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 ($\beta$) radioactive samples as well as 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:

Radiation Safety Officer will utilize scintillation machine on wipe test taken during quarterly lab inspections. Lab employees that use H-3 (tritium), C-14 or S-35 shall perform wipe test surveys (see EHS-100.07 - Wipe Test Procedures and Policy) and use the scintillation machine to analyze results.

3.0 EQUIPMENT DESCRIPTION:

The scintillation system machine most used at LSUHSC is the Beckman Coulter, Inc. model # LS 6500. All information presented is based on this model, but may be generically used for other machines since procedures are similar.
3.1 Instrument Specs

**Manufacturer:** BECKMAN COULTER, INC.

**Model:** LS 6500

**Sample Vial Capability:**
- 336 Standard vials
- 648 Miniature vials

**Calculation types:**
- Counts per minute (CPM)
- Disintegrations per minute (DPM)

**Scintillation Efficiencies:**

<table>
<thead>
<tr>
<th>Isotope</th>
<th>LSC efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-14</td>
<td>96 %</td>
</tr>
<tr>
<td>H-3</td>
<td>65 %</td>
</tr>
<tr>
<td>P-32 &amp; P-33</td>
<td>100 %</td>
</tr>
<tr>
<td>S-35</td>
<td>97 %</td>
</tr>
<tr>
<td>Cr-51</td>
<td>35 %</td>
</tr>
<tr>
<td>Cs-137</td>
<td>100 %</td>
</tr>
<tr>
<td>I-125</td>
<td>78 %</td>
</tr>
</tbody>
</table>

**Small check source:** Cs-137 @ 30 uci (microcuries)

**Printer:** Dot matrix

**CRT:** Color

**Reference samples:**
- Background Standard (BKG)
- H3 standard and C14 standard

**Product Dimensions:**
- Width: 36.2 in without side monitor shell
- Height: 26.5 in
- Depth: 31.5 in
- Weight: 460 lbs

**Minimum Power Requirements:**
- 120 V 3.0 A
- 240 V 1.5 A
3.2 How it works

This device detects and measures radiation by means of tiny visible flashes of light created when radition emission react with scintillation fluid. This fluid contains a fluor, a compound that fluoresces when it is bombarded with radioactivity. The scintillation fluid converts this invisible radioactivity into visible light (photons). The counter takes the vial and places it in a dark chamber with two photomultiplier tubes. There, the photomultiplier tubes detect the light resulting from radioactive emissions exciting the fluor. See below:

The instrument counts these burst of lights (photons) and records them as counts per minute (cpm). The scintillation counter classifies each pulse of photons according to the number of photons in the pulse, which corresponds to the energy of the individual radiation emission event. These pulses are collated into channels, and the counts per minute (cpm) in each channel is recorded. Each channel (counting window) corresponds to a specific range of energies and counts with energies above or below set limits are excluded from a particular channel. **If the LSC is not set to see the correct channel, you will not see any contamination from your wipe survey.** Example: If the LSC is set to read only the low energy channel of H-3 and you are using p-32 you will not read. See below:
3.3 Operating Instructions

1) Turn on machine: The default menu is shown below on the Beckman Coulter LS6500
Note: Screen will go in sleep mode when not operated, hit any key to activate.

![Main Menu Image]

2) Initially, change the MAIN MENU from Automatic Counting to the Review and Edit User Programs selection. (This allows user to determine types of preset programs available to use for the specific radioactive isotope you are determining)
Note: use the up and down arrow buttons on the LSC touchpad to get to desired program (See image below)

![Touchpad Image]
3) You should now be highlighted on the **Review and Edit User Programs** menu as image shown below:

![Main Menu Image](image)

Note: use the Select button on the LSC touchpad to review user programs. (See image below)

![Select Button Image](image)
4) Review all programs currently stored in memory on the LSC similar as shown below:

5) Determine what number program will allow you to identify what isotope contamination you are looking for.

Examples from above screen indicate:

<table>
<thead>
<tr>
<th>User Program</th>
<th>Isotope</th>
<th>Unit type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C-14</td>
<td>CPM (counts per minute)</td>
</tr>
<tr>
<td>2</td>
<td>H-3</td>
<td>DPM (disintegrations per minute)</td>
</tr>
<tr>
<td>3</td>
<td>P-32</td>
<td>CPM (counts per minute)</td>
</tr>
<tr>
<td>4</td>
<td>H3 &amp; C14</td>
<td>DPM (disintegrations per minute)</td>
</tr>
<tr>
<td>5</td>
<td>I-125</td>
<td>CPM (counts per minute)</td>
</tr>
<tr>
<td>6</td>
<td>S-35</td>
<td>CPM (counts per minute)</td>
</tr>
<tr>
<td>7</td>
<td>Cr-51</td>
<td>CPM (counts per minute)</td>
</tr>
<tr>
<td>8</td>
<td>Cs-137</td>
<td>CPM (counts per minute) for sealed sources</td>
</tr>
<tr>
<td>9</td>
<td>Ni-63</td>
<td>CPM (counts per minute) for sealed sources</td>
</tr>
<tr>
<td>10</td>
<td>Zn-65</td>
<td>CPM (counts per minute)</td>
</tr>
</tbody>
</table>

Note: Many other programs may be created, or edited by user. Be careful!!
6) Running a sample. Select the correct numbered vial sleeve container for the corresponding user program you are trying to determine: In this example we will run a basic H3 & C14 DPM survey corresponding to program # 4 so use sleeve numbered as # 4.

- Make sure BKG standard in first position.

- Obtain all wipe test samples and fill with approved biodegradable cocktail fluid in small opaque vials.
- Place all filled numbered samples in slots in numerical order after BKG standard.
- You may also want to place the H3 and C-14 check standards for accuracy test at rear.
- If more than one rack of samples are needed, add additional racks (without number code)
- Place HALT rack after all samples are in selected sleeves.

- Closed top cover
- Go to Main Menu by selecting Previous Menu button and select Automatic counting
- Select the START button on the LSC control panel

![Image of LSC control panel with a finger pressing the START button.]

- The machine should now run the selected program. (see image below)

![Image of a counting table in automatic mode, displaying sample counts.]

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>3H</th>
<th>14C</th>
</tr>
</thead>
<tbody>
<tr>
<td>B7</td>
<td>83044.3</td>
<td>156.6</td>
</tr>
<tr>
<td>B6</td>
<td>17.3</td>
<td>20.5</td>
</tr>
<tr>
<td>B5</td>
<td>22.0</td>
<td>16.6</td>
</tr>
<tr>
<td>B4</td>
<td>6.7</td>
<td>21.8</td>
</tr>
<tr>
<td>B3</td>
<td>3.8</td>
<td>25.7</td>
</tr>
<tr>
<td>B2</td>
<td>42.9</td>
<td>17.8</td>
</tr>
<tr>
<td>B1</td>
<td>16.3</td>
<td>8.6</td>
</tr>
</tbody>
</table>

**ACTIVE KEYS**
- Help
- Select
- Reset
- Stop

**Internet Count / Edit / Review**
- Hot Graph Display
- Histogram Display

*(SELECT) for Multi-Task Edit*
- If you see a large count and want to try to identify the radionuclides energy spectrum use your arrow keys and select cursor down one level.

- This will select the view on the monitor in HotGraph Display.
- Then hit the select button.

- Then look at the sample energy spectrum on the monitor and interpret.
8) Review and Interpret results. The printout of the results will allow you to identify contamination levels. Also, keep this printout on file for RSO to review.

Comments:
The background standard (sample #1) and 5 wipe samples (#2-#6) show all low cpm and dpm values. H3 reference sample (#7) and C-14 reference sample (#8) Show similar high DPM values that are printed on these reference standard vials.

Contamination levels of concern
CPM should not be more than three X background standard value.
DPM should not be more than 200 dpm.
Note: Decontaminate wipe area and take wipes again until values are below contamination levels of concern.
4.0 REFERENCES:

1. EHS-100.07 Radiation Survey – Wipe Test Policy and Procedures