Radiation Sciences – Nuclear Medicine Technology Program

Lab Procedures for Radiopharmacy CLRS 461

Table of Content

Radioactive Sealed Source Inventory
CLRZ 461 Lab

Isotope	Source Type	Model #	Serial #	Reference Activity, mCi	Ref. Date	Room Location	Source Check
Cs-137	Disk	check source	CS137101604 1104	0.010000	2/15/2016	Rad Sci Allied Health Prof	
Co-57	Disk	SM-057-50U	1792-59-3	0.050000	3/1/2015	Rad Sci Allied Health Prof	
Co-57	Disk	SM-057-50U	1655-91-13	0.050000	3/1/2015	Rad Sci Allied Health Prof	
Co-57	Disk	SM-057-50U	1445-89-19	0.050000	6/1/2011	Rad Sci Allied Health Prof	
Co-57	Disk	SM-057-50U	1445-89-20	0.050000	6/1/2011	Rad Sci Allied Health Prof	
Co-57	Disk	SM-057-50U	1333-91-14	0.050000	1/1/2009	Rad Sci Allied Health Prof	
Co-57	Disk	SM-057-50U	1333-91-13	0.050000	12/1/2008	Rad Sci Allied Health Prof	
Co-57	Flood	MED3709	2082-008	15.000000	6/1/2019	Rad Sci Allied Health Prof	
Co-57	Flood	MED3709	1788-147	10.000000	3/1/2015	Rad Sci Allied Health Prof	
Co-57	Flood	MED3709	1566-121	20.000000	3/1/2012	Rad Sci Allied Health Prof	
Cs-137	Rod	GF-290-1R2	1181-12-5	0.000996	3/1/2006	Rad Sci Allied Health Prof	
Ba-133	Rod	GF-290-1R2	1181-12-1	0.001042	3/1/2006	Rad Sci Allied Health Prof	
Co-60	Rod	GF-290-iR2	1181-12-4	0.001091	3/1/2006	Rad Sci Allied Health Prof	
Na-22	Rod	GF-290-1R2	1181-12-7	0.001074	3/1/2006	Rad Sci Allied Health Prof	
Co-57	Rod	GF-0210	1988-32-3	0.000999	11/1/2018	Rad Sci Allied Health Prof	
Co-57	Rod	GF-0210	1510-2-1	0.000987	6/1/2011	Rad Sci Allied Health Prof	
Cd-109	Rod	GF-290-1R2	1181-12-2	0.001039	3/1/2006	Rad Sci Allied Health Prof	
Mn-54	Rod	GF-290-1R2	1181-12-6	0.001056	3/1/2006	Rad Sci Allied Health Prof	
Co-57	Rod	GF-0207	1356-63-3	0.000115	6/1/2009	Rad Sci Allied Health Prof	
Co-57	Rod	GF-290-!R2	1181-12-3	0.001049	3/1/2006	Rad Sci Allied Health Prof	
Co-57	Ruler	RR-057-160U	1795-50	0.160000	3/1/2015	Rad Sci Allied Health Prof	
Cs-137	Standard	MED3550	68964	0.203000	2/1/2006	Rad Sci Allied Health Prof	
Ba-133	Standard	MED3550	67392	0.270000	11/1/2005	Rad Sci Allied Health Prof	
Co-60	Standard	MED3550	67398	0.055610	11/1/2005	Rad Sci Allied Health Prof	
Co-57	Vial	RV-057-5M	2029-30-18	5.462000	10/1/2018	Rad Sci Allied Health Prof	
Co-57	Vial	RV-057-5M	1869-89-4	5.508000	10/1/2016	Rad Sci Allied Health Prof	
Co-57	Vial	RV-057-5M	1461-58-10	5.000000	6/1/2011	Rad Sci Allied Health Prof	

Please Indicate if the inventory is correct a shown by checking the "Source Check" Box for each source which is accounted for. Use the space below for any comments or corrections.

Signature of Person Performing Inventory **Date**

Well Counter Efficiency Calculation

1. The energy gamma most used in nuclear medicine is? _____
2. The closest source that matches is? _____
3. From question #2, find the rod source with the most recent calibration date and count it on the well counter for one minute. _____ cpm
4. Radionuclide used _____ and its ID # _____
5. Date of source calibration is _____.
6. The amount of days that has transpired since the day of calibration _____
7. The source's half-life _____.
8. Theoretical activity in μC _____.
9. Convert the theoretical activity to dpm and show your work (1 μCi = 2.22×10^6 dpm)
10. Compare the measured cpm to the theoretical dpm (see formula below)
11. Determine % Efficiency _____%

$$\frac{\text{Source counts cpm}}{\text{Theoretical dpm}} \times 100 = \% \text{ Efficiency}$$

ENERGY CALIBRATION AND REPEATABILITY

^{137}Cs source ID and calibration date _____

Well Counter

Date	Chan / LLD / ULD	Measured CPM	FWHM / %Var	Pass or Fail

^{137}Cs source ID and calibration date _____

Update Probe

Date	Chan / LLD / ULD	Measured CPM	FWHM / % Var	Pass / Fail

There is a difference from counting with the well count and the uptake probe. One must assume that you are not familiar with how to peak the uptake probe and that information is provided.

1. Do not you're a rod source!
2. Take the ^{137}Cs sealed source and place it on the table next to the probe.
3. Select a distance between probe and source. <u>Always</u> keep the distant constant, whenever you measure the source.
4. Measure activity for 1 minute and enter data above.

Receiving Of A Radioactive Package

1. Date _____ and time _____
2. What is the content of the package?

3. Does the content match invoice? (circle one) Yes or No
4. Inspect the package on arrive.
    a. Is there damage? (circle one) Yes or No
    b. If yes, describe the damage. Was the RSO contacted?

    c. What is the package's label (circle one) White I, Yellow II, Yellow III)
    d. Survey meter Bkg = _____ mr/hr
    e. Survey @ 1 meter = _____ mr/hr
    f. Survey @ 1 meter = _____ mr/hr
5. Complete 100 cm^2 wipe test of the package
    a. Results, cpm = _____
    b. Rm Bkg, cpm = _____
    c. Net cpm = _____
    d. What is the well counter efficiency _____
    e. Results in dpm = _____
6. Monitor the empty package to assure that there is no radioactive contamination

Removable contamination should not exceed 0.001 uCi or 2200 dpm/cm^2

Dose Calibrator Accuracy Test

Using a low, medium, and high energy sealed source (repeat these steps for each source) determine dose calibrator accuracy. Suggest ^{57}Co, ^{137}Cs, and ^{60}Co

1. Select the appropriate dose calibrator setting and first measure record the background.
2. Now place the corresponding sealed source with the dose calibrator.
3. Assay the source x3 and record each reading.
4. Average the three reading.
5. Subtract the background.
6. Calculate the percent variation based on theoretical and measured levels of activity.
7. Record all your data.

Date _____

Name _____

Accuracy Test – Sealed Source 1

Radionuclide_____

Serial-Number_____

Theoretical Activity _____

Reading 1_____ Background _____

Reading 2 _____ Average Activity _____

Reading 3 _____ Net Activity _____

$$\frac{\text{Theoretical} - \text{Measured}}{\text{Theoretical}} \times 100$$ % Variation _____

Accuracy Test - Sealed Source 2

Radionuclide_____

Serial-Number_____

Theoretical Activity _____

Reading 1_____ Background _____

Reading 2 _____ Average Activity _____

Reading 3 _____ Net Activity _____

$$\frac{\text{Theoretical} - \text{Measured}}{\text{Theoretical}} \times 100$$ % Variation _____

Accuracy Test - Sealed Source 3

Radionuclide_____

Serial-Number_____

Theoretical Activity _____

Reading 1_____ Background _____

Reading 2 _____ Average Activity _____

Reading 3 _____ Net Activity _____

$$\frac{\text{Theoretical} - \text{Measured}}{\text{Theoretical}} \times 100$$ % Variation _____

Did any of the three energy levels fail? If so which one(s)?

Geometry Variation – Dose Calibrator

Date _____

Time the procedure was Started _____ **Ended** _____

Volume in mL	Measured Activity	Expected Activity	Percent Error
0.5			
1.0			
1.5			
2.0			
2.5			
3.0			

- Draw up between 1 – 10 mCi of ^{99m}Tc into a three mL syringe and expand to 0.5 mL.
- Measure and record each reading as quickly as possible.
- Background should not be an issue since that was measured with the morning QC. DC automatically subtracts it to give you net activity.
- Continue to expand you activity by 0.5mL intervals, measure it to the point where 3.0 mL is recorded.
- Activity levels should vary less than 10%.
- Greater amounts require a the determination of the correction factor.

$$\frac{\text{Measured - Expected}}{\text{Expected}} \times 100 = \% \text{ Error}$$

- Determine the difference between the measured and expected levels of activity for each volume and chart your answer above.
- Calculate % Error(s) for each

Questions

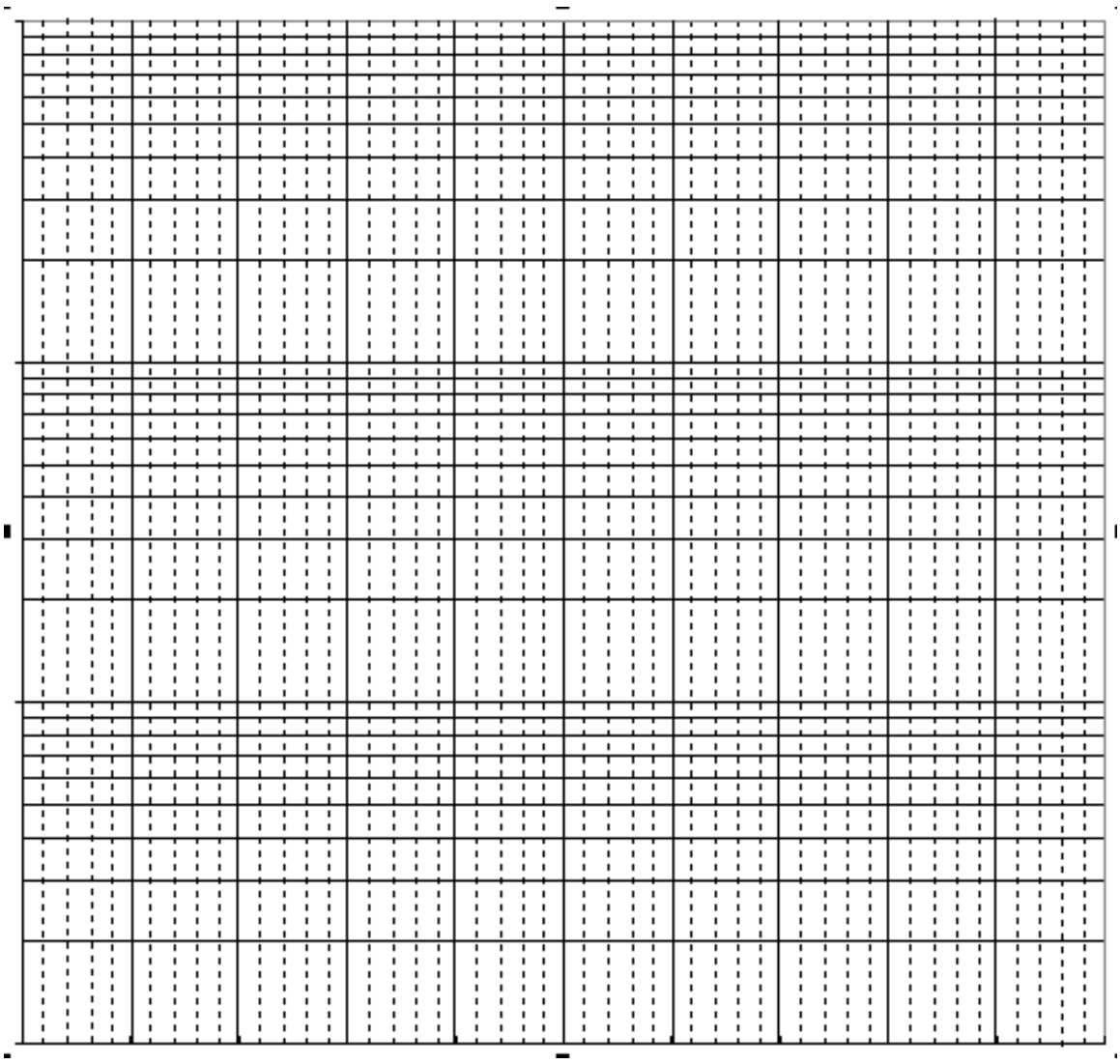
1. Is the variation acceptable?

2. If no, then what is/are the correction factors and where should it be applied?

Linearity Log - 1 (Complete Log – 2)

Date/Time	Measured Activity	Theoretical Activity	Difference in %

Plot the Linearity Curve



Calicheck Lab (Linearity)

1. Place the radioactivity into the dose calibrator and measure it with the designated tube or tubes. Write the measured activity in the second column. Note each cell requires 2 values.
2. Calculate the ratios in column B and write down your answer in column C. This is referred to as your Calibration Factor.
3. This lab needs to be repeated on another day and the data re-entered below. Then compare your CF factors between the two different days and generated a percent difference. Enter than data into the last column. The suggested variation is less than 5%, but must not exceed 10%.

Tubes (add and Combine)	Measured activity (mCi)	Calibration Factor	Final Product
	Measured Activity x	**Calibration Factor =**	**Final Product**
Black Black			
Black Black + Red			
Black Black + Orange			
Black Back + Yellow			
Black Black + Green			
Black Black + Blue			
Black Black + Purple			
Black Black + Purple + Red			
Black Black + Purple +Orange			
Black Black + Purple +Yellow			
Black Black + Purple +Green			
Black Black + Purple +Blue			
		Sum of the Products	
		Average of the Products	

Final Product

Should

Equal

±5% in each

Cell

Acceptable Range

5% Below _____

5% Above _____

Link to Manual - http://anyflip.com/gpad/xfek/basic

Comment on your results

Name _____

Nuclear Medicine Program - VCU

Constancy Log

Date	^{137}Cs			^{99m}Tc			^{111}In			^{123}I			Pass Y/N	Name
	TA	MA	%SD	TA	MA	%SD	TA	MA	%SD	TA	MA	%SD		

Sealed Source: 203.4 µCi of ^{137}Cs – Serial # 68964

TA – Theoretical Activity MA – Measured Activity

Calibration Date – 02/01/06

df ^{137}Cs for 1 month = 0.99808

$$\frac{\text{Measured µCi - Theoritical µCi}}{\text{Theortical µCi}} \times 100 = \% \text{ Variance}$$

DAILY AMBIENT RADIATION EXPOSURE RATE SURVEY

All Dose Rates Are in mR/hr **The Month and Year :**_____**Survey instrument:**_____

Location Date	1	2	3	4	5	6	7	8	9	Comments	SC Y/N	Initials

See department schematic to determine the corresponding numerical locations. SC - Source Check

Weekly Wipe Test
Department of Radiation Science
Nuclear Medicine Hot Lab

Well Counter Efficiency _____

Technologist _____

Date _____

Location	WIPE in CPM	BKG in CPM	Net CPM	DPM
1				
2				
3				
4				
5				
6				
7				
8				
9				

See department schematic to determine the corresponding numerical locations.

Weekly Wipe Test
Department of Radiation Science
Nuclear Medicine Hot Lab

Well Counter Efficiency _____

Technologist _____

Date _____

Location	WIPE in CPM	BKG in CPM	Net CPM	DPM
1				
2				
3				
4				
5				
6				
7				
8				
9				

See department schematic to determine the corresponding numerical locations.

Kit Compounding and QC – One Strips

Show your calculations

Date _____

This sheet should correspond to your morning elution and daily preparation documents.

Name of the pharmaceutical _____

Amount of activity and volume of ^{99m}Tc added _____mCi/mL

Amount of saline used to expand the kit _____ mL. Total volume _____

Kit concentration is _____mCi/mL @ _____ am/pm

Describe your compounding process (what as added, mixing, heating, sonic bath, incubation time?)

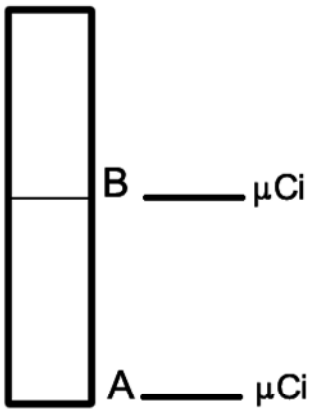
What color is the compounded solution? _____

What was the amount of measured activity in the vial? _____ mCi?

Using One TLC Strip

Write in the measured counts and µCi readings to calculate the percent bound.

surements with DC



Measurements with WC

% Bound Calculation

$$\frac{A}{A+B} \times 100$$

_____**% Bound**

_____**% Bound**

Which of the two TCL calculations most accurately reflects % Bound?

Kit Compounding and QC – Two Strips

Date _____

Name of the pharmaceutical _____

This sheet should correspond to your morning elution and daily preparation documents.

Amount of activity and volume of ^{99m}Tc added _____mCi/mL

Amount of saline used to expand the kit _____ mL. Total volume _____

Kit concentration is _____mCi/mL @ _____ am/pm

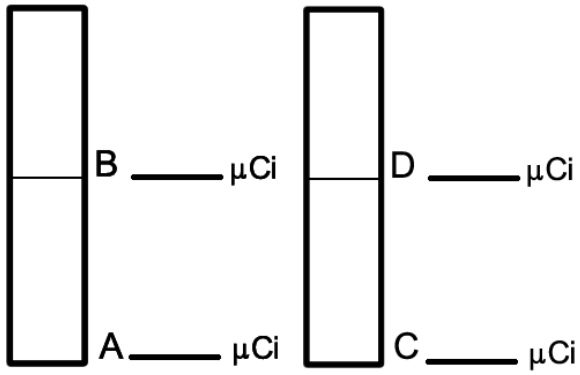
How did you make the kit (ingredients, mixing, heating, sonic bath, incubation time?)

What color is the compounded solution? _____

Describe your compounding process (what as added, mixing, heating, sonic bath, incubation time?)

.**Using Two TLC**

Write in the measured counts and µCi readings to calculate the % radiopharmaceutical purity.



% Bound Calculation

$$\frac{A}{A+B} \times 100$$

% HR Calculation

$$\frac{C}{C+D} \times 100$$

% Bound - % HR = % Radiochemical Purity

Enter your data on the next page

Measure and calculate TLC using your Well Counter, but only do this once. Always count your strips in the and Dose Calibrator.

Well counter data, calculations, and results (below)

% Bound _____ % HR _____ %RP _____

Dose Calibrator data, calculations, and results (below)

% Bound _____ % HR _____ %RP _____

In one of your 1-strip TLCs - Add 3 mL of air to the vial, mix 30 seconds, and let the vial stand for 5 minutes. Now repeat TLC calculations measurements with the well counter. Has %RP changed? If so, why?

Particle Size Evaluation

Using a compound microscope place the hemocytometer into the microscope's field of view.

Take a small quantity of ^{99m}TcMAA and place it underneath the slide cover of the hemocytometer. Focus the microscope on to the particles and evaluate the size of the particles.

Date _____

Identify the size of the particles

largest particle _____ µ

smallest particle _____ µ

average size particle _____ µ

Comments:

Take a small quantity of ^{99m}TcSC and place it under the slide cover of the hemocytometer . Focus the microscope on to the particles.

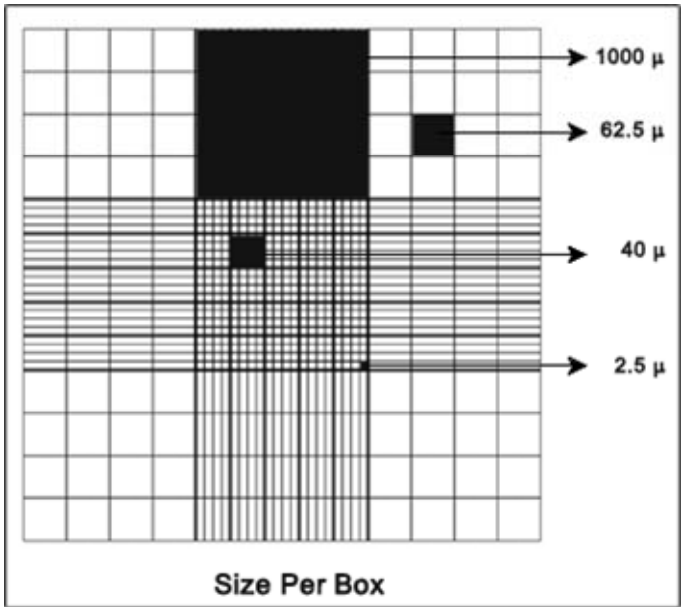
Date _____

Do you see in colloid particles? _____

Does the particle size pass the test? _____

Comments:

Measurements to determine particle size



Radioactive Storage and Disposal Record

Date - In	Radioisotope	Date Disposed	BKG <0.05 mr/hr	Trash mr/hr	Bin #	Signature

Process of trash disposal

1. When the “bin” is full, label it, measure it, and if the activity is above BKG place it in storage.
2. If there is no measureable activity label it, document BKG level, and dispose in routine trash.
3. If it’s in storage - after 10 $T_{1/2}$ measure the amount of activity and if it’s at BKG then it can be disposed of. If activity is above BKG, place back in storage and repeat step 3 after several $T_{1/2}$.
4. Document the disposal process by entering the above data for each “bin” of trash.

Kit Compounding and QC of Labeled RBCs

Not required~!

Name of the Clinical Affiliate _____

Labeling Process

1. Take a 5 mL syringe and wet it with heparin. Then remove 3 mL of patient's whole blood and place this into a reaction vial.
2. Mix gently the contents within the reaction vial and the whole blood and let stand for 5 minutes.
3. To the reaction vial add **syringe 1** (sodium hypochlorite), invert 4-5 times, then add contents from **syringe 2** (citric acid, sodium citrate, and dextrose) and invert vial another 4-5 times.
4. Add 10 – 100 mCi of $^{99m}TcO_4^-$ in no greater than a 3 mL solution into the reaction vial and invert 4-5 times . Now let the reaction vial stand for 20 minutes before injecting the dose into the patient. How much activity did you add to the reaction vial in how many mL?

   _____ mCi and _____ mL
5. What was the measured dose to the patient? _____ mCi

QC the Bound RBCs

1. Remove 0.2 mL of RBC from reaction vial and place into test tube.
2. Add 2.0 mL of saline and gently mix the solutions before centrifuging for 5 minutes. Make use the centrifuge is balanced with an equal amount of liquid at the opposite end. In practice, usually a second tubes of RBCs are used, in case someone messes up the pipetting of plasma.
3. Remove supernatant and place into separate test tube.
4. Measure supernatant (A) in dose calibrator and measure packed cells (B) in the dose calibrator.
5. Calculate the Radiochemical purity of the tagged cells

$$\frac{B}{A+B} \times 100$$

Should a Spill Occur Please follow the instructions below!
SPILL/CONTAMINATION PROCEDURES
FOR LOW AND HIGH DOSE UNSEALED SOURCES

MINOR SPILLS OF LIQUIDS AND SOLIDS

1. **NOTIFY:** Notify persons in the area that a spill has occurred.
2. **PREVENT THE SPREAD OF CONTAMINATION:** Cover the spill with absorbent paper.
3. **ABSORB LIQUID:** Wear gloves and protective clothing such as a lab coat and booties, and clean up the spill using absorbent paper. Carefully fold the absorbent paper with the clean side out and place in a bag labeled “caution radioactive material” for transfer to a radioactive waste container. All contaminated gloves and any other contaminated disposable material should be placed in the bag.
4. **SURVEY:** With a G.M. survey meter, check for removable contamination to ensure contamination levels are below trigger levels. Check the area around the spill. Also, check hands, clothing, and shoes of self and anyone else who may be potentially contaminated.
5. **DECONTAMINATE:** Clean the area with a soap solution. Perform a swipe survey to check for removable contamination. Continue decontamination efforts until swipe surveys show less than the trigger level.
6. **REPORT:** Report the incident to the Radiation Safety Section and Nuclear Medicine Manager. Complete “Spill/Contamination Incident Report” and deliver to Nuclear Medicine Manager.

MAJOR SPILLS OF LIQUIDS AND SOLIDS

1. **CLEAR THE AREA:** Notify all persons not involved in the spill to vacate the room.
2. **PREVENT THE SPREAD OF CONTAMINATION:** Cover the spill with absorbent pads labeled “caution radioactive material”, but do not attempt to clean it up. To prevent the spread of contamination, clearly indicate the boundaries of the spill and limit the movement of all personnel who may be contaminated.
3. **SHIELD THE SOURCE:** If possible, the spill should be shielded, but only if it can be done without further contamination or significant increase in radiation exposure.
4. **CLOSE THE ROOM:** Close the room and lock or otherwise secure the area to prevent entry.
5. **CALL FOR HELP:** Notify the Radiation Safety Section immediately. Notify Nuclear Medicine Manager immediately. Complete “Spill/Contamination Incident Report” and deliver to Nuclear Medicine Manager (following personnel decontamination procedure).
6. **PERSONNEL DECONTAMINATION:** Remove contaminated clothing and flush contaminated skin with lukewarm water and then wash with mild soap. If contamination remains, induce perspiration by covering the area with plastic. Then wash the affected area again to remove any contamination that was released by the perspiration.

RADIATION SAFETY SECTION: 828-9131

GUIDELINES FOR DETERMINING
MINOR SPILL VS. MAJOR SPILL

Estimate the amount of radioactivity spilled. Institute a major or minor spill/contamination procedure based on the table below. Spills/contamination above the millicurie trigger level are considered major. Spills below the millicurie trigger level are considered minor. Downgrade to minor spill following decay or restrict access pending complete decay.

Trigger Level Table

Radionuclide	**Millicurie Trigger Level** Minor Spill if Under/ Major Spill if over	**Trigger Levels Restricted area DPM**	**Trigger Level Unrestricted Area DPM**
Diagnostic	**mCi**		
F-18	100	20,000	2,000
Ga-67	10	20,000	2,000
I-123	10	2,000	2,000
In-111	10	2,000	2,000
Tc-99m	100	20,000	2,000
Tl-201	100	20,000	2,000
Therapeutic			
I-131	1	2,000	200
P-32	1	2,000	2,000
Sm-153	1	2,000	2,000
Sr-89	1	2,000	2,000
Y-90	1	2,000	2,000

NUCLEAR MEDICINE
RADIOACTIVE MATERIAL SPILL/CONTAMINATION INCIDENT REPORT

Technologist involved in spill: _____ Date: _____

Approximate millicurie amount of spill: _____ Isotope: _____
Location of spill room:

Major or Minor Spill (circle one)

Description of Incident:

Notification:

		Pre-Clean			Post-Clean		
Personnel Contaminated	**Contaminated**	**mR/hr**	**DPM**	**Time**	**mR/hr**	**DPM**	**Time**
	Yes No						
	Yes No						
	Yes No						
	Yes No						
	Yes No						

Survey and Contamination Control:

	Pre Clean			Post Clean		
Area/Items Contaminated	**mR/hr**	**DPM**	**Time**	**mR/hr**	**DPM**	**Time**

Decontaminate:

- **Contacted Radiation Safety YES NO If no why?**

- **Who did you speak to? _____ Date: _____ Time: _____**
- **What instructions were you given?**
- **Proceed with decontamination.**

- **Wait for Radiation Safety for decontamination supervision.**
  - **Other:**

Incident Reported to:

- Nuclear Medicine Faculty or Staff (required):

- Radiation Safety (required):

- Other
- :

Follow up actions:

Student Completing Report: _____ Date: _____

Faculty Reviewing Report: _____ Date: _____

Department Chair Reviewing Report: _____Date: _____

Additional Comments?

Area Surveys and Wipe Testing for rooms 3101 and 3101A

Surveys will be completed at the end of each day when unsealed sources are present. This will be in conjunction with a student lab.

Wipe testing will be completed at the end of each week when unsealed sources are present. This will be in conjunction with a student lab. Only those areas where the unsealed source is applied will a wipe test be completed.

The laboratory map shows Rooms 3101 and 3101A. These rooms are marked with numbers 1 through 9, which is where surveys and wipes will be completed.