Calibrating and Oper		Environmental	
Liquid Scintillation C		Health & Safety	
SOP NUMBER	1	University of Missouri	
WORKING GUIDE	N/A		,
Latest Version Prepared By	APPROVAL	EFFECTIVE DATE	PAGE NUMBERING
Leona Choi, HP	Rachel Nichols, ARSO	11/1/24	Page 1 of 6

The purpose of this working guide is to provide the Radiation Safety Staff (RSS), Permitted Individuals (PI) and their secondaries step-by-step instructions on how to calibrate and operate the Beckman 6500 Liquid Scintillation Counter (LSC) commonly found around MU.



Pictured above is a Beckman LS 6500 located in Schweitzer 17. Important components include: (a) printer, (b) calibration sticker, (c) cover, (d) user program flag drawer, (e) keyboard, (f) monitor. Pictured below is a closer look at the keyboard.



Calibrating and Operating the Beckman 6500 Environmental Liquid Scintillation Counter Health & Safety SOP NUMBER SUPERCEDES SOP (IF APPLICABLE) University of Missouri

WORKING GUIDE	N/A		·
Latest Version Prepared By	APPROVAL	EFFECTIVE DATE	PAGE NUMBERING
Leona Choi, HP	Rachel Nichols, ARSO	11/1/24	Page 2 of 6

Calibration 1.

- 1.1 For calibration, you will need a set of 7 ml unquenched standards. This would typically include a background, 3H, 14C, and 32Si (a progeny of 32P).
- 1.2 On the "MAIN MENU" screen, use the arrow keys to highlight "Review and Edit User Programs" and press **SELECT** on the keyboard (Fig. 1).
- On the "REVIEW / EDIT" screen, use the arrow keys to highlight your counting protocol and press SELECT on 1.3 the keyboard. In this guide, we are using protocol 4 SWIPES (Fig. 2).

	•DATA BUFFER, %FREE: 0• 30 JAN 1924 11:00		•DATA BUFFER, %FREE: 0• 30 JAN 1924 11:89
	MAIN NENU		REVIEN / EDIT
ACTIVE KEYS	Autonatic Counting Count Single Rack Review and Edit User Programs Elsotope / DPM / Alpha-Beta Libraries Access Interrupt Data E Data Management System Test / System Setup	ACTIVE KEYS	Mext 10 User Programs Previous 10 User Programs 1 Default Values 1.00 14C NONE NONE SHIPES 1.00 3H 14C 32P 3 KA 1.20 14C NONE NONE 6 ANU 1.20 3H 14C 32P 5 5 1.00 3H 14C 32P 5 5 1.00 3H 32P NONE 6 ANU 1.20 3H 32P NONE 7 Default Values 1.00 3H 14C NONE 9 JEN K 2.00 3H NONE NONE 10 NICK POHER 2.00 14C NONE NONE
Main Help Select Start Reset	Move Cursor then [SELECT]	Main Help Select Reset Prev Print Cancel	[SELECT] to select highlighted user or Enter desired user number:

Figure 1. Main menu.

Figure 2. Selecting the user program "4 SWIPES" to edit its settings.

- 1.4 Verify that the protocol has a count time of 1 minute and the correct isotopes are listed based on the standards you will be using (Fig. 3a). If changes are needed, highlight the appropriate field with the arrow keys and press SELECT. Use the keyboard to input your desired changes and press ENTER to submit the change. To return, press **PREVIOUS MENU** on the keyboard.
- 1.5 On the "REVIEW / EDIT" screen for the user program, highlight "Edit Other Parameters" and press SELECT (Fig. 3b). Press SELECT again to enter the "Data Calculation" screen (Fig. 5).

Calibrating and Ope Liquid Scintillation C	5500		Environmental Health & Safety University of Missouri			
WORKING GUIDE	N/A					
Latest Version Prepared By Leona Choi, HP	APPROVAL Rachel Nichols, ARSO		EFFECTIVE DATE PAGE NUMBERING 11/1/24 Page 3 of 6			
	•DATA BUFFER, %FREE: 0• 30 JAN 1924 11:10	USER PRO		DATA BUFFER, %FREE: 0. 30 JAN 1924 11:10		
User: 4 ID: SHIPES Count time: 1.00 CPM Repeats: 1 Liquid Replicates: 1 Cycle Reps: 1 Low Reject: 0 Blanks Isotope: 3H 14C 32P	Id: SHIPES Comments: CPM ARE DPM CORR.FAC. APPL.	User: 4 ID: Count time: 1.6 Repeats: Replicates: Cycle Reps: Low Reject: Isotope: 3H	SHIPES 1 Liquid 1 1 0 Blanks 14C 32P	Data Calculation Data Calculation Counting Precision Background < Blank Subtraction Quench < Lum-Ex < 2 Phase		

 A C T I U E K E Y S

 Main Help Select
 Reset

 ISELECT1 to edit Data Calculation, Counting Precision, Background Subtract Buench & Lum-Ex.
 A C T I U E K E Y S

 Main Help Select
 Reset

 Setup calculation node, sample repeats, cycle repeats, replicates, and factors.

 Figure 2. The "Derivice" (Edit", page for the colority of the solect (Edit", page for the colority of the solect (Edit")

Std RS232: Off Disk: Off

Figure 3. The "Review/Edit" page for the selected userFigure 4. Select "Data Calculation" after you select "Edit
Other Parameters."

- 1.6 In "Data Calculation," check that the background subtraction is set to 0 (Fig. 5a). Edit the factors for each Isotope. Use the arrow keys to highlight the isotope, enter a factor of 1, and then press ENTER (Figure 6). Repeat for each isotope then return to the "MAIN MENU" by pressing MAIN MENU on the keyboard.
- 1.7 Load a rack with the standards (left to right) and protocol flag into the right side of the LSC. The order doesn't matter, but you should be aware of the order you choose since it will be critical for transferring data into the spreadsheet. It is recommended to load the standards by mass number for convenience: background, 3H, 14H, and 32Si. Load another empty rack with the HALT flag following. Note that these flags should be facing away from you. Be sure that the printer is on, and the paper is properly aligned. Shut the LSC lid and press the START button to begin "Automatic Counting" on the Main Menu.



1.260

Std RS232: Off Disk: Off

14C

32P

🛙 Isotope 2:

Isotope 3:



🖥 Low Level 🗸 Low Count Reject

🖥 Copy User Program

Figure 5. In the "Data Calculation page," check that "Bkgsub" is set to 0 for each region and set each isotope factor to 1.

Figure 6. LSC sample racks should be loaded on the rightside, top to bottom. The racks should be oriented such that only the top part of the flag is facing you. Don't forget the *HALT* rack!

Calibrating and O	perating the Beckman 650	00	M	Environmental		
Liquid Scintillation	n Counter		U j	Health & Safety		
SOP NUMBER SUPERCEDES SOP (IF APPLICABLE)			University of Missouri			
WORKING GUIDE	N/A			,		
Latest Version Prepared By	APPROVAL	EFFECTIVE DATE		PAGE NUMBERING		
Leona Choi, HP	Rachel Nichols, ARSO	11/1/24		Page 4 of 6		

1.8 Next, the data from the counting results will need to be entered to the spreadsheet⁺ to calculate the new isotope factors and minimum detectable activity (Fig. 7, 8). Enter the background CPM for each respective isotope region (Fig. 7a). Then enter the data for each standard according to the isotope and region of interest (Fig. 7b). Note that the CPM taken for each sample number corresponds to the isotope standard used in that position. E.g. The 3H standard was placed in the second slot of the rack, so the CPM result we use is in column 3H, row 2 (Fig. 7c, d).

	PAGE: 1	
•	ID:EHS WIPE TEST 26 JUL 42 09:31 USER: 4 COMMENT:CPM EQUAL DPM 2024 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 AQC :NO CYCLE REPEATS : 1	
	SCINTILLATOR: LIQUID LUMEX: NO LOW SAMPLE REJ: 0 LOW LEVEL : NO HALF LIFE CORRECTION DATE: none	9
	ISOTOPE 1: 3H %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0 ISOTOPE 2: 14C %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0 ISOTOPE 3: 32P %ERROR: 0.00 FACTOR: 1.000000 BKG. SUB: 0	Э
	SAM POS TIME H# <u>SH</u> C <u>14C</u> <u>32P</u> LUMEX ELAPSED 3 NO MIN CPM %ERROR CPM %ERROR <u>CPM %ERROR</u> % TIME	
	1 **-1 1.00 14.7 0.00 1.E+06 3.00 230.94 0.00 1.E+06 0.18 1.44 2 **-2 1.00 15.4 148868.0 0.52 667.00 7.80 0.00 1.E+06 0.00 3.02	•
	3 **-3 1.00 16.2 26935.00 1.22 100097.0 0.83 92.00 22.90 0.00 4.00 4 **-4 1.00 92.2 25383.00 1.25 49162.00 0.90 50736.00 0.89 0.00 6.16	•
	b	0

Figure 7. Counting analysis print-out results: (a) contains the background counts for each isotope region, (b) contains the CPM taken for each isotope region with respect to the sample number, (c) shows the isotope region column headers.

[†]The fillable spreadsheet referenced here is attached separately.

Calibrating and Oper		Environmental	
		Health & Safety	
WORKING GUIDE	N/A		University of Missouri
Latest Version Prepared By	APPROVAL	EFFECTIVE DATE	PAGE NUMBERING
Leona Choi, HP	Rachel Nichols, ARSO	11/1/24	Page 5 of 6

	A	В	C	D	E	F	G	н		J	K	L	M	N	0	P
1	Permitter	1 Individual:			Ins	trument Tyne:	19	r								
2	Termittee	Ruilding:			Manufa	cturor/Model:		<u> </u>	-							
2		Poom:			Wallula	Sorial No :			-							
3	Calib	ration Date:	7/20/	2024		Senarivo										
5	Calib	facion Date.	1/25/	2024	-											
6																
										Standard	Standard					
			Instrument		Sample	Background		Gross	Net	Assav	Δssav		Decaved			
			Setting	Channel/	Count Time	Count Time	Background	Sample	Sample	Activity	Reference	Half-Life	Activity		Calibration	MDA
7 Radio	nuclide	Serial No.	(Window)	Region	(min)	(min)	(CPM)	(CPM)	(CPM)	(DPM)	Date	(days)	(DPM)	Efficiency	Factor	(DPM)
8 P-32/	Si-32		256-2000	C	1	1	()	50736	50736	75180	4/30/2019	5 73E+04	73456 8147	0.69	1.45	4
9 C-14	0.02		18.5-256	B	1	1	3	100097	100094	99900	10/8/2018	2.08E+06	99829.4316	1.00	1.00	11
10 H-3			2-18.6	Δ	1	1	0	148868	148868	213120	10/8/2018	4.50E+03	153687.225	0.97	1.03	3
11					-											
12	Swipe	Protocol #:	4													
13 Cal	ibration pe	rformed by:	EH	IS												
14	Unknow	n Efficiency:	69	%				1								
15																
16	How to use	this spread	sheet:													
17 Step 1	1:	All highlight	ted fields ar	e where yo	u enter your o	data. Example	data has beer	n entered f	or demonst	ration purp	oses and wil	I need to be	updated wit	h your data		
		RSS recomm	nends counti	ing your sar	mples for 1 m	inute. Most of	the time, LSC	standards	sets come v	vith a backg	round, C-14	, and H-3 sta	ndard. If you	have more	sources to c	ount, you
18 Step 2	2:	can adjust the above template as you need.														
19 Step 3	3:	Make sure to enter each standard's Assay Date and Assay Activity so the spreadsheet can decay correct it to today's date.														
20 Step 4	4:	The Calibration Date above will auto populate with the day you open the spreadsheet.														
Char I	r.	If you have an older LSC such as a Beckman, you will need to make sure your swipe protocol has a calibration factor set to 1 for each isotope before you collect data. This will ensure														
21 Step 3	5:	that your results will be in CPM. See the red circle below for the calibration factors.														
22 Step 6	6:	Once you co	ollect data, e	nter the ba	ckground cpn	n for each regi	on. Data from	the image	below has	been enter	ed as an exa	mple				
		Enter the da	ata for each s	standard. O	nly enter the	cpm that corre	sponds to the	e isotope a	nd region o	f interest. S	ee the highl	ighted porti	ons in the be	low examp	le, data has	been
	> 0	alibration	Print this	out MD	A Formula											

Figure 8. This spreadsheet calculates calibration factors based on the counting efficiencies.

- **1.9** Check that your MDAs are <200 dpm which is the trigger level for removable contamination.
- **1.10** If the data looks good, press MAIN MENU and steps 1.2 1.5 to navigate back to where you can enter the new calibration factors for each isotope. The calibration is then complete.
- **1.11** It can be useful to create a "calibration sticker" where you can record the efficiencies for each region, the date of calibration, and the name or initials of the person that performed the calibration. Some form of calibration information should be on the equipment.
- **1.12** Be sure to send your calibration print-out to EHS so radiation safety may update your LSC's records.

2. Counting

- **2.1** Once an LSC is within calibration, it can be used to analyze contamination swipes. Depending on the location of the LSC and the supplies available, you may need to prepare your vials in advance. Be sure to have a blank vial for background counts.
- **2.2** Load the sample vials from right to left, beginning with the blank vial.
- 2.3 Insert the protocol flag designated for counting on the first rack only. load your samples into the rack(s).From the "MAIN MENU" window, highlight "Automatic Counting" and press the START button.

Calibrating and Operating the Beckman 6500
Liquid Scintillation Counter



SOP NUMBER	SUPERCEDES SOP (IF APPLICABLE)	τ	University of Missouri		
WORKING GUIDE	N/A				
Latest Version Prepared By	APPROVAL	EFFECTIVE DATE	PAGE NUMBERING		
Leona Choi, HP	Rachel Nichols, ARSO	11/1/24	Page 6 of 6		

3. Troubleshooting

Cancel analysis/counting 3.1 To interrupt the counting process, simply press

STOP

on the keyboard.

3.2 Reset

If the LSC is unresponsive, you can do a soft reset by pressing



simultaneously.