The Nuclear Pharmacy

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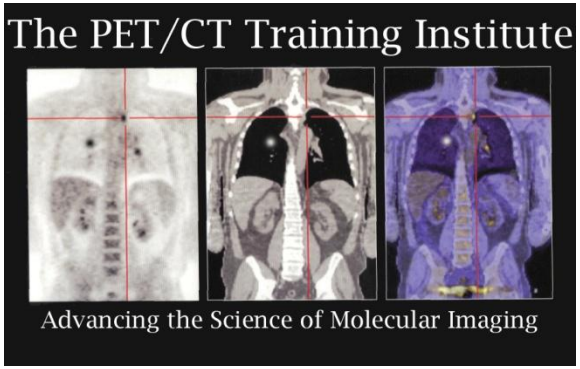

NMTCB/SNMTB Approved

- 45-Hour Alternative Eligibility Course
- “The Nuclear Pharmacy”
- SNMTS Voice Credit: #028719 2.0 CEH’s

Program Objectives

Discuss equipment found in the nuclear pharmacy
Review the Dose Calibrator Quality Control procedures
Review the Survey Meter Quality Control procedures
Discuss Area Surveys
Review Ancillary Equipment in the Hot Lab
Review the Unit Dose Manager
Discuss Radioactive Receipts
Review Waste Logs
Review Hot Lab Record Keeping

Typical Equipment found in the Nuclear Medicine Radiopharmacy

- Dose calibrator
- Survey Meter
- Unit Dose Manager
- Safety Equipment

Dose Calibrators or Activity Calibrators

A Dose calibrator is a well-type ionization chamber that is used for assaying gamma ray emitting radioactivity. Dose calibrators are used for measuring or verifying the activity of radionuclides for patient administration and technetium 99m (Tc-99m) generator eluates, shipments of radioactivity received from suppliers, and similar quantities of activity for assay.

- **The DETECTOR in the Dose Calibrator**

- **The detector element for a dose calibrator is a gas-filled ionization chamber, sealed to avoid variations in response with changes in ambient temperature and atmospheric pressure. The gas used is argon, which is pressurized to about 20 atmospheres.**

Different radionuclides with the same amount of activity will produce different amounts of electrical current in the ionization chamber because they emit different energy gamma rays.

Ionization chambers cannot be used to identify radionuclides on the basis of gamma ray energy, like detectors with pulse-height analysis capabilities. They must be calibrated with known amounts of activity for different radionuclides.

Once the calibration factors are known, then the unknown radioactivity of a given radionuclide is easily obtained by dividing the current produced in the chamber by the calibration factor for that radionuclide.

Dose calibrators utilize plug-in resistor modules, pushbuttons, or other selector mechanisms with a predetermined calibration factor to "adjust" the electrometer readout and display the activity of the selected radionuclide directly in mCi or µCi units.

The Tc-99m source in a dose calibrator will display radioactivity at settings for other radionuclides, however these will not be correct measurements of the Tc-99m radioactivity since other calibration

Quality Control Procedures for a Dose Calibrator

Quality Control

- Quality control is the term used to refer to the routine assessment of instrument performance in nuclear medicine
- Quality control procedures should be used to establish a baseline level of performance
- Action levels are required by the Society of Nuclear Medicine


SUITABLE FOR
PET
CRC-15 R
Dose Calibrator
item #5130-3056
CRC-127 R
Dose Calibrator
item #5130-3032

The quality control program for a Dose Calibrator consists of a series of procedures that measures its:

- Constancy
- Linearity
- Geometry Dependence
- Accuracy

CONSTANCY TEST

- Constancy means reproducibility in measuring a constant source over a long period of time.
- Assay at least one relatively long-lived source such as Cs-137, Co-60, or Co-57 using a reproducible geometry each day before using the calibrator.
- Use the following procedure:

A. Assay each reference source, using the appropriate dose calibrator (i.e., use the Cs-137 setting to assay Cs-137)

B. Measure background at the same setting, and subtract or confirm the proper operation of the automatic background subtract circuit if it is used.

C. For each source used, either plot on graph paper or log in a book the background level for each setting checked and the net activity of each constancy source.
D. Using one of the sources, repeat the above procedure for all commonly used radioisotope settings. Plot or log in the results.
E. Establish an action level or tolerance for each recorded measurements at which the individual performing the test will automatically notify the chief technician or authorized user of a suspected malfunction of the calibrator. These action levels will be written in the log book or posted on the calibrator. The regulation requires repair or replacement if the error exceeds 10 percent.

LINEARITY TEST

- Linearity means that the calibrator is able to indicate the correct activity over the entire range of use of that calibrator.
- This test will be done using a vial or syringe of Tc-99m whose initial activity is at least as large as the maximum activity normally assayed in a prepared radiopharmaceutical kit, in a unit dosage syringe, or in a radiopharmaceutical therapy dose, whichever is largest.
- The test shall continue until the activity contained in the vial or syringe is smallest activity assayed, but greater than 10 microcuries.
- Linearity test is done at installation and at least every three months. Repair, replace or a correction factor is done if the result is outside plus or minus 10 percent.

Decay Method

A. Assay the Tc-99m syringe or vial in the dose calibrator, and subtract background to obtain the net activity in millicuries. Record the date, time to the nearest minute, and net activity. This first assay should be done in the morning at a regular time, for example, 8:00 a.m.
B. If starting at 8:00a.m., repeat the assay at 2:00 p.m. Continue on subsequent days until the assayed activity is less than the minimum activity normally assayed. For dose calibrators with a range switch, select the range normally used for the measurement.
C. Convert the time and date information recorded for each assay to hours elapsed since the first assay.

D. On a sheet of semi-log graph paper, label the logarithmic vertical axis in millicuries and label the linear horizontal axis in hours elapsed. At the top graph, note the date and the manufacturer, model number, and serial number of the dose calibrator. Plot the data.

E. Draw a "best fit" straight line through the data points. For the point farthest from the line, calculate its deviation from the value on the line.

$$\frac{\text{A observed} - \text{A line}}{\text{A line}} = \text{deviation}$$

F. If the worst deviation is more than plus or minus 0.10, the dose calibrator should be repaired or adjusted. If this cannot be done, it will be necessary to make a correction table or graph that will allow you to convert from activity indicated by the dose calibrator to "true activity"

G. Put a sticker on the dose calibrator that says when the next linearity test is due.

Shield Method

For initial calibration or reinstallation of the dose calibrator the decay method will be used to determine linearity and to establish calibration factors for shield methods.

- The Calicheck device will be used for doing linearity test of the dose calibrator. These procedures must be in writing and available for review by the department.
- The Lineator device will be used for doing linearity test of the dose calibrator. These procedures must be in writing and available for review by the department.
- A set of “sleeves” of various thickness will be used to test for linearity other that the Calicheck or Lineator device. The sleeves will be calibrated using the following procedure.

Calibration of the Sleeves

A. Begin the linearity test as described in the above decay method. After making the first assay, the sleeves will be calibrated as follows. Steps B – D below must be completed within six minutes.
B. Put the base and sleeve one in the dose calibrator with the vial. Record the sleeve number and indicated activity.
C. Remove the sleeve one and put in sleeve two. Record the sleeve number and indicated activity.
D. Continue for all sleeves.
E. Complete the decay method linearity test steps B – G above.
F. From the graph made in step D of the decay method, find the decay time associated with activity indicated with sleeve one in place. This is the “equivalent decay time” for sleeve 1. Record that time with the data recorded in step B.
G. Find the decay time associated with the activity indicated with sleeve 2 in place. This is the “equivalent decay time” for sleeve 2. Record that time with the data recorded in step C.

H. Continue for all sleeves.
I. The table of sleeve numbers and equivalent decay times constitutes the calibration of the sleeve set. The sleeve set may now be used to test dose calibrators for linearity.

Calibration of the Dose Calibrator

A. Assay the Tc-99m syringe or vial in the dose calibrator, and subtract background to obtain the new activity in millicuries. Record the net activity.
B. Steps C – E below must be completed within six minutes.
C. Put the base and sleeve 1 in the dose calibrator with the vial. Record the sleeve number and indicated activity.
D. Remove sleeve one and put it in sleeve two. Record the sleeves number and indicated activity.
E. Continue for all sleeves.

F. On a sheet of semi-log graph paper, label the logarithmic vertical axis in millicuries, and label the linear horizontal axis in hours elapsed. At the top of the graph, note the date and the model number and serial number of the dose calibrator.

G. Plot the data using the equivalent decay time associated with each sleeve.

H. Draw a "best fit" straight line through the data points. For the point farthest from the line, calculate its deviation from the value on the line.

$$\frac{\text{A observed} - \text{A line}}{\text{A line}} = \text{deviation}$$

I. If the worst deviation is more than plus or minus 0.10, the dose calibrator should be repaired or adjusted. If this cannot be done, it will be necessary to make a correction table or graph that will allow a conversion from activity indicated by the dose calibrator to "true activity".

J. Place a sticker on the dose calibrator that says when the next linearity test is due.

GEOMETRY DEPENDENCE TEST

- Geometry dependence means that the indicated activity does not change with volume or configuration.
- This test will be done using a syringe that is normally used for injection.
- The following test assumes injections are done with 3-cc plastic syringes and that radiopharmaceutical kits are made in 30-cc glass vials.
- If volumes of syringes and vials differ from above, then the procedures will be changed so that the syringes and vials are tested throughout the range of volumes commonly used.
- Geometry dependence is done at installation. Repair, replace or correction factor is done if outside plus or minus 10 percent.

A. In a small beaker or vial, mix 2 cc of a solution of Tc-99m with an activity concentration between 1 and 10 mCi/ml. Set out a second small beaker or vial with non-radioactive saline or tap water.
B. Draw 0.5 cc of the Tc-99m solution into the syringe and assay it. Document the volume, millicuries and record instrument setting.
C. Remove the syringe from the calibrator, draw an additional 0.5 cc of non-radioactive saline or tap water, and assay again. Record the volume and millicuries indicated.

D. Repeat the process until a 2.0-cc volume has been assayed.

E. Select as a standard the volume closest to that normally used for injections. For all the other volumes, divide the standard millicuries by the millicuries indicated for each volume. The quotient is a volume correction factor. The data will be graphed with horizontal 10 percent error lines drawn above and below the chose “standard volume”.

F. If any correction factor are greater than 1.10 or less than 0.90, or if any data points lie outside the 10 percent error lines, it will be necessary to make a correction table or graph that will allow conversion from “indicated activity” to “true activity”. If it is necessary, label the table or graph “syringe geometry dependence”, and note the date of the test and the model number and serial number of the calibrator.

ACCURACY TEST

- Accuracy means that, for a given calibrated reference source, the indicated millicuries value is equal to the millicuries value determined by the National Institute of Standards and Technology (NIST) or by the supplier who has compared that source to a source that was calibrated by the NIST.
- At least two sources with different principal photon energies (such as Co-57, Co-60, or Cs-137) will be used.
- One source will have principal photon energy between 100 keV and 500 keV.
- If a Ra-226 source is used, it will be at least 10 microcuries; other sources will be at least 50 microcuries.
- Use at least one reference source with an activity in the range of activities normally assayed.
- Accuracy test is done at installation and annually thereafter. Repair or replace if outside plus or minus 10 percent.

A. Assay a calibrated reference source at the appropriate setting (i.e., use the Co-57 setting to assay Co-57), and then remove the source and measure background. Subtract background from the indicated activity to obtain the net activity. Record this measurement. Repeat for a total of three determinations.
B. Average the three determinations. The average value should be within 10 percent of the certified activity of the reference source, mathematically corrected for decay.
C. Repeat the procedure for other calibrated reference sources.
D. If the average value does not agree, within 10 percent, with the certified value of the reference source, the dose calibrator must be repaired or replaced.

DOSE CALIBRATOR DAILY CHECK LOG

Facility: _____

Month: _____
Year: _____

Dose Calibrator Model: _____
Serial Number: _____

Cs-137 source ID: _____
Co-57 source ID: _____
Ba-133 source ID: _____

Day	Test (Volts)	Bkg (uCi)	Cs-137 Source								Co-57 Source		Ba-133 Source		Initials
			Cs-137	Tc-99m	I-131	I-123	Xe-133	Ga-67	Tl-201	Other	Co-57	Tc-99m	Ba-133	I-131	
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Form provided by: DTC, Inc., 5930 Roe Ave., Mission, KS 66205 (913) 236-6000

DOSE CALIBRATOR LINEARITY TEST

Facility: _____ Calibrator Manufacturer: _____

Model: _____

Serial Number: _____

NOTE: Initial activity must be greater than the maximum dose given to any patient. Measurements must be continued until the measured activity is less than 30 uCi (NRC), 10 uCi (most Agreement States), or as stated by the facility license.

Date	Time of Day (Military Time)	Measured Activity (mCi)	Range Setting	Initials

Form provided by: DTC, Inc., 5930 Roe Ave., Mission, KS 66205 (913) 236-6000

(913) 236-6655 FAX

Survey Instruments

The interpretation of the studies performed in nuclear medicine are done assuming that all the systems used are reliable and accurate

Survey Meters

The Geiger Mueller (GM) detector is the most common instrument used for contamination surveys in a nuclear medicine department. It is a gas-filled detector that is very sensitive to small amounts of radioactivity.

GM detectors are incapable of differentiating types of radiation like gamma rays and beta particles, and incapable of energy discrimination. However they are excellent in detecting contamination and are also used in certain types of wipe test counters.

Survey Meter

- A radiation survey meter is used to detect moderate to high energy beta, gamma and x-ray radiation
- The unit is composed of a probe to detect radioactivity, the base containing the electronics, and the meter face.

Survey Meter

- Two types of survey instruments are commonly used:
  - The cutie-pie, it has an ionization chamber for areas of high levels of x-rays or gamma-rays
  - The Geiger-Mueller counter is used for lower levels of radiation because of its higher sensitivity
  - They both require an annual calibration and a daily constancy testing with long lived radionuclide standards

Quality Control

- Quality control sometimes called QC, is the term used to refer to the routine assessment of instruments performance in nuclear medicine. It is very important.
- Once acceptance tests are completed and it is determined that the camera is satisfactorily operating and meets the vendors specifications.
- Quality control procedures should be used to establish a baseline level of performance
- Quality control procedures are then used each day to monitor the continued performance of the instrument

Accuracy

- Survey instruments are calibrated before first use, annually and after repair
- Calibration is performed at two different operating points of the instruments scale, 1/3 and 2/3 of the full scale
- The standard used must be traceable within 5% accuracy to the NIST, (National Institute of Standards and Technology)
- Many departments send their instruments out for calibration because they do not wish to keep a standard source on hand.

Accuracy

- Differences
  - Ionization chambers respond in proportion to the total energy deposited in the detector, and it can be related to exposure rate, no matter what the energy of the incoming photon
  - Geiger-Mueller detectors produces pulses with sizes that are independent of energy deposited. Count rate may only be related to exposure rate if the energy of the radiation is known. This can be done if the photon energy used to calibrate the detector is the same as the source measured

Constancy

- A reference with a long half life must be used to check the constancy of the survey meter performance
- Initial measurement of the source (CPM) or exposure rate (mR/hr) is made at time of calibration and should be noted on the instrument
- The source is checked with the same source each day the instrument is used, after battery change and maintenance
- If the exposure rate or cpm is not within 10% of expected results, it should be recalibrated

Regulations require exposure rate surveys to be made in areas of the nuclear medicine department and are best performed using an ionization chamber that will read out directly in units of exposure (Roentgen or coulombs/kg).

Facilities use GM detectors for this purpose, even though most GM detectors are not designed to measure exposure or exposure rate except under certain conditions.

GM instruments are usually calibrated with cesium 137 (Cs-137), that emits a 662 keV gamma ray (recall that Tc-99m emits a 140 keV gamma ray). Still, making exposure or exposure rate measurements for Tc-99m with a GM instrument calibrated with Cs-137 is acceptable to regulatory agencies.

Steps to take when using a survey meter:

1. **Check** for a calibration sticker. The CNSC requires meters used for dose rate measurements (i.e. mR/hr or mSv/hr) to be calibrated annually.
   Note: instruments that read in counts per minute (cpm) or counts per second (cps) are called "contamination meters" and cannot be calibrated. Instead they are given a verification check on an annual basis to see if they operate well.

Cont.

2 **Ensure that the probe is capable of detecting the radioisotope you are using. If unsure, contact the RSO.**

3 **Check for tightness of cable connections. Loose cable connections can cause instrument damage.**

4 **Perform a battery check.**

5 **Turn the on/off switch to the lowest multiplication scale. Turn on the audio and ensure the unit is on the "F" position, if there is a F/S switch.**

Cont.

6 **Allow the unit to warm up (15-20 seconds). Determine the background. This should be done away from sources of radioactivity.**

7 **Measure the area of radioactivity, by placing the probe as close as possible to the area being monitored without actually touching it. Note the audio function will guide you to the source of contamination.**

8 **Find the highest count rate and record it in cpm. Determine the spread of the contamination. Take a wipe to determine if the contamination is removable.**

9 **Never forget to turn off the survey meter once the work is completed.**

Interpreting survey meter readings

- When using an end window or pancake probe:
  Survey Meter Readings
  Assessment of Measurements

- 0-200 cpm / 0-0.05 mR/hr
- Background readings

- 200-400 cpm / 0.05-0.1 mR/hr
- Suspect contamination

- >400 cpm / >0.1 mR/hr
- Contamination

Nuclear survey meter - $315 each
List: $950. MedCon: VG. Bicron Surveyor, portable or stationary survey meters for hot rooms.
Hand portable unit, battery operated with standard commercial 9 volt batteries.
May be used for either area surveys, or stationary on the counter of hot lab to monitor radiation during dose preparation.

Radiation survey monitor - $375 each
List: $2370. MedCon: EX. radiation survey monitor, for use and nuclear medicine labs and hot rooms.
Made by Mini instruments company, United Kingdom.

Features:
count display, 0.5-2000 counts per second
built in battery test
radiation sensitivity as noted per table on back of unit in photograph
adjustable sensitivity built in alarm
completely hand portable

Survey Meter Records

- Meters must be calibrated annually. At this time, exposure reading from a check source is placed on a label attached to the meter.
- Before each use, a reading of the check source must be done to ensure proper operation.

Sample Survey Meter Form

Survey Meter Record

Site______________________ Survey Meter Serial #_________________

Calibration Date (Last)_________ Calibration Date (Next)____________

Exposure reading from check source at last calibration ______________

Check source used ______________

****

Check source reading on: ________ Expected ________ Actual ________

Condition___________________ Battery Check __________Initials____

Check source reading on: ________ Expected ________ Actual ________

Condition___________________ Battery Check __________Initials____

Check source reading on: ________ Expected ________ Actual ________

Condition___________________ Battery Check __________Initials____

Check source reading on: ________ Expected ________ Actual ________

Condition___________________ Battery Check __________Initials____

Check source reading on: ________ Expected ________ Actual ________

Condition___________________ Battery Check __________Initials____

Check source reading on: ________ Expected ________ Actual ________

Condition___________________ Battery Check __________Initials____

Check source reading on: ________ Expected ________ Actual ________

Condition___________________ Battery Check __________Initials____

Area Survey Records

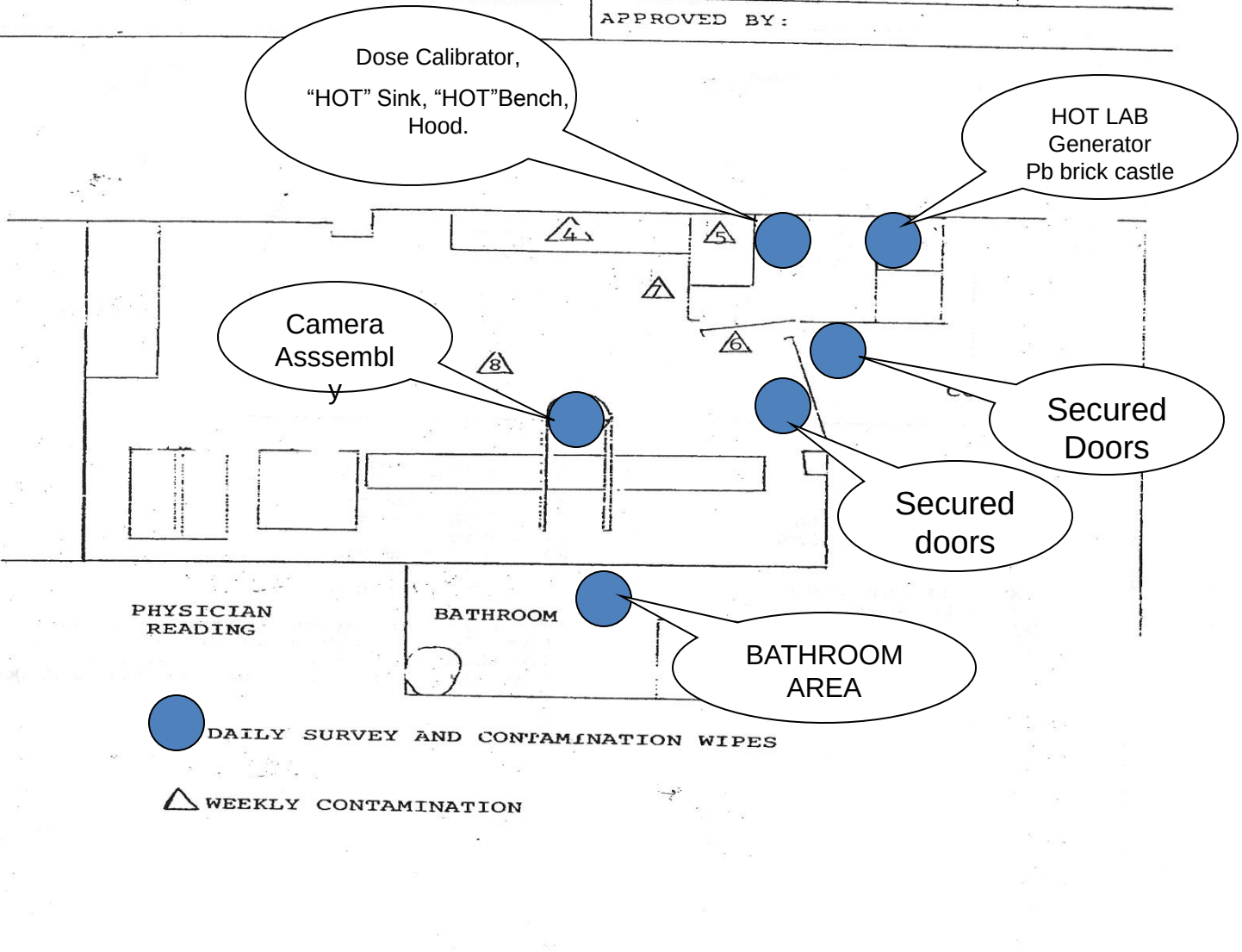
- **1. Survey at the end of each day of use with a radiation detection survey meter in radiopharmaceutical elution, preparation, and administration areas. If diagnostic administrations are occasionally made in patients' rooms and special care is taken to remove all paraphernalia, those rooms need not be surveyed,**
- **2. Survey weekly with a radiation detection survey meter in radiopharmaceutical storage and radiopharmaceutical waste storage areas,**
- **3. Survey quarterly with a radiation measurement survey meter in sealed source and brachytherapy storage areas,**
- **4. Immediately notify the radiation safety officer (RSO) if you find unexpectedly high or low levels.**

What to have on survey records

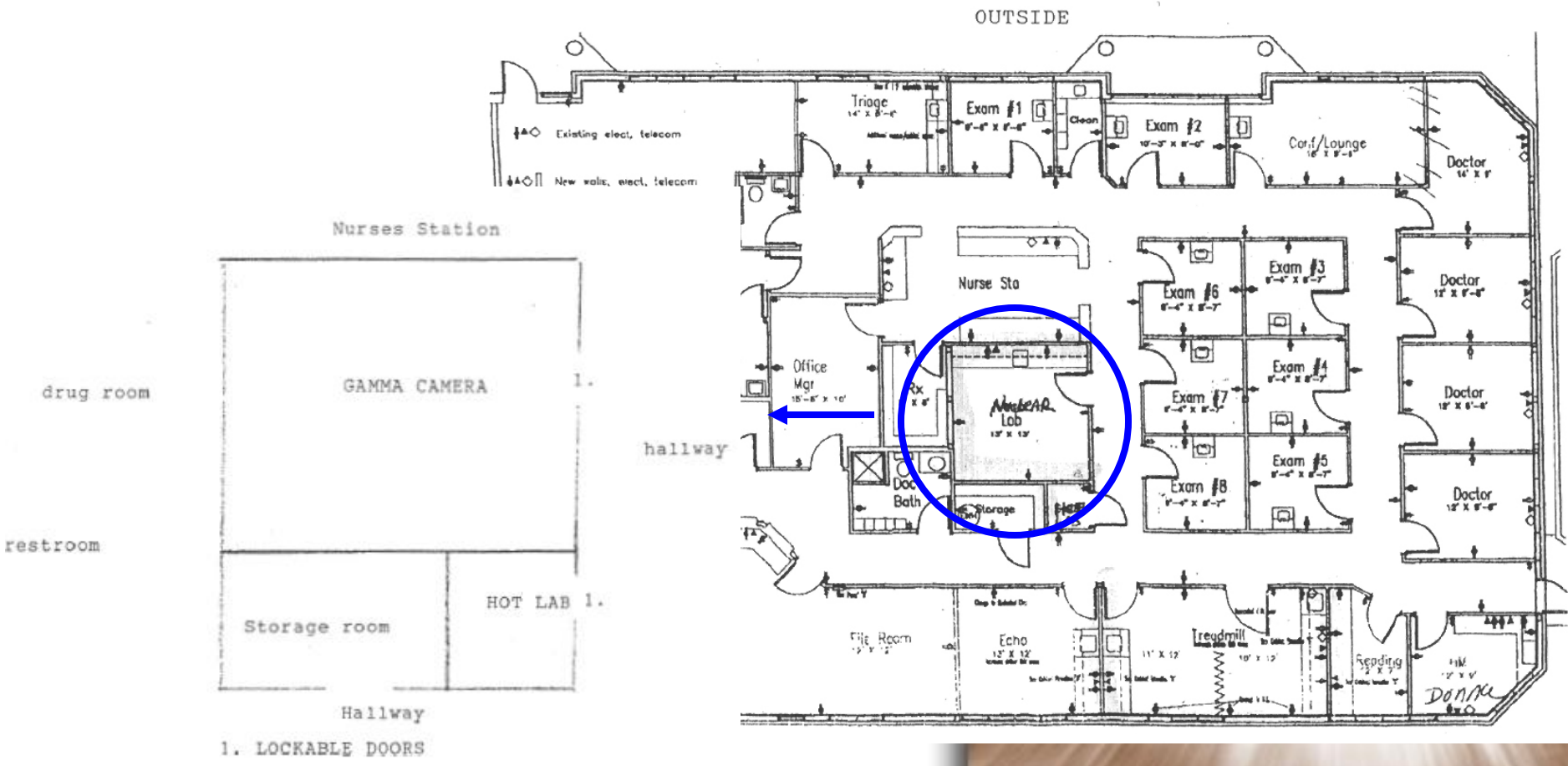
- **The date, area surveyed**
- **A sketch of each area surveyed**
- **Action levels established for each area**
- **Measured doserate at several points in each area, expressed in millirems (microseiverts) per hour or the removable contamination in each area expressed in disintegrations per minute (becquerels) per 100 cm2, or counts per minute if performed with a radiation survey instrument as described in Appendix B**
- **The serial number and the model number of the instrument used to make the survey or analyze the samples**
- **The initials of the person who performed the survey**

COLUMBIA MEDICAL CENTER-COLLEGE STATION
TEXAS

SUBJECT: RADIATION AND CONTAMINATION SURVEYS	ISSUED: 4/87	REVISED: 6/96	NO.
	APPROVED BY:		



Nuclear Medicine Facility



SW FL HRT GRP- BONITA

3501 HEALTH CENTER BLVD.
SUITE 2330
FT MYERS, FL 34135

Survey Summary Check Report - Wipes & Surveys

1/1/05 to 1/31/05

Location: Nuclear Medicine Department SW FL Heart Group- Bonita

Area Wipe Survey Wipe test WEEKLY WIPE TEST

Survey Area 2005	Reading: Cpm / Efficiency% / Net results: DPM / Action Level	Date: / Time: / Bkgnd:	01/03 14:42 20	01/05 13:26 20	01/06 12:33 20	01/14 13:40 20	01/18 14:08 20	01/27 13:35 30
	Survey Instrument Lab-ID/Initials:		S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM
01 TREADMILL			20	20	30	20	20	30
			10	10	10	10	10	10
			0	0	100	0	0	0
			20000	20000	20000	20000	20000	20000
02 DOSE CALIBRATOR			40	20	40	20	20	30
			10	10	10	10	10	10
			200	0	200	0	0	0
			20000	20000	20000	20000	20000	20000
03 DOSE PREP AREA			40	20	20	20	20	30
			10	10	10	10	10	10
			200	0	0	0	0	0
			20000	20000	20000	20000	20000	20000
04 KEYBOARD			20	20	20	20	20	30
			10	10	10	10	10	10
			0	0	0	0	0	0
			20000	20000	20000	20000	20000	20000
05 SINK HOT LAB			20	20	20	20	20	30
			10	10	10	10	10	10
			0	0	0	0	0	0
			20000	20000	20000	20000	20000	20000

Area Meter Survey Survey test DAILY SURVEY TEST

Survey Area 2005	Net results: mR/Hr / Action Level	Date: / Time: / Bkgnd:	01/03 14:41 0.01	01/04 13:46 0.01	01/05 13:28 0.01	01/06 12:32 0	01/07 11:33 0.01	01/10 07:32 0.01	01/10 13:35 0.01	01/11 07:59 0.01	01/12 14:10 0.01	01/13 12:32 0.01
	Survey Instrument Lab-ID/Initials:		S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM
06 CAMERA			0	0	0	0.01	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
07 CAMERA ROOM FLOOR			0	0	0	0.01	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
08 PATIENT TOILETS			0.01	0	0	0.01	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
01 TREADMILL			0	0	0	0.01	0	0	0	0	0	0

Radiation Safety Officer:_____

Location: Nuclear Medicine Department SW FL Heart Group- Bonita

Survey Area 2005	Net results: mR/Hr Action Level	Date:	01/03	01/04	01/05	01/06	01/07	01/10	01/10	01/11	01/12	01/13
		Time:	14:41	13:46	13:28	12:32	11:33	07:32	13:35	07:59	14:10	12:32
		Bkgnd:	0.01	0.01	0.01	0	0.01	0.01	0.01	0.01	0.01	0.01
	Survey Instrument Lab-ID/Initials:		S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM
			5	5	5	5	5	5	5	5	5	5
04 KEYBOARD			0	0	0	0.01	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
02 DOSE CALIBRATOR			0.01	0	0	0.01	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
03 DOSE PREP AREA			0.01	0	0	0.01	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
05 SINK HOT LAB			0	0	0	0.01	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
09 WASTE CANS			0	0	0	0.01	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5

Survey Area 2005	Net results: mR/Hr Action Level	Date:	01/14	01/17	01/18	01/19	01/20	01/21	01/24	01/25	01/26	01/27
		Time:	13:39	14:26	13:59	12:57	12:36	09:36	14:17	13:53	13:44	13:30
		Bkgnd:	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Survey Instrument Lab-ID/Initials:		S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM	S1/TKM
06 CAMERA			0	0	0	0	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
07 CAMERA ROOM FLOOR			0	0	0	0	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
08 PATIENT TOILETS			0	0	0	0	0	0	0	0.01	0	0
			5	5	5	5	5	5	5	5	5	5
01 TREADMILL			0	0	0	0	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
04 KEYBOARD			0	0	0	0	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
02 DOSE CALIBRATOR			0	0	0	0	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
03 DOSE PREP AREA			0	0	0	0	0	0	0	0.01	0	0
			5	5	5	5	5	5	5	5	5	5
05 SINK HOT LAB			0	0	0	0	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5
09 WASTE CANS			0	0	0	0	0	0	0	0	0	0
			5	5	5	5	5	5	5	5	5	5

Survey Area 2005	Net results: mR/Hr Action Level	Date:	01/28	01/31
		Time:	15:07	13:29
		Bkgnd:	0.01	0.01
	Survey Instrument Lab-ID/Initials:		S1/TKM	S1/TKM
06 CAMERA			0	0
			5	5

Radiation Safety Officer:_____

Location: Nuclear Medicine Department SW FL Heart Group- Bonita

Survey Area 2005	Net results: mR/Hr Action Level	Date: Time: Bkgnd:	01/28 15:07 0.01	01/31 13:29 0.01
	Survey Instrument Lab-ID/Initials:		S1/TKM	S1/TKM
07 CAMERA ROOM FLOOR			0	0
			5	5
08 PATIENT TOILETS			0	0
			5	5
01 TREADMILL			0	0
			5	5
04 KEYBOARD			0	0
			5	5
02 DOSE CALIBRATOR			0	0
			5	5
03 DOSE PREP AREA			0	0.01
			5	5
05 SINK HOT LAB			0	0
			5	5
09 WASTE CANS			0	0
			5	5

Survey Instrument List for summary reports

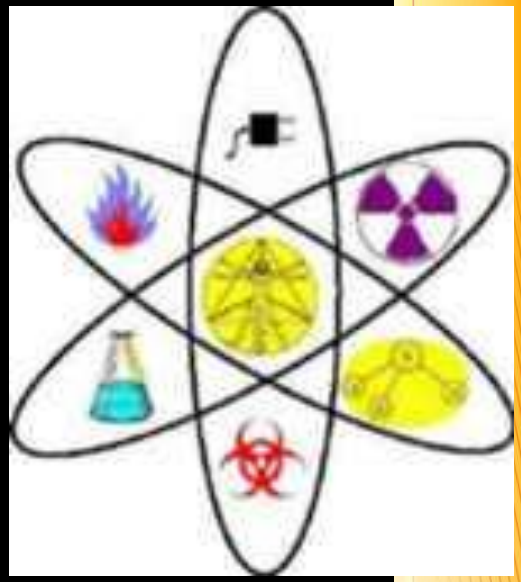
Lab ID	Instrument	Make	Model	Serial number	Last calibration
S1	LUDLUM 194301	LUDLUM	14C	194301	6/10/04
S1	LUDLUM 194301	LUDLUM	14C	194301	6/10/04

Radiation Safety Officer:_____

Ancillary Equipment

Safety Equipment

- L- blocks
- Syringe shields
- Container shields
- Sharps containers
- Latex gloves
- Ammo boxes



Lead Blocks (L-blocks)

Nuclear medicine makes extensive use of shielding. Work is performed behind an L-block, a physical barrier consisting of a lead front shield and base, with leaded glass for viewing the work area.

L-blocks are designed based upon the highest energy and amount of radioactivity used in the intended work area. Lead bricks may also be added for partial barriers.

Syringe Shields

Syringe shields are very effective in reducing exposure to the occupational worker's hands and fingers during patient injection.

Syringe shields should be thick enough to protect the occupational worker from the highest photon energy in use.

Container Shields

Container shields are also effective at reducing dose exposure to the occupational worker during manipulation of multi-use vials.

Sharps Containers

All biological hazard material must be properly stored and disposed. Sharps containers are commonly used to store needles, scalpels, IV tubing and other equipment containing biological fluids.

If radioactive material is present, these containers may be encased in lead and appropriately labeled.

Latex Gloves

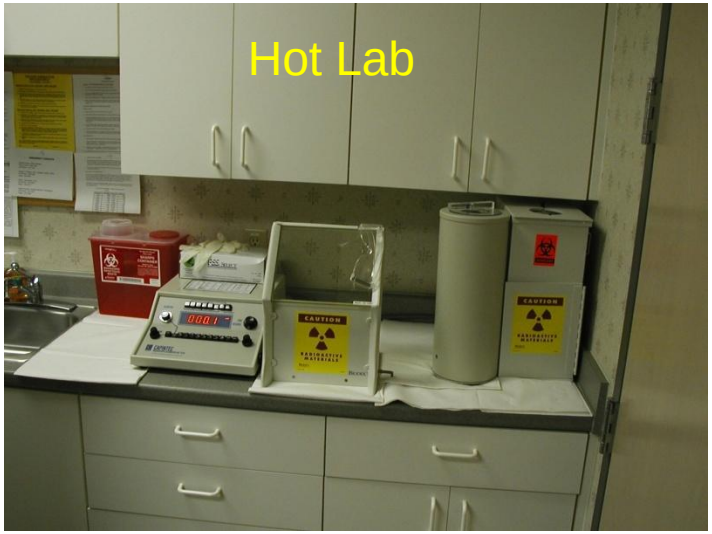
Gloves are primarily used in nuclear medicine to protect the occupational worker from biological hazards and radiation contamination.

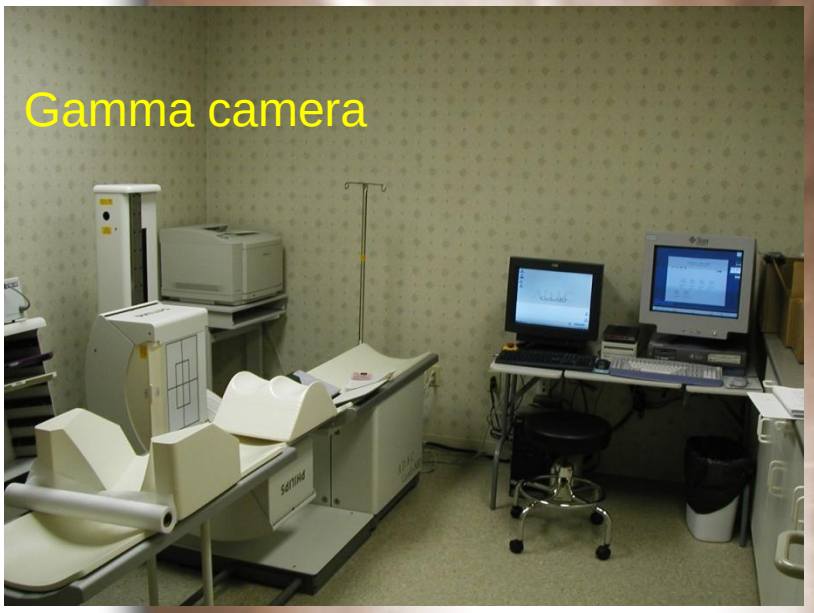
Transportation Cases

Radiopharmaceutical doses (single unit doses) are delivered to administer at a predetermined time. The short half-life of the nuclides requires that an efficient method is used to safely transport the doses to licensees.

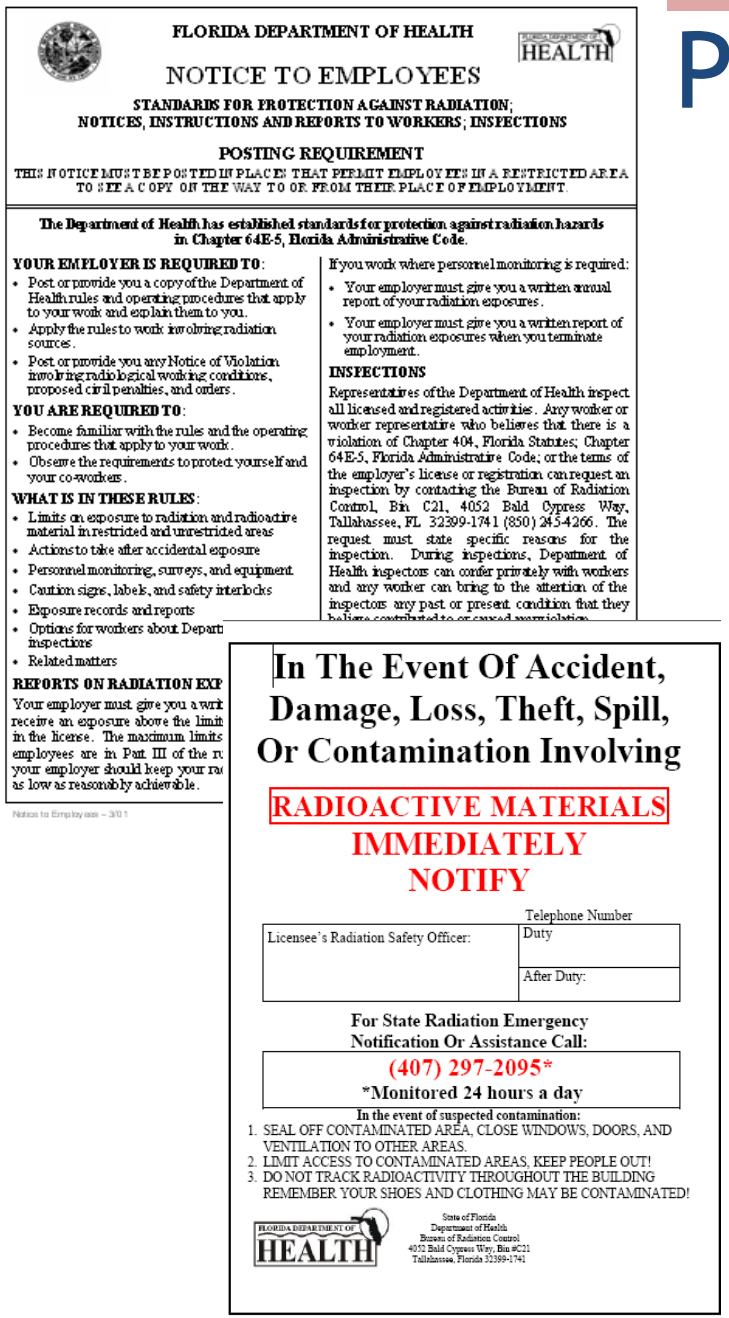
Radiopharmacies use dedicated vehicles to transport the doses in specially designed DOT approved transport containers ("suitcases" or “ammo boxes”) to minimize exposure to occupational workers and the public.

Nuclear Medicine Facility





Posting



FLORIDA DEPARTMENT OF HEALTH

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION; NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS

POSTING REQUIREMENT

THIS NOTICE MUST BE POSTED IN PLACES THAT PERMIT EMPLOYEES IN A RESTRICTED AREA TO SEE A COPY ON THE WAY TO OR FROM THEIR PLACE OF EMPLOYMENT.

The Department of Health has established standards for protection against radiation hazards in Chapter 64E-5, Florida Administrative Code.

YOUR EMPLOYER IS REQUIRED TO:

- Post or provide you a copy of the Department of Health rules and operating procedures that apply to your work and explain them to you.
- Apply the rules to work involving radiation sources.
- Post or provide you any Notice of Violation involving radiological working conditions, proposed civil penalties, and orders.

YOU ARE REQUIRED TO:

- Become familiar with the rules and the operating procedures that apply to your work.
- Observe the requirements to protect yourself and your co-workers.

WHAT IS IN THESE RULES:

- Limits on exposure to radiation and radioactive material in restricted and unrestricted areas
- Actions to take after accidental exposure
- Personnel monitoring, surveys, and equipment
- Caution signs, labels, and safety interlocks
- Exposure records and reports
- Options for workers about Departi inspections
- Related matters

REPORTS ON RADIATION EXP

Your employer must give you a writ receive an exposure above the limit in the license. The maximum limits employees are in Part III of the r your employer should keep your ra as low as reasonably achievable.

If you work where personnel monitoring is required:

- Your employer must give you a written annual report of your radiation exposures.
- Your employer must give you a written report of your radiation exposures when you terminate employment.

INSPECTIONS

Representatives of the Department of Health inspect all licensed and registered activities. Any worker or worker representative who believes that there is a violation of Chapter 404, Florida Statutes; Chapter 64E-5, Florida Administrative Code; or the terms of the employer's license or registration can request an inspection by contacting the Bureau of Radiation Control, Bin C21, 4052 Bald Cypress Way, Tallahassee, FL 32399-1741 (850) 245-4266. The request must state specific reasons for the inspection. During inspections, Department of Health inspectors can confer privately with workers and any worker can bring to the attention of the inspectors any past or present condition that they

In The Event Of Accident, Damage, Loss, Theft, Spill, Or Contamination Involving

RADIOACTIVE MATERIALS

IMMEDIATELY NOTIFY

Licensee's Radiation Safety Officer:	Telephone Number Duty
	After Duty:

For State Radiation Emergency Notification Or Assistance Call:

(407) 297-2095*

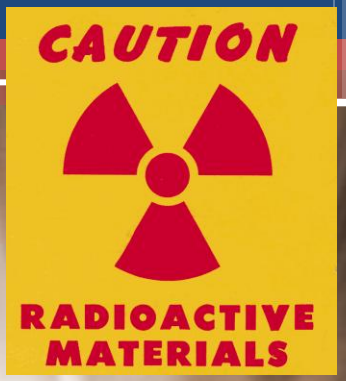
***Monitored 24 hours a day**

In the event of suspected contamination:

1. SEAL OFF CONTAMINATED AREA, CLOSE WINDOWS, DOORS, AND VENTILATION TO OTHER AREAS.
2. LIMIT ACCESS TO CONTAMINATED AREAS, KEEP PEOPLE OUT!
3. DO NOT TRACK RADIOACTIVITY THROUGHOUT THE BUILDING REMEMBER YOUR SHOES AND CLOTHING MAY BE CONTAMINATED!

FLORIDA DEPARTMENT OF HEALTH

State of Florida
Department of Health
Bureau of Radiation Control
4052 Bald Cypress Way, Bin #C21
Tallahassee, Florida 32399-1741

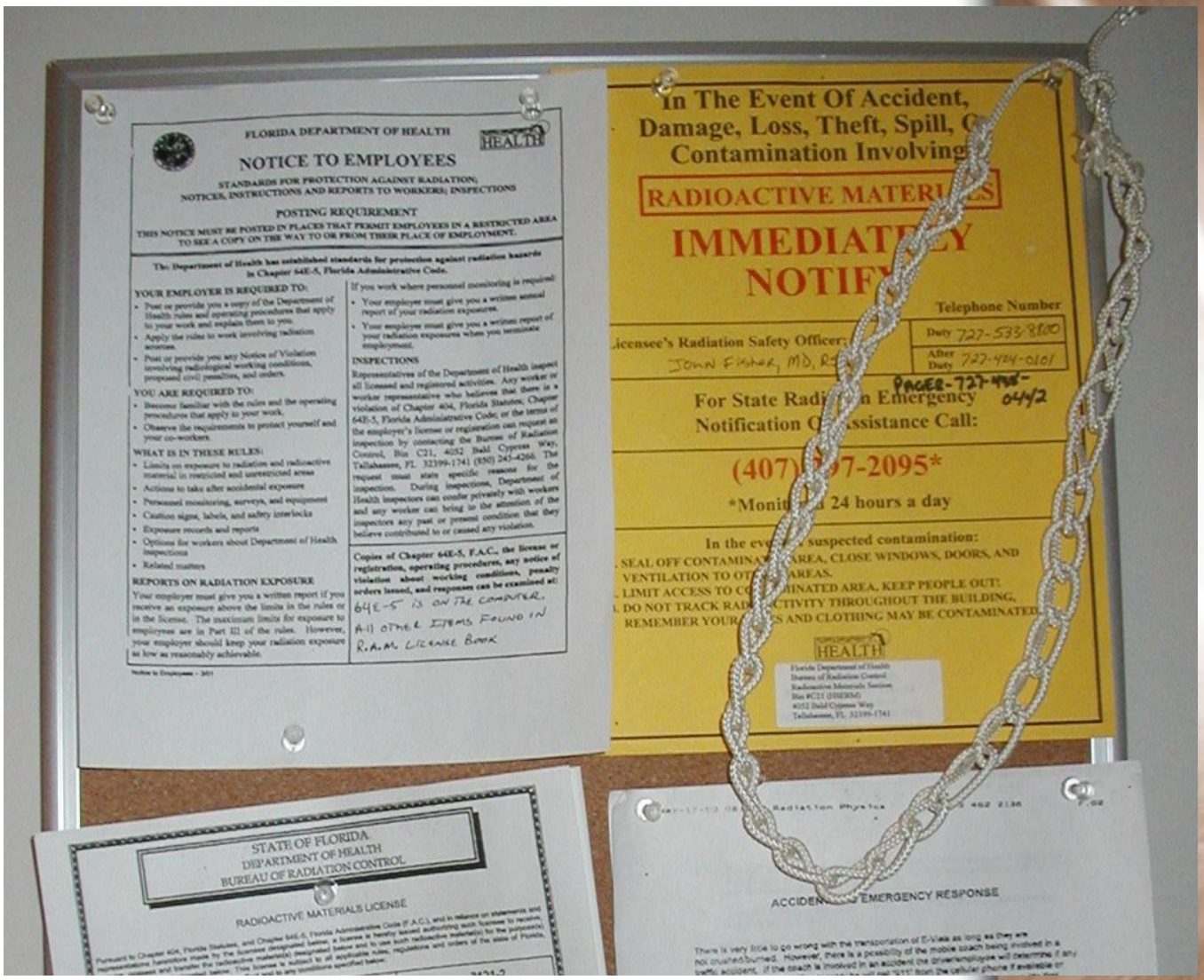


Facilities possessing and using radioactive material must have proper posting.

Some of the postings include:

- **Caution Radioactive Materials**
- **Emergency Notification Information**
- **Notice to Employees**

Nuclear Medicine Facility



The Unit Dose Manager

- It is a network computer system that allows the NMT to order radiopharmaceuticals directly online with the radiopharmacy. All required compliance forms and QC procedures are stored on the Unit Dose Manager.


23 10:40

COLUMBIA MEDICAL CENTER

CONTAMINATION WIPE TEST FOR THE MONTH OF _____

LOCATION	WIPE TEST RESULTS (dpm)				
DATE					
INSTRUMENT USED					
BACKGROUND					
1. PREPARATION AREA					
2. INJECTION AREA					
3. CAMERA FACE					
4. COMPUTER CONTROLS					
5. DOSE CALIBRATOR					
6. IMG RM DOORKNOBS					
7. TELEPHONE					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
PERFORMED BY					
APPROVED BY					

ACTION LEVELS: 200 dpm/100cm²over background for ^{131}I; 1000 dpm for ^{99m}Tc & ^{201}Tl

DECONTAMINATION:(USE OTHER SIDE OF SHEET IF FULL)

DATE	LOC #	COMMENTS/RETEST	DATE	LOC #	COMMENTS/RETEST

RSO REVIEW___

WIPEWK.FRM(11/92)

Waste Disposal Log

- Segregate by half life: Materials with a half live of less than 90 days must be kept separate from materials with a half life greater than 90 days. Material with a half life of less than 90 days is decayed in storage for 10 half lives then sent to the county landfill. Material with a greater than 90 day half life is sent off site for burial and is expensive. Please make every effort to minimize generation of material that must be sent off site.

- Dry solids: Place in labeled metal step-cans. Metal step cans must be lined with thick clear plastic bags. Use a cardboard box or other means to contain glass or sharp material. Call EHS when the step can is full so that the contents can be placed in the decay chamber.

Waste Disposal Log

- Liquids: Collect liquids in labeled plastic or glass bottles with screw caps of less than 1 gallon size. Call EHS when a bottle or bottles needs to be placed into the decay chamber.
- Multi-hazard Waste: Radioactive materials with a greater than 90 day half life that are also chemically or biologically hazardous (i.e. mercury, carcinogens, animals, sharps, heavy metals) require special handling and disposal. Multi-hazardous waste is extremely expensive and in some cases impossible to dispose of. The RSO and/or EHS must be notified BEFORE multi hazardous waste is generated.

SOLID RADIOACTIVE WASTE DISPOSAL LOG ($T^1/_2 < 120$ days)

Authorized User _____ Room _____ Isotope(s) _____ GWU # _____

*INITIALS ATTEST THAT ***NO NEEDLES***, MEDICAL WASTE, FLAMMABLES, ***RADIATION LABELS***, *OR OTHER HAZARD LABELS*, WERE DISPOSED!!

Date	Isotope	Activity, µCi	Initials*		Date	Isotope	Activity, µCi	Initials*

Approved by: _____ Date: _____

HR8a.4 Rev. 02/17/00 (The completed form may be discarded after three years from the last date recorded as data on the form).

SOLID RADIOACTIVE WASTE DISPOSAL LOG ($T^1/_2 < 120$ days)

Authorized User _____ Room _____ Isotope(s) _____ GWU # _____

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Approved by: _____ Date: _____

HR8a.4 Rev. 02/17/00 (The completed form may be discarded after three years from the last date recorded as data on the form).

Radioactive Materials Receipt

- When any package of radioactive material is received, it should be checked for contamination and leakage.
- Its receipt should be noted in a log, then the package should be stored in an appropriate shielded area.

Transportation Labels for Packaging Containing Radiation Area

- **Category I** (white):
  Dose rate < 0.005 mSv/hr (0.5 mrem/hr) at any point on the surface of the package
- **Category II** (yellow):
  Dose rate < 0.1 mSv/hr (10 mrem/hr) at any point on the surface and < 0.005 mSv/hr (0.5 mrem/hr) at 1m. Transport Index stated on the label
- **Category III** (yellow):
  Dose rate < 2 mSv/hr (200 mrem/hr) at any point on the surface and < 0.1 mSv/hr (10 mrem/hr) at 1m. Transport Index stated on the label

Radioactive Materials Receipt

- Procedures for receiving and opening packages:
  - 1. Receive the package in a licensed lab or department by a trained radiation worker.
  - 2. Put on lab coat and gloves while handling and opening the package.
  - 3. Examine the package to ensure that it is not damaged or leaking.
  - 4. Notify the appropriate person (Radiologist or Supervisor) that the package has arrived and place it in a secure location until it can be monitored and opened. Monitoring and opening should be performed right away!

Radioactive Materials Receipt

- Wipe Test Package

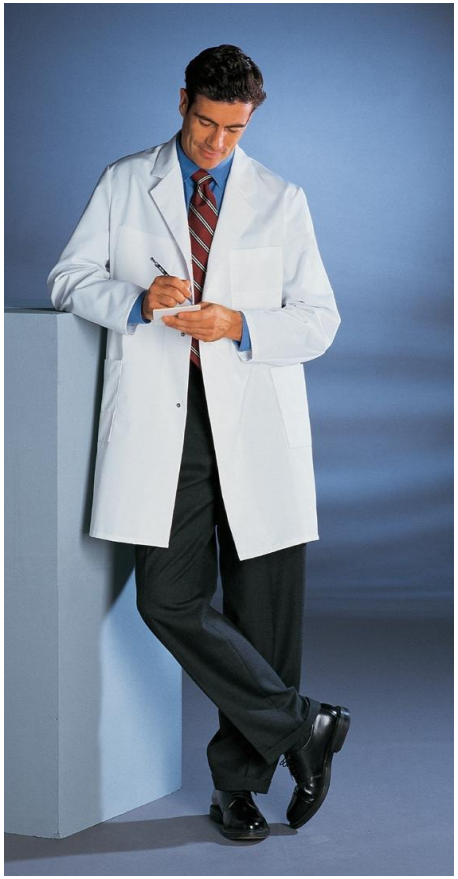
  a. Monitor the external surface of the shipping container (box) for removable contamination (wipe test) and document the results in your receipt log.

  b. Perform the wipe within 3 hours of receipt. Wipe an area of 300 cm2.

  c. Notify RSO immediately if wipe test results exceed background.

Radioactive Materials Receipt

- 6. Open the inner package to verify the contents and check the integrity of the final source container (inspect for evidence of breakage, leakage, discoloration. etc.). Report any problems to RSO.
- 7. Remove the radioactive material immediately and store it in a secure location.
- 8. Document the receipt in your lab inventory records.



CEDARS MEDICAL CENTER
[redacted]
MIAMI, FL 33136

Inventory Receipt Listing

for Vendor: CARDINAL HEALTH NPS Shipper: 710088955

Vendor	Receipt Date/Time	Shipper	Product	Prescription	Quantity	Amount
CARDINAL HEALTH NP	06/22/06 06:35	710088955	TC99M SODIUM PERTECHNETATE BULK	419509	1 Vial	150.0000 mCi / 1.8900 ml 6/22/06 08:00
			TC99M CARDIOLITE UNIT DOSE	419560	1 Syr	30.0000 mCi / 0.7600 ml 6/22/06 11:00
			TC99M CARDIOLITE UNIT DOSE	419561	1 Syr	30.0000 mCi / 0.7600 ml 6/22/06 11:00
			TC99M CARDIOLITE UNIT DOSE	419757	1 Syr	30.0000 mCi / 0.7600 ml 6/22/06 11:00
			TC99M CARDIOLITE UNIT DOSE	419758	1 Syr	30.0000 mCi / 0.7600 ml 6/22/06 11:00
			TC99M CARDIOLITE UNIT DOSE	419759	1 Syr	30.0000 mCi / 0.7600 ml 6/22/06 11:00
			TC99M MAA UNIT DOSE	419760	1 Syr	10.0000 mCi / 0.8900 ml 6/22/06 11:00
			TC99M MDP UNIT DOSE	419499	1 Syr	25.0000 mCi / 0.5600 ml 6/22/06 11:00
			TC99M MDP UNIT DOSE	419500	1 Syr	25.0000 mCi / 0.5600 ml 6/22/06 11:00
			TC99M SOURCES POINT SOURCE	419534	1 Syr	0.2500 mCi / 0.4000 ml 6/22/06 12:00

Patient Dose Records

- The purpose of Patient Dose Records or Patient Schedule is to help in achieving an overall reduction in the radiation received by patients undergoing medical radiological examinations and avoid misadministration.

- Record is kept in a computer (hard drive) or a log book (hand written).

Patient Dose Records

- Records of dosage must be retained for a period of 3 years and must contain:
  - The name of the dosage and the doctor.
  - The name of the patient w/ ID number.
  - The prescribed dosage or a notation that the total activity is less than 30 μCi (1.1 MBq).
  - The date and time of administration.
  - The name of the technician who determined the dosage.

[redacted] MEDICAL CENTER

[redacted]

MIAMI, FL 33136 Department Default Department

Daily Study Report

for 6/26/06

Patient Name / Patient MRN	Procedure / Doctor Name	Time	Product / Administration Route / Administration Site	Requested / Administered	RX # / Lot # / Admin. By / AdminTime	Assay Time By	Assay Amount	Disposal
PENA, [redacted] 713[redacted]	GA 67 SCAN WHOLE BODY FERNANDEZ-MIRO, [redacted]	08:00	72HR SCAN					
KING, [redacted] 713[redacted]	GA 67 SCAN WHOLE BODY RODRIGUEZ, [redacted]	12:00	48HR SCAN					
CHANG, [redacted] 711[redacted]	WHOLE BODY BONE SCAN RUBINFELD, [redacted]	08:00	TC99M MDP HEPARIN LOCK LEFT ARM	25.0000 mCi 25.2031 mCi	420138 KM 08:02	08:00 KM	25.3000 mCi	4021
RUSSELL, [redacted] 713[redacted]	WHOLE BODY BONE SCAN MONTANE, [redacted]	08:30	TC99M MDP HEPARIN LOCK LEFT HAND	25.0000 mCi 25.8008 mCi	1630851 KM 08:32	08:30 KM	25.9000 mCi	4021
FRANCIS, [redacted] 479[redacted]	3 PHASE BONE SCAN RUBINFELD, [redacted]	09:00	TC99M MDP HEPARIN LOCK LEFT HAND	25.0000 mCi 22.7804 mCi	420137 AFS 07:35	07:30 AFS	23.0000 mCi	4021
RILEY, [redacted] 695[redacted]	LASIX RENAL FLOW / FUNCTION CAMP, [redacted]	09:00	TC99M MAG3 I.V. LEFT SUBCLAVIAN	10.0000 mCi 9.9235 mCi	420611 AFS 11:04	11:00 AFS	10.0000 mCi	4021
SIMMONS, [redacted] 713[redacted]	HEPATOBILIARY SCAN CRESPO, [redacted]	09:30	TC99M CHOLETEC I.V. RT.FEMORAL LINE	10.0000 mCi 9.9045 mCi	1630804 AFS 10:25	10:20 AFS	10.0000 mCi	4021
DAVID, [redacted] 347[redacted]	WHOLE BODY BONE SCAN VILLOCH, [redacted]	09:30	TC99M MDP RIGHT HAND	25.0000 mCi 24.7613 mCi	420608 AFS 10:20	10:15 AFS	25.0000 mCi	4021
WINGATE, [redacted] 155[redacted]	WHOLE BODY BONE SCAN COHEN, [redacted]	10:00	TC99M MDP LEFT ANTECUBITAL	25.0000 mCi 24.8089 mCi	420607 AFS 10:04	10:00 AFS	25.0000 mCi	4021
SANCHEZ, [redacted] 616[redacted]	GA 67 SCAN WHOLE BODY RODRIGUEZ, [redacted]	10:30	GA67 GALLIUM EXISITNG I.V. RIGHT ARM	7.0000 mCi 5.9806 mCi	420606 AB 14:22	14:00 AB	6.0000 mCi	4021

Daily Patient Schedule

06/27/06

Time	Patient Name/MRN	Doctor	Procedure/Drug	Dose Amount
12:00	AGULLA, [redacted] 713626	NARULA, [redacted]	ADENOSINE CARDIOLITE S / R TC99M CARDIOLITE	10.0000 mCi
12:00	AGULLA, [redacted] 713626	NARULA, [redacted]	ADENOSINE CARDIOLITE S / R TC99M CARDIOLITE	25.0000 mCi
11:30	SANCHEZ, [redacted] 530701	JIMENEZ, [redacted]	ADENOSINE CARDIOLITE S / R TC99M MYOVIEW	10.0000 mCi
07:30	WHACK, [redacted] 595085	SHOEMAKER, [redacted]	TC99M CERETEC WBC WHOLE BODY TC99M CERETEC WBC	15.0000 mCi
12:30	JUNG, [redacted] 713692	NARULA, [redacted]	ADENOSINE CARDIOLITE S / R TC99M CARDIOLITE	10.0000 mCi
12:30	JUNG, [redacted] 713692	NARULA, [redacted]	ADENOSINE CARDIOLITE S / R TC99M CARDIOLITE	25.0000 mCi
11:00	BROWNE, [redacted] 701901	NASS, [redacted]	ADENOSINE CARDIOLITE S / R TC99M MYOVIEW	25.0000 mCi
11:00	MOTA, [redacted] 641038	JIMENEZ, [redacted]	ADENOSINE CARDIOLITE S / R TC99M MYOVIEW	25.0000 mCi
12:00	AGULLA, [redacted] 713626	NARULA, [redacted]	ADENOSINE CARDIOLITE S / R TC99M MYOVIEW	10.0000 mCi
11:30	SANCHEZ, [redacted] 530701	JIMENEZ, [redacted]	ADENOSINE CARDIOLITE S / R TC99M MYOVIEW	25.0000 mCi
12:30	JUNG, [redacted] 713692	NARULA, [redacted]	ADENOSINE CARDIOLITE S / R TC99M MYOVIEW	10.0000 mCi
12:00	AGULLA, [redacted] 713626	NARULA, [redacted]	ADENOSINE CARDIOLITE S / R TC99M MYOVIEW	25.0000 mCi
12:30	JUNG, [redacted] 713692	NARULA, [redacted]	ADENOSINE CARDIOLITE S / R TC99M MYOVIEW	25.0000 mCi
14:30	CARTWRIGHT, [redacted] 668418	CHERTMAN, [redacted]	THYROID UPTAKE AND SCAN TC99M SODIUM PERTECHNETATE	10.0000 mCi

Mo99/Tc99m Records

- A written record must be kept of every “milking” of a generator
- Record must include:
  - Date of milking
  - Date generator was received
  - Tc99 & Mo99 activity
  - The ratio of Tc99 to Mo99
  - The initials of the person performing the milking

Mo99/Tc99m Records

MOLYBDENUM-99 CONCENTRATION

Facility: _____

NOTE: **A licensee may not administer to humans a radiopharmaceutical containing more than 0.15 uCi Mo-99 per mCi Tc-99m.**

Date	Date Generator Received	Generator Number	Time of Elution	Tc-99m Activity (mCi)	Mo-99 Activity (uCi)	**RATIO** uCi (Mo-99) / mCi (Tc-99m)	Ratio <0.15 (Y/N)	Initials

Form provided by: DTC, Inc., 5930 Roe Ave., Mission, KS 66205 (913) 236-6000

Decay-in-Storage Form

- Must record information about all radionuclides being decayed
- Information must include:
  - Type of survey meter used & serial #
  - Type of radionuclide & date placed in storage
  - Date of final disposal
  - All survey counter readings of radionuclide & container

Decay-in-Storage Form

DECAY-IN-STORAGE LOG

Facility: _____

Location of stored material: _____

Survey Meter used: _____

Serial Number: _____

NOTE: By-product material must be stored for 10 half-lives.

Radio-nuclide	Date placed in storage	Date of final disposal	At Time of Final Disposal			
			Bkg (mR/hr)	Container Surface (mR/hr)	Labels defaced	Initials

Form provided by: DTC, Inc., 5930 Roe Ave., Mission, KS 66205 (913) 236-6000

Dose Log Sheet

MULTIDOSE USE LOG

(FOR Tc-99M KIT PREPARATION AND ADMINISTRATION)

Facility: _____ Year: _____

KIT PREPARATION								PATIENT DOSE					
		Generator / Bulk Tc		Kit		Time			Patient				
Date	Time	Receipt Date	Lot No.	Supplier	Lot No.	Kit Expir.	mCi cc	Time	Name	ID	Activity (mCi)	Vol. (ml)	Initials

Form provided by: DTC, Inc., 5930 Roe Ave., Mission, KS 66205 (913) 236-6000