Authorized User Training for Research PIs

Module 7: Radiation Surveys and Patient Release

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Introduction

- This module focuses on the practical aspects of regulations regarding:
  - Radioactive contamination
  - Surveys for radiation
  - Shipping and receiving of radioactive materials
- It also covers generic information regarding the use of routine radioisotopes

Assigned reading:

7.1. NRC Regulatory Guide 8.2: Administrative Practices in Radiation Surveys and Monitoring

7.2. NRC Regulatory Guide 8.39, Rev 1: Release of Patients Administered Radioactive Materials

Outline

- Radiation Units of Measurement: A Review
- Monitoring for Ambient Dose Rates and Contamination
  - Daily closeout surveys
  - Weekly wipe test surveys

- Department of Transportation (DOT) Regulations
- Quiz

Radiation Units of Measurement: A Review

Radioactivity Quantity Units	
Becquerel (Bq)	Curies (Ci)
SI unit	Customary unit
Decays per second (dps)	3.7 x 10^{10} Bq

Units Describing Radiation Field		
Roentgen (R)	Radiation Absorbed Dose (rad)	Roentgen Equivalent Man (rem)
Photon ionization in air (exposure)	Amount of energy deposited in unit mass of medium	Biological effect of energy deposited by radiation in system
2.58E-4 C/kg	SI unit: Gray (Gy) = 100 rad Gray = J/kg	SI Unit: Sievert (Sv) = 100 rem Sv = Rad*QF

Mathematical Notations: Prefixes		
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}

Where:

C = Coulombs

J = Joules

QF = Quality Factor

Useful Conversion Factors

1 mCi = 37 MBq = 0.37 GBq

1 MBq = 27 μCi = 0.027 mCi

1 mR/h = 0.88 mrem/h

1 mrem/h = 1.136 mR/h

How To Use Various Units of Measurement: A Review

Units Describing Radiation Field		
Exposure	Contamination	Occupational Dose
Roentgen (R)	dpm/mCi/Bq	Roentgen Equivalent Man (rem)

- Use Roentgen (R) when describing an exposure in air or mR/h for exposure rate in air.
  - "Exposure" measures how much radiation is present in air.
  - Measured with an ion chamber or a GM ratemeter.
  - Used for daily surveys or release measurements.
- Use dpm when describing how much radioactivity or contamination is present.
  - Dpm is "disintegrations per minute." 1 mCi = 2.22E6 dpm; 1 Bq = 1/60 dpm
  - Use a GM ratemeter to quantify contamination on a wipe sample (See Module 7 for more details).
  - Dpm = cpm/eff; where cpm is the counts per minute on the GM ratemeter and eff is the efficiency for the isotope in question.
- Use rem or Sievert (Sv) when describing the "occupational dose," or biological effect to the human body as a system.
  - These units are used to communicate risk in terms of cancer induction probability.
  - Note, the US still recognizes the rem (1 Sv = 100 rem).
  - This is the unit you will see on your dosimetry or occupational badge report.
- While it is recognized that exposure (mR) and dose (mrem) are different concepts, the units are often interchanged for radiation safety purposes. This builds an additional layer of conservatism, given that 1 mR = 0.88 mrem. If a particular standard in mrem is met with an mR measurement, it ensures that the requirement is met with 'room to spare'.

Ambient Dose Rate and Removable Contamination

Contamination is simply unwanted radioactive materials.

- There are two categories of radioactive contamination:
  - Fixed
  - Removable
- Your radioactive materials (RAM) license sets two types of trigger levels to ensure compliance with regulations:

  Ambient dose rate and **removable contamination** in the areas where you use unsealed radioactivity

These limits are set for two types of areas at the facility:

1. For a "controlled area" such as the hot lab, dedicated waste storage room, or in-patient animal enclosure, where access is restricted
2. For an "uncontrolled area" such as a generic injection room, where more people have access

Typical Trigger Levels for ^{90}Y and ^{117m}Sn	Ambient Dose Rate	Removable Contamination
Controlled Area	5 mrem/h	10,000 dpm/100cm^2
Uncontrolled Area	0.2 mrem/h	1,000 dpm/100cm^2
Typical Trigger Levels for ^{131}I	**Ambient Dose Rate**	**Removable Contamination**
Controlled Area	5 mrem/h	2,000 dpm/100cm^2
Uncontrolled Area	0.2 mrem/h	200 dpm/100cm^2

Daily Closeout Surveys for Ambient Dose Rates

Daily closeout surveys are conducted in areas of use where you're looking for:

- Sources or waste not appropriately shielded
- Contaminated areas
- Any other radiation or source of radioactivity which shouldn't be exposed
- Daily closeouts should include all areas that were used with radioactive material during the day, such as dose preparation area, injection area, imaging area, and waste storage area. Cold waste containers will be surveyed to look for RAM items accidentally disposed of.

  Acrylic shields will be placed if necessary if any areas outside the enclosure exceed trigger limits (for ^{90}Y).

Daily closeouts can be completed with a GM ratemeter.

- The preferred equipment for ^{131}I and ^{51}Cr is a Ludlum Model 3 with a 44-3 pancake GM probe. For ^{90}Y, it is the Ludlum 26-1 integrated frisker / ratemeter.
- Even though the instrument reads in mR/h, the readout is considered interchangeable with mrem/h in this context (to be extra conservative).
- The trigger level for uncontrolled area is set to be 0.2 mrem/h, between natural background radiation (0.02 to 0.05 mR/h) and the regulatory upper limit of 2 mrem in 1 hr. Notice here that mR/h and mrem/h are being used interchangeably.

	Ambient Dose Rate
Controlled Area	5 mrem/h
Uncontrolled Area	0.2 mrem/h

Daily Closeout Surveys *(continued)*

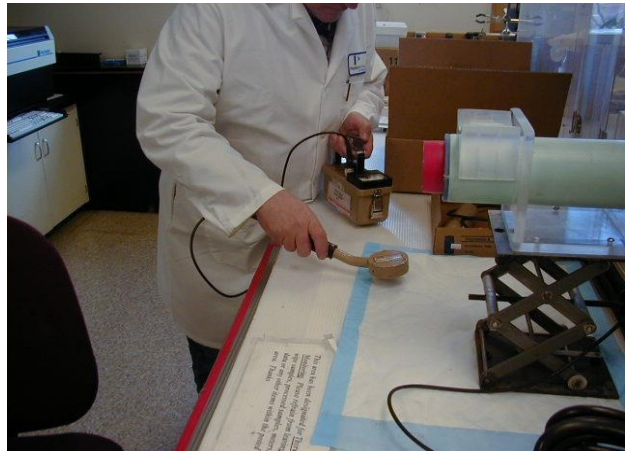
- Daily closeout surveys are completed with a GM ratemeter.
- Take a background reading with your GM counter in mR/h (typically 0.02–0.05 mR/h).
- Slowly move your GM probe over the surfaces which must be surveyed (areas where you used unsealed RAM).
    - You will hear the audible “clicks” using the audio function.
- (Gross rate – background rate) = net exposure rate

    Example:

    Gross reading = 0.5 mR/h

    Background = 0.05mR/h

    Net rate = 0.5 mR/h – 0.05 mR/h = 0.45 mR/h



Sample Daily Closeout Report

- Maintain a floor plan showing all areas of RAM use, identifying all areas and objects pertinent to the RAM license, such as dose preparation bench, “L” Shield, hot and cold waste containers, injection table, scan room table, animal housing enclosure used for IsoPet patients, etc.
- Daily Survey is required:
  - Only in areas where RAM were used
  - Only on days when RAM were used
  - It is customary to perform surveys along with weekly wipe tests as well, even if no RAM was used that day. These are called **Weekly Surveys**
- If excessive dose rate is found (> 0.2 mR/h):
  - Record reading
  - Decontaminate the area
  - Resurvey
  - Record action in comments section.

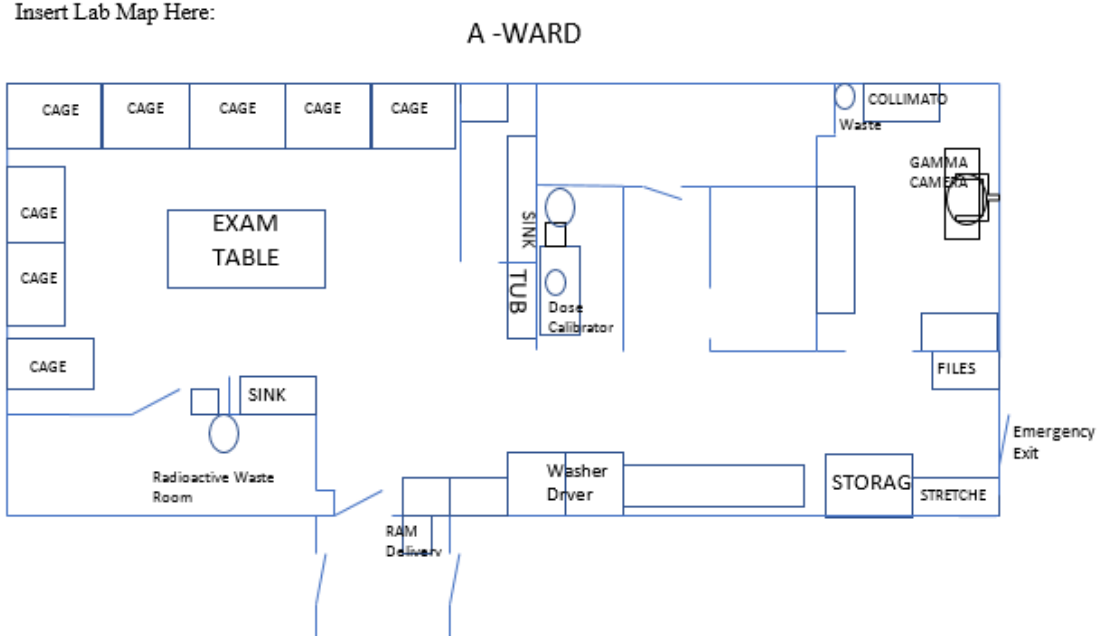
DAILY CLOSEOUT REPORT

DEPARTMENT: Canine Ward	LOCATION: Animal Medical Center
INSTRUMENT: Ludlum 26-1 Dose	SERIAL NUMBER: 12345

* Unless otherwise specified, measurements made with GM survey meter with results in mR/h.
✓ = background reading 0.02 mR/h
Note that Action level is 0.2 mR/h for an uncontrolled area and 5 mR/h for controlled areas. Daily closeout surveys are only required on days of use.

Date	1	2	3	4	5	6	7	8	9	10	11	12	Survey By
4/15	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	CAS
4/16	✓	✓	✓	0.5	0.6	✓	✓	✓	✓	✓	✓	✓	CAS

Insert Lab Map Here:



Removable Contamination Surveys

- **Wipe Survey**
  - Checks for removable contamination
  - Wipe tests are required weekly for all areas of unsealed use
  - Surface area to be wiped for each sample should be 100 cm^2 (about a 4” x 4” square, or postcard size area), using moderate pressure
  - Take one or more representative sample(s) in each area of use.
    - Radioactive **Waste Rooms** do not require a weekly wipe test, but do require a weekly survey
    - Trigger levels for further action are based on the hazard posed by the radioisotope. They are more stringent for ^{131}I than for ^{90}Y or ^{117m}Sn.

Typical Trigger Levels for ^{131}I	Removable Contamination
Controlled Area	2000 dpm/100cm^2
Uncontrolled Area	200 dpm/100cm^2

Typical Trigger Levels for ^{90}Y and ^{117m}Sn	Removable Contamination
Controlled Area	10,000 dpm/100cm^2
Uncontrolled Area	1,000 dpm/100cm^2

Minimum Detectable Activity and Wipe Tests

- The instrument used to monitor for contamination must be able to detect below the removable contamination limits.
- A wipe test is taken with a plain 1-inch round filter paper, such as the Whatman® No. 1 product.
- ‘Home made’ wipes from coffee filters also work well: Cut out 1 inch squares, or punch out 1 inch circles using a punch tool. Kim Wipes® work equally well.
- The used filter paper is then placed on a clean lead brick with the contaminated side up for scanning.
- Gauze can be used as a quick check for removable contamination, but be sure to cover the GM probe with a disposable glove to avoid contaminating it.
- See next slide for more complete wipe test instructions.

Wipe Test measurement: Ludlum 26-1 (^{117m}Sn and ^{90}Y)

- Place the GM ratemeter probe (e.g, Ludlum 26-1) on a clean lead brick to obtain background reading in cpm.
- Wipe an area of 100 cm^2 (about the size of a postcard).
- Place the wipe on the lead brick with the “dirty” side up.
- Place the GM ratemeter directly over the wipe.
- Allow the unit to settle and take a gross reading/measurement.
- (Gross reading – background)/efficiency = quantity of removable contamination.

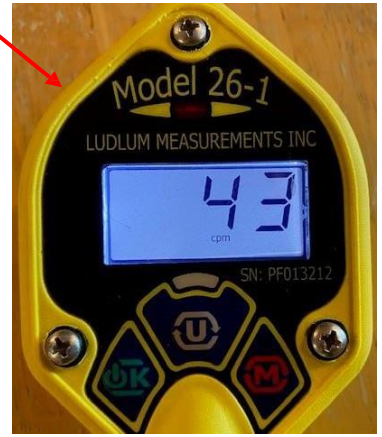
  Example:

  Gross reading = 100 cpm

  Background = 45 cpm

  Efficiency = 22% or 0.22

  (100 cpm – 45 cpm) / 0.22 = 250 dpm of removable contamination
- Record the result on the wipe test survey report .



Wipe Test measurement: Ludlum 44-9 (^{131}I or ^{51}Cr)

- Turn on the meter and perform a battery check and verify check source reading.
- Place the pancake probe on a clean lead brick to obtain background reading in mR/h (typically 0.02 to 0.05 mR/h, on the x0.1 scale).
- Wipe an area of 100 cm^2 (about the size of a postcard).
- Place the wipe on the lead brick with the “dirty” side up.
- Place the probe directly over the wipe. Place a counterweight on the probe if necessary, to hold it steady.
- Allow the unit to settle and take a gross reading/measurement, on the SLOW toggle switch. Watch the needle over 30 sec, to obtain the average value in mR/h.
- Each division on the x0.1 scale above background represents 200 dpm for ^{131}I
- Ten divisions on the x0.1 scale above background represent 2000 dpm for ^{131}I
- This method bypasses the need to obtain cpm values and divide by efficiency to obtain dpm.

For a background of 0.03 mR/h in this example, 0.04 mR/h is the trigger for unrestricted areas (200 dpm), and 0.13 mR/h is the trigger for restricted areas (2000 dpm). Contamination levels exceeding triggers require cleanup.

Sample Wipe Test Report

- Maintain a floor plan showing all areas of RAM use, identifying all areas and objects pertinent to the RAM license, such as dose preparation bench, “L’ Shield, hot and cold waste containers, injection table, and scan room table.
- A weekly entry is required whether or not radioactive materials were used.
- Perform an ambient survey prior to wipe test. This will be an indicator of potential areas of removable contamination.
- Use a GM counter or well-chamber to assess if contamination is present.
- If removable contamination is found (>1000 dpm/100cm^2):
  - Decontaminate the area
  - Re-wipe and retest
  - Record actions in comments section of report.

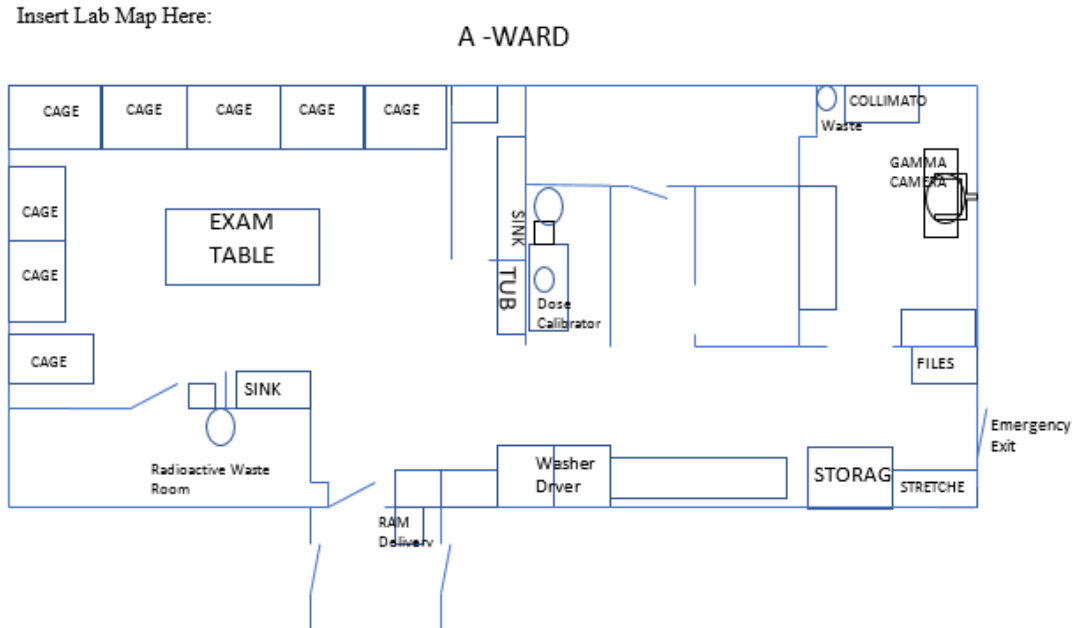
WEEKLY WIPE REPORT

DEPARTMENT: Canine Ward	LOCATION: Animal Medical Center
INSTRUMENT: Ludlum 26-1 Dose	SERIAL NUMBER: 12345

* Unless otherwise specified, measurements made with GM survey meter with results in dpm/100 cm^2.
✓ = background reading (<200 dpm/100 cm^2)
Note that Action level is 1000 dpm/100 cm^2 for an uncontrolled area and 10,000 dpm/100 cm^2 for controlled areas. Efficiency for a Ludlum 26-1 or Ludlum 44-9 is 20% for ^{117m}Sn.

Date	1	2	3	4	5	6	7	8	9	10	11	12	Survey By
4/15	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	CAS
4/16	✓	✓	✓	500	600	✓	✓	✓	✓	✓	✓	✓	CAS

Insert Lab Map Here:



Radioactive Spill Control

- Sooner or later, every facility will experience a radioactive spill. It is best to be prepared to handle a spill by reviewing spill control procedures periodically.

- Generally speaking, a spill happens when a dose is mishandled, and the contents is ejected to non-intended surface, such as a treatment table, the floor, or on the body of the animal or personnel.

- A hot-spot detected at the daily closeout survey, or urine from a treated animal is not necessarily a spill.

- UREG 1557 Vol 7, appendix L directs that "Licensees should not neglect, delay, or ignore appropriate first aid and other immediate medical needs of injured individuals due to suspected contamination" from a spill. In other words, medical needs of an individual take precedence over spill control procedures.

- Spills can be loosely classified into **major** and **minor** spills. Spills of activities less than 1 mCi may be considered minor, and spills involving >1 mCi, or any personnel contamination may be considered major.

- Each hot lab must have a **spill kit**, the recommended contents of which are listed on the next page. The spill kit must be examined at least annually to make sure its contents are intact and usable. Discovering that latex gloves have stuck together, or plastic waste bags are in tatters when you have a spill to clean up, is not predictive.

- The most practical tip for spill cleanup is not to spread it and make it worse, for instance using a mop on the floor. Delineating the extent of the spill by carefully surveying with a meter, and confining cleaning to a small area is the way to go.

Radioactive Spill Control *(continued)*

Recommended contents of a spill kit. A commercial spill kit may be purchased, or one can be put together using in-house materials.

— disposable gloves
— housekeeping gloves
— disposable lab coats
— disposable head coverings
— disposable shoe covers
— roll of absorbent paper with plastic backing
— masking tape
— plastic trash bags with twist ties
__ cleanup solution such as RadiacWash®
__ cleanup gel such as DeconGel ®
__ scrubbers, sponges
— "Radioactive Material" labeling tape
— marking pen
— pre-strung "Radioactive Material" labeling tags
— box of wipes
— instructions for "Emergency Procedures"
— clipboard with a copy of the Radioactive Spill Report Form for the facility
— pencil

Radioactive Spill Control *(continued)*

Minor Spills of Liquids and Solids

1. Notify persons in the area that a spill has occurred.
2. Prevent the spread of contamination by covering the spill with absorbent paper.
3. Clean up the spill using disposable gloves and absorbent paper. Carefully fold the absorbent paper with the clean side out and place in a plastic bag for transfer to a radioactive waste container. Also put contaminated gloves and any other contaminated disposable material in the bag.
4. Survey the area with a low-range radiation detector survey meter. Check the area around the spill. Also check your hands, clothing, and shoes for contamination.
5. Report the incident to the Radiation Safety Officer (RSO).
6. The RSO or his designee will follow up on the cleanup of the spill and will complete the Radioactive Spill Report and the Radioactive Spill Contamination Survey.

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 by covering the spill with absorbent paper, but do not attempt to clean it up. To prevent the spread of contamination, limit the movement of all personnel who may be contaminated.
3. Shield the source if possible. This should be done only if it can be done without further contamination or a significant increase in radiation exposure.
4. Close the room and lock or otherwise secure the area to prevent entry.
5. Notify the RSO immediately.
6. Decontaminate personnel by removing contaminated clothing and flushing contaminated skin with lukewarm water and then washing 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.
7. The RSO or designee will supervise cleanup of the spill and will complete the Radioactive Spill Report and the Radioactive Spill Contamination Survey.

Radioactive Spill Control *(continued)*

- Each spill must be documented in a report to the RSO.
- An Area Contamination Form and / or a Personnel Contamination Form must be filled out, as appropriate
- The report must include details of how the spill occurred, and how things can be improved to precent recurrence
- A spill report is not meant to be punitive; it is a means to improve practice and offers an opportunity to correct systematic mistakes, If identified.

Department of Transportation (DOT) Regulations

- The Department of Transportation has regulations surrounding the shipment and receipt of radioactive materials:
  - Each package containing radioactive material will be delivered to the **secure delivery location** listed on your RAM license.
    - This is typically a lockable cabinet which can house a large box.
  - The package must be **checked in within 3 hours of receipt** and **logged on the RAM inventory** for the site.
    - A sample package check-in template is included in the supplemental reading materials.
  - The package must be **measured for exposure rate** 1 m from each side and on the surface of the exterior package.
  - A **wipe test** must be taken of the exterior and interior packaging.
  - Records must be kept for each package containing radioactive material.

DOT Regulations *(continued)*

The dose arrives as a DOT Class 7 Type A package. It will have markings as a White I package, or a Yellow II package.

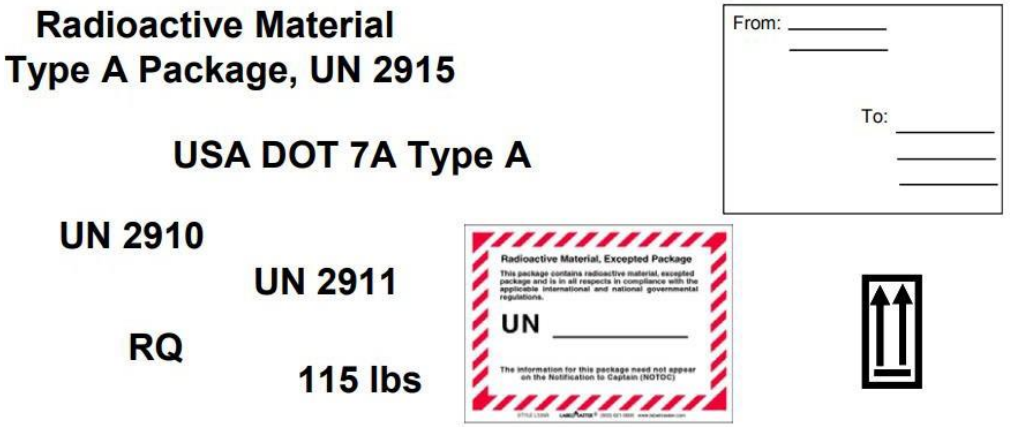


Figure-1. Examples of common radioactive package **markings**. These include proper shipping names, package types, UN numbers, and From/To addresses, orientation markers, and weights. For excepted packages, the candy-striped UN number sticker is optional; a simple sign stating the UN number can be used instead.

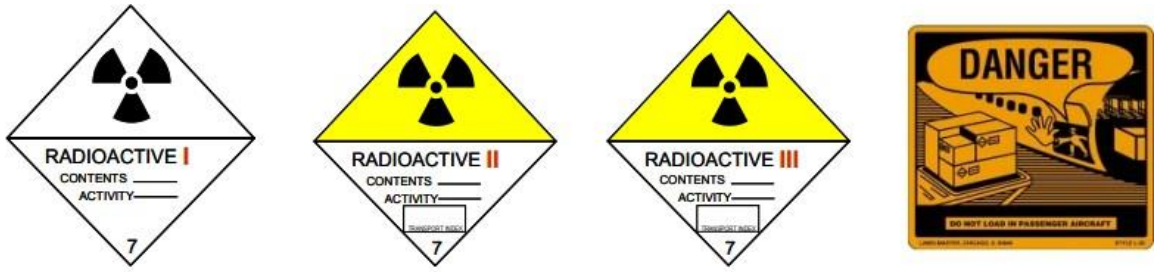


Figure-2. Examples of common radioactive package **labels.**

Specific DOT training is available through the FX Masse Training Course portal entitled “HazMat / DOT Training”
This training course is not mandatory to send a license application or license amendment. However, most state regulatory agencies will require an individual associated with the RAM license to maintain DOT certification to oversee shipment and receipt of radioactivity.

Summary of Module 7: Radiation Surveys and Patient Release

- RAM licensees are required to conduct daily closeout surveys with a GM ratemeter to comply with license exposure limits.
- RAM licensees are required to conduct weekly wipe test surveys with filter paper to assess removable contamination. This can be completed with a GM ratemeter Ludlum model 26-1, or a Ludlum model 3 or model 14C with a 44-9 Pancake probe.
- Each received package containing radioactive materials must be checked in following DOT and license requirements. This is typically completed with an exposure rate measurement at one meter, on the surface of the package, and a wipe test to quantify removable radioactivity. The receipt must be logged and added to the site inventory.

Supplemental Reading Material

Assigned reading material for Module 7:

7.1. NRC Regulatory Guide 8.2: Administrative Practices in Radiation Surveys and Monitoring

7.2. NRC Regulatory Guide 8.39, Rev 1: Release of Patients Administered Radioactive Materials

Upon successful completion of the Module 7 quiz, you may continue to Module 8.