

Environmental Health & Safety
Title: Standard Operating Procedure of Beckman LS 6500
Document #: EHS-200.01
Version #: 02
Approved by EHS Date: 28 Jan 2026

1.0 PURPOSE:

This procedure document outlines how to use a scintillation machine at UNT Health to detect the activity of particulate-emitting beta (β) radioactive samples and auger electrons emitted by gamma particles. The isotopes listed below, along with their emission types, are commonly used.

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

This procedure document outlines how to use a scintillation machine at UNT Health to detect the activity of particulate emitting beta (β) radioactive samples and auger electrons emitted by gamma particles. The isotopes listed below, along with their emission types, are commonly used.

2.0 SCOPE:

The Radiation Safety Officer (RSO) uses a scintillation machine for wipe tests during quarterly lab inspections and potential release events. EH&S staff may use the scintillation machine to assist RSO with spill response testing. Lab personnel using H-3 (tritium), C-14, or S-35 must conduct wipe tests (refer to EHS100.07 - Wipe Test Procedures and Policy) and analyze results using a scintillation machine.

3.0 INSTRUMENT DESCRIPTION:

The liquid scintillation counter (LSC) currently in use at UNT Health EH&S Radiation Lab is the Beckman LS 6500 counter. All information presented is based on this model, but may be referenced for other machines as respective use procedures are similar.

STANDARD OPERATING PROCEDURE OF BECKMAN LS 6500



Figure 1: Picture of Beckman LS 6500 Liquid Scintillation Counter

3.1 Instrument Specifications

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>^{14}C</td><td>96 %</td></tr><tr><td>^3H</td><td>65 %</td></tr><tr><td>^{32}P & ^{35}P</td><td>100 %</td></tr><tr><td>^{35}S-35</td><td>97 %</td></tr><tr><td>^{51}Cr</td><td>35 %</td></tr><tr><td>^{137}Cs</td><td>100 %</td></tr><tr><td>^{125}I</td><td>78 %</td></tr></tbody></table>	Isotope	LSC efficiency	^{14}C	96 %	^3H	65 %	^{32}P & ^{35}P	100 %	^{35}S -35	97 %	^{51}Cr	35 %	^{137}Cs	100 %	^{125}I	78 %
Isotope	LSC efficiency																
^{14}C	96 %																
^3H	65 %																
^{32}P & ^{35}P	100 %																
^{35}S -35	97 %																
^{51}Cr	35 %																
^{137}Cs	100 %																
^{125}I	78 %																
Small check source:	^{137}Cs @ 30 μCi (microcuries)																
Printer:	Dot matrix																
CRT:	Color																
Reference samples:	Background Standard (BKG) ^3H standard and ^{14}C standard																
Product Dimensions:	Width: 36.2 in (91.9 cm) with side monitor shell 49.7 in (126.2 cm) with side monitor shell Height: 26.5 in (67.3 cm) Depth: 31.5 in (80.0) cm Weight: 460 lbs																
Minimum Power Requirements:	120 V 3.0 A 240 V 1.5 A																

3.2 Operating Instructions

- A. When turned on, the Beckman Counter LS 6500 comes with the default menu as shown in Figure 2.
- 2. When not in use, the screen will go into sleep mode, and pressing any key will activate it.

					MAIN MENU
					Automatic Counting
					Count Single Rack
					Review and Edit User Program
					Isotopes / DPM / Alpha-Beta Libraries
ACTIVE KEYS					Access Interrupt Data
Main	Help	Select	Start	reset	System Test / System Setup
	Print				Move Cursor then [SELECT]

Figure 2: LSC Default Main Screen

- B. To enable the user to identify the kind of preset programs that are suitable for the particular radioactive isotope of interest, the user has to first change Automatic Counting to the Review and Edit User Program option from the MAIN MENU by using the up and down arrow keypad buttons of the LSC (Figure 3).



Figure 3: LSC keypad buttons

- C. After selecting the Review and Edit User Programs from the MAIN MENU, the main screen will look as in Figure 4 below.

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					MAIN MENU
					Automatic Counting
					Count Single Rack
					Review and Edit User Program
ACTIVE KEYS					Isotopes / DPM / Alpha-Beta Libraries
					Access Interrupt Data
Main	Help	Select	Start	reset	System Test / System Setup
	Print				Move Cursor then [SELECT]

Figure 4: Main Screen with Review and Edit User Programs Highlighted

- D. Pressing the select keypad after highlighting the Review and Edit User Programs will send you to the next screen as shown in Figure 5, to examine all programs currently stored in memory on the LSC.

					Date and Time				
					REVIEW / EDIT				
					Next 10 User Programs				
					Previous 10 User Programs				
					1 C14	1.00	14C	NONE	NONE
					2 H3	3.00	3H	NONE	NONE
					3 P32	1.00	32P	NONE	NONE
					4 S35	1.00	35S	NONE	NONE
					5 DS	1.00	3H	NONE	NONE
					6 DC	1.00	125I	NONE	NONE
					7 Cs137	1.00	137Cs	NONE	NONE
8 H3 C14	1.00	3H	14C	NONE					
9 DEFAULT VALUES	1.00	MANUAL	NONE	NONE					
10 DEFAULT VALUES	1.00	MANUAL	NONE	NONE					
ACTIVE KEYS					[SELECT] to view next 10 User Programs Or Enter desired user number: <input type="text"/>				
Main	Help	Select	Start	Reset					
	Print								

Figure 5: Main Screen with stored programs

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- E. Determine which number program will help you identify the isotope contamination you're looking for from Figure 5 and Table 1.

Table 1: Examples from Figure 5

User Program	Isotope	Unit type
1	C-14	CPM
2	H-3	CPM
3	P-32	CPM
4	S-35	CPM
5	H-3	CPM
6	I-125	CPM
7	Cs-137	CPM
8	H-3 & C-14	CPM
9	Default	CPM
10	Default	CPM

Note: Other programs may be created or edited by the user. But users must be careful when creating and editing the stored programs.

- F. Running a sample. Choose the correct numbered vial sleeve container for the user program you're trying to identify.

In this example, we will conduct a basic H-3 and C-14 CPM survey corresponding to program #8, so use the sleeve numbered #8.

- Ensure BKG standard (green) is in the first position (Figure 6).
- Collect wipe test samples and fill a small opaque vial with approved biodegradable cocktail fluid (example Figure 7).
- Place filled numbered samples in numerical order following the BKG standard.
- Consider placing the H-3 and C-14 (Blue and Red) check standards for accuracy tests at the end of all loaded samples.
- Add additional racks (without numbering) if needed.
- Place the HALT rack (Red rack in Figure 5) after selecting all samples and sleeves.

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Figure 6: Sample and Halt racks with BGKG standards (Green), sample vials (white), H-3 standard (Blue), and C-14 standards (Red).



Figure 7: Sample biodegradable cocktail

- Close the LSC top cover after inserting all samples and HALT racks.
- Access the Main Menu of the LSC by clicking the previous button and select Automatic Counting.
- After selecting Automatic Counting, Figure 8, showing Load samples and what to do next, will display.

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					AUTOMATIC COUNTING				
					Load samples, Press [START] to begin AUTOMATIC COUNTING				
ACTIVE KEYS									
Main	Help	Select	Start	Reset					
Prev	Print								

Figure 8: Automatic counting mode, showing “Load sample”.

- Click the START button on the LSC control panel, and the machine will now run the chosen program.
- The machine will now run the chosen program and should display samples counting screen, an example shown in Figure 9.

COUNTING IN AUTOMATIC MODE						
User:	8	Data Calc:	CPM	Time:	1:00	of 1:00
SAMPLE	3H	14C		SAMPLE	3H	14C
6						
5	16.0	10.0				
4	17.0	7.0				
3	13.0	5.0				
2	11.0	10.0				
1	13.0	3.0				
ACTIVE KEYS				Interrupt Count / Edit / Review		
	Help	Select		Reset	Hot Graph Display Histogram Display	
			Stop		[SELECT] for Multi-Task Edit	

Figure 9: Sample counting screen

- If you see a large count and want to try to identify the radionuclide's energy spectrum, use the arrow keys to move the cursor down one level from the “Interrupt Count / Edit / Review to Hot Graph Display.”
- With the “Hot Graph Display” selected, click on the “Select” keypad to display the energy spectrum as shown in Figure 9 on the monitor.

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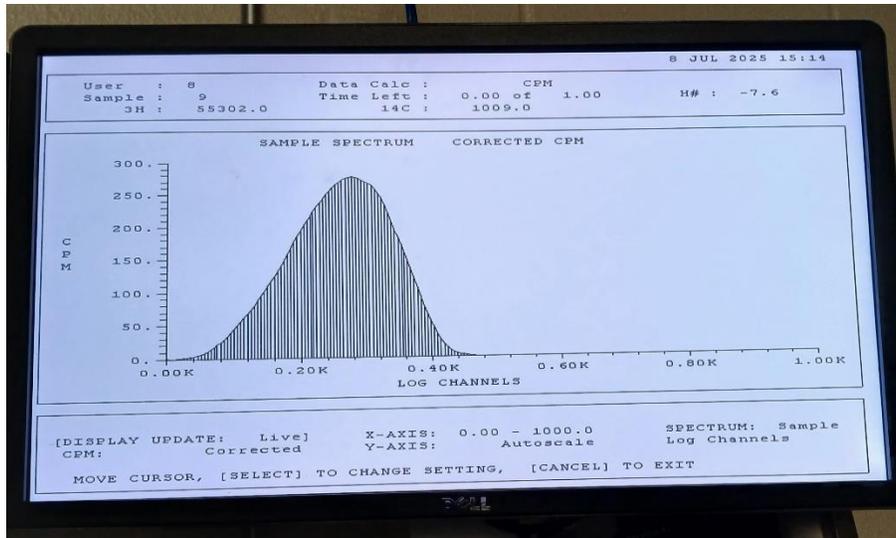


Figure 9: Screenshot of sample analysis energy spectrum

G. Review and Interpret Results.

The printout of the results after the sample analysis will allow one to identify contamination levels. Also, keep the printout on file for RSO to review.

Comment:

A sample of the results printout is attached as Figure 10.

Contamination levels of concern

CPM should not be more than two and a half times the background standard value.

DPM should not be more than 200 dpm.

Note: Decontaminate the wipe area and take wipes again until values are below the contamination levels of concern. 17230

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ID:H3 C14
USER: 8
PRESET TIME : 1.00
DATA CALC : CPM H# :YES SAMPLE REPEATS: 1 PRINTER : STD
COUNT BLANK : NO IC# : NO REPLICATES : 1 RS232 : OFF
TWO PHASE : NO ADC : NO CYCLE REPEATS : 1
SCINTILLATOR: LIQUID LUMEX: NO LOW SAMPLE REJ: 0
LOW LEVEL : NO HALF LIFE CORRECTION DATE: none

ISOTOPE 1: 3H %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0
ISOTOPE 2: 14C %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0

SAMP POS TIME H# 3H 14C LUMEX ELAPSED
NO MIN CPM %ERROR CPM %ERROR % TIME
1 **-1 1.00 -10.5 13.00 55.47 3.00 115.47 0.67 1.52
2 **-2 1.00 52.1 11.00 60.30 10.00 63.25 0.78 3.12
3 **-3 1.00 47.2 13.00 55.47 5.00 89.44 21.34 4.86
4 **-4 1.00 52.6 17.00 48.51 7.00 75.59 14.48 6.57
5 **-5 1.00 53.9 16.00 50.00 10.00 63.25 23.00 8.22
6 **-6 1.00 44.6 20.00 44.72 6.00 81.65 12.80 9.92
7 **-7 1.00 50.6 13.00 55.47 5.00 89.44 17.58 11.65
8 **-8 1.00 52.9 17.00 48.51 5.00 89.44 20.26 13.37
9 **-9 1.00 -7.6 55302.00 0.85 1009.00 6.30 0.00 15.14
10 **-10 1.00 -14.3 7042.00 2.38 36642.00 1.04 0.00 16.92
    
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Figure 10: Sample printout of the results

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4. References

LS 6500 Scintillation System Operating Manual

Louisiana State University Policy # EHS-100.08 Radiation Survey – Liquid Scintillation Counter Use Procedure

5. Version revisions

Initial approval July 31, 2025

Revised 28Jan 2026 - rebranding