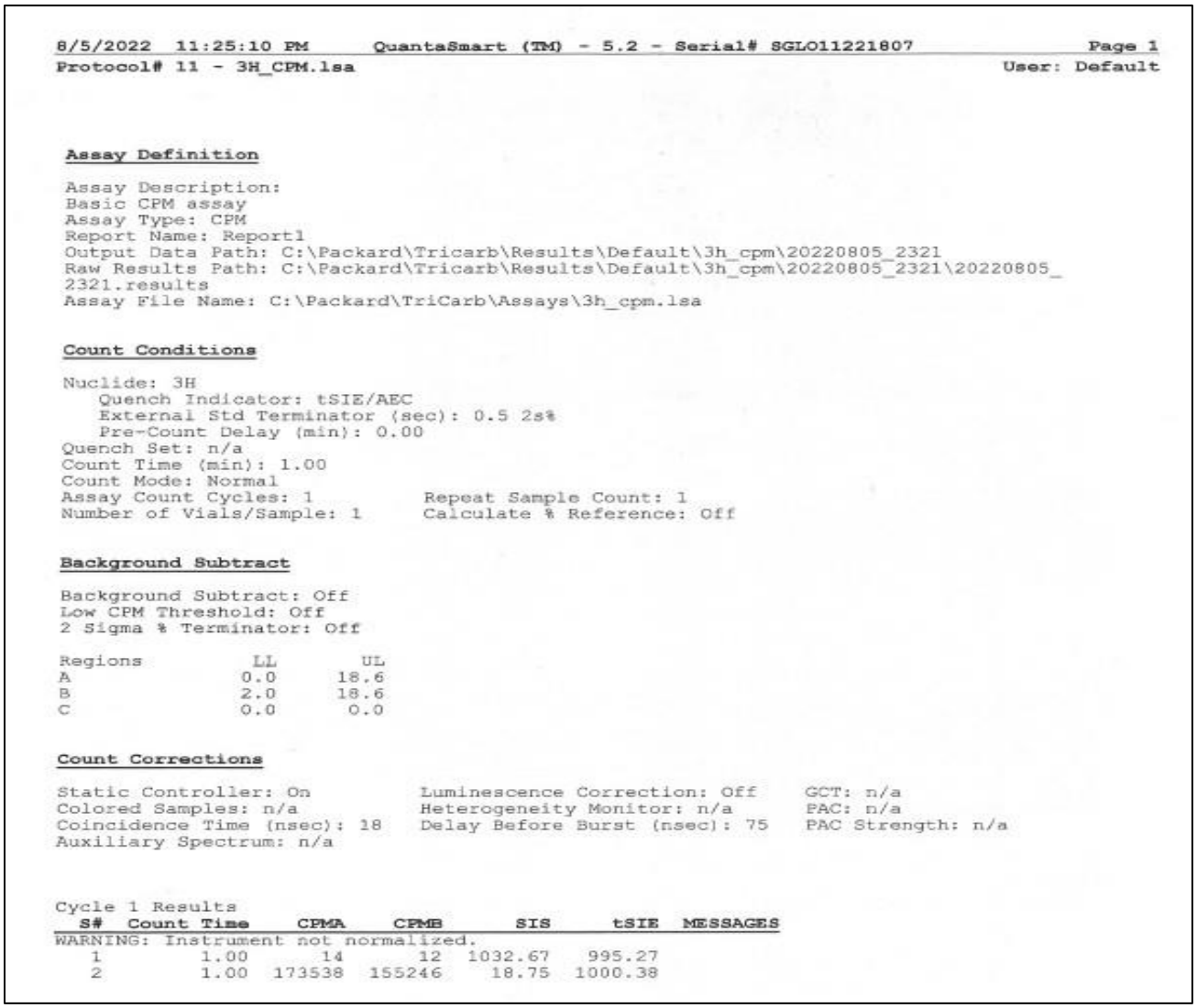
User Program	Isotope	Unit type
1	S-35	CPM (counts per minute)
2	Cs-137	CPM
3	I-125	CPM
4	B-133	CPM
5	P32	CPM
6	Rb-66	CPM
7	Cr-51	CPM
8	Ca-45	CPM
9	Zn-65	CPM
10	Ni-63	CPM
11	H-3	CPM
12	C-14	CPM
13	H-3	DPM (disintegrations per minute)
14	C-14	DPM
15	H-3 & C-14	DPM

Note: Other future isotope user programs may be created or edited. Please contact EH&S for additional programing information.

5. **Report Generation:** Once the sample analysis is complete, a report will be generated on screen. You may print this report by selecting the printer icon at the top left-center of the report screen.



Example Analysis Report



8/5/2022 11:25:10 PM QuantaSmart (TM) - 5.2 - Serial# SGLO11221807 Page 1
Protocol# 11 - 3H_CPM.lsa User: Default

Assay Definition

Assay Description:
Basic CPM assay
Assay Type: CPM
Report Name: Report1
Output Data Path: C:\Packard\Tricarb\Results\Default\3h_cpm\20220805_2321
Raw Results Path: C:\Packard\Tricarb\Results\Default\3h_cpm\20220805_2321\20220805_2321.results
Assay File Name: C:\Packard\TriCarb\Assays\3h_cpm.lsa

Count Conditions

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

Background Subtract

Background Subtract: Off
Low CPM Threshold: Off
2 Sigma % Terminator: Off

Regions	LL	UL
A	0.0	18.6
B	2.0	18.6
C	0.0	0.0

Count Corrections

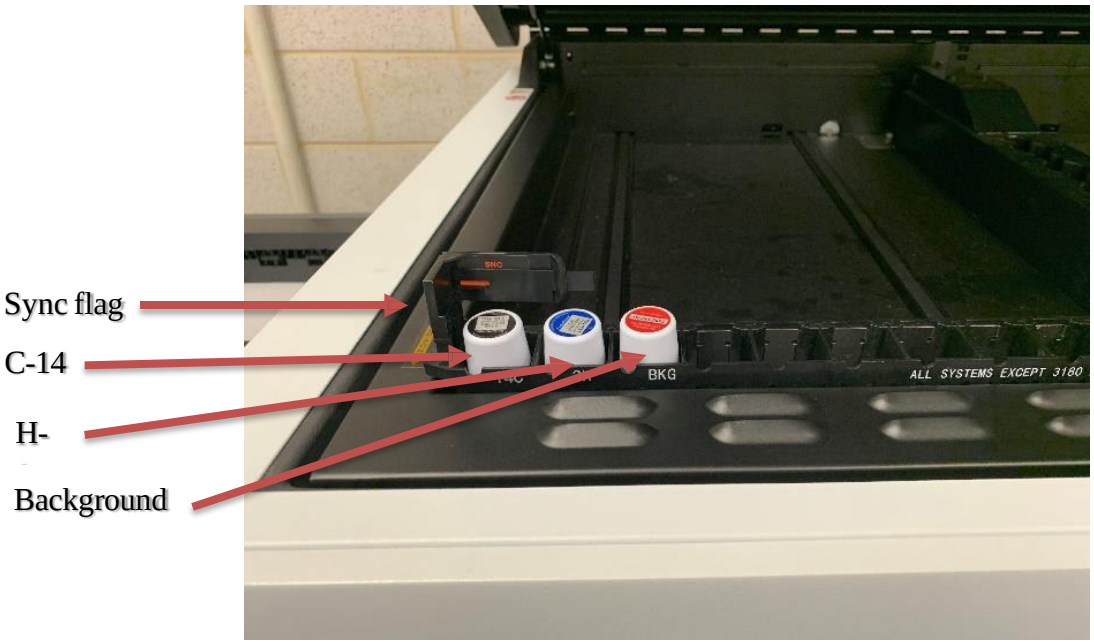
Static Controller: On Luminescence Correction: Off GCT: n/a
Colored Samples: n/a Heterogeneity Monitor: n/a PAC: n/a
Coincidence Time (nsec): 18 Delay Before Burst (nsec): 75 PAC Strength: n/a
Auxiliary Spectrum: n/a

Cycle 1 Results

S#	Count Time	CPMA	CPMB	SIS	tSIE	MESSAGES
WARNING: Instrument not normalized.						
1	1.00	14	12	1032.67	995.27	
2	1.00	173538	155246	18.75	1000.38	

6. **Reset Equipment for Self-Calibration:** Once analysis is complete and vials have been discarded properly in the Rad Lab, reset the sample rack for the equipment's automatic self-calibration. To do this, place the SYNC identifier flag back at the front slot of the rack and insert the C-14, H-3, and background vials, in that order, back into the rack.

Proper rack configuration for self-calibration / SYNC.



Note: the equipment runs a self-calibration, or a "SYNC" cycle at specified frequency to ensure the equipment is calibrated. You can also perform a manual calibration at any time.

4.0 Results Interpretation

Reviewing the **(DPM) disintegrations per minute** data recorded is the preferable means to analyze true radiation contamination by the scintillation machine. If not available, **CPM (counts per minute)** will have to suffice.

An area must be cleaned and retested if the removable contamination level exceeds **200 DPM,** or if the exposure rate exceeds approximately **three times CPM** of background reading (See example Scintillation Report). Results below these values should be acceptable, with no further cleaning or testing required.

5.0 Recordkeeping

The RSO shall keep records of the lab inspections for Louisiana State Department of Environmental Quality (DEQ) audits.

The laboratory shall maintain all wipe test survey records for the current fiscal year and the previous three fiscal years.

Appendix A: Radiation Survey Wipe Test Policy and Procedure

Appendix B: Radioactive Material Laboratory Survey and Wipe Test Form

Appendix A: Radiation Survey Wipe Test Policy and Procedure

Instruments Needed

Wipe Tests are performed using the following items:

- Cotton swab or filter paper
- Gloves and eye protection
- Scintillation vials
- Pen Marker and Gloves
- Scintillation machine

Procedure

1) A cotton swab or filter paper should be used to wipe the surface of the target area. Gloves and eye protection are required to perform the survey safely. Plastic scintillation vials are recommended.
2) Perform the wipe test on all designated areas of concern using a new swab/filter paper for each location.
3) Use Appendix **B**, Radiation Survey Wipe Test Form, for documentation.
   Complete the form and draw schematic on where wipes are to be performed and label locations.
4) Moisten the swab/filter paper and wipe approximately 100 cm^2. (Note: this is equivalent to a 4" x 4" square or a large S motion with your arm).
5) Place the swabs/filter papers into scintillation vials and label cap top with location number.
6) After obtaining all samples, add biodegradable scintillation fluid to each vial.
7) Perform sample analysis as directed in LSC use procedures.

Radioactive Material Laboratory Survey and Wipe Test Form

PI: _____ Department: _____ Building & Lab #: _____

Gamma Counter - Manufacturer/Model/Serial #: _____

LSC – Manufacturer/Model/Serial #: _____
Note: LSC must be used to protect H_2 & C_{14}.

Survey Meter – Manufacturer/Model/Serial # _____

Background: mR/Hr or cpm Battery Check: _____ Calibration Date: _____

Counter Information Type (Check one) ☐gamma counter or ☐LSC:

Isotopes used in Lab: (Check all that apply)
☐C-14 ☐Ch-51 ☐H-3 ☐P-32 ☐I-125 ☐S-35 ☐_____

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	

Rewipe of # _____ Rewipe of # _____

(* Results should read less than twice background in cpm.
Inform the Radiation Safety Officer if it exceeds this amount.
(Contaminated areas must be decontaminated immediately and documented)

Performed By: _____ Date: _____

Appendix B