THE UNIVERSITY OF RHODE ISLAND

Radioactive Material User Safety Refresher Training

University of Rhode Island

Radiation Safety

401-874-2600

www.uri.edu/radiation

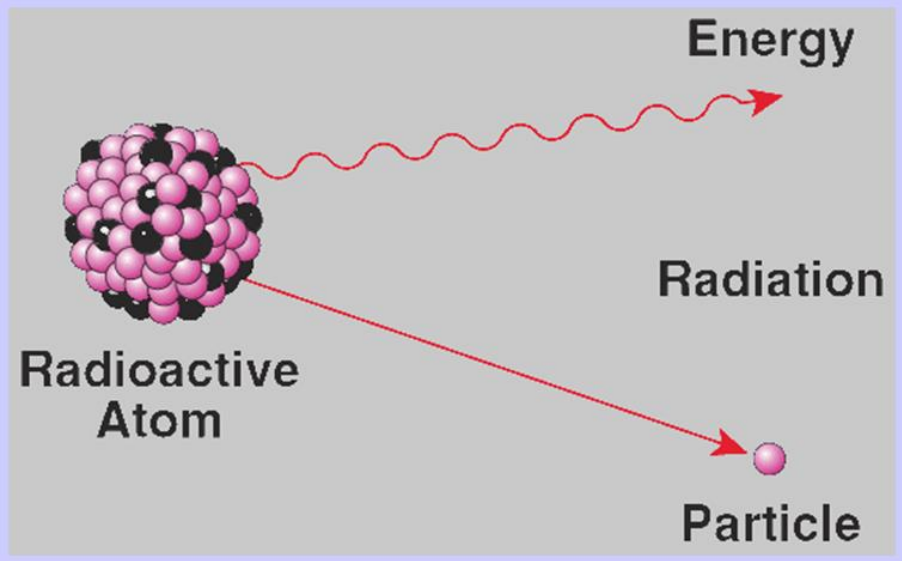
THINK BIG WE DO℠

- This is the refresher training that only covers basic necessary items you need to know when you work with radioactive materials or in the radioactive material use labs.
- This training is an annual training that required every year

Characteristics of Radiation

- Radioactivity - The process by which unstable atoms spontaneously transform into different atoms and emits radiation

- Radiation - The emissions of particles or energy from a radioactive atom



Types of Radiation

- Ionizing Radiation-
  Radiation that interacts with matter to form ions
  - Examples: x-rays, gamma (γ), alpha (a), beta ($ß^-$), Positrons ($ß^+$), neutrons, protons, heavy nuclei

- Non-Ionizing Radiation-
  Radiation that does not form ions when interacting with matter
  - Examples: microwaves, heat, light, lasers, UV, RF

Basic Principles

- Alpha
- Beta
- Gamma
- X-ray

Alpha (α) Decay

- Emit heavy, doubly charged particles
- α particles are two protons + two neutrons
- α particles have a short range in air
- Almost all α particles can not go through out layer of the skin - only an internal hazard
- Alpha particle has approximately the same high energy, above 5 MeV
- Examples - Ra-226, Rn-222, Po-210, Am-241

Beta (β) Decay

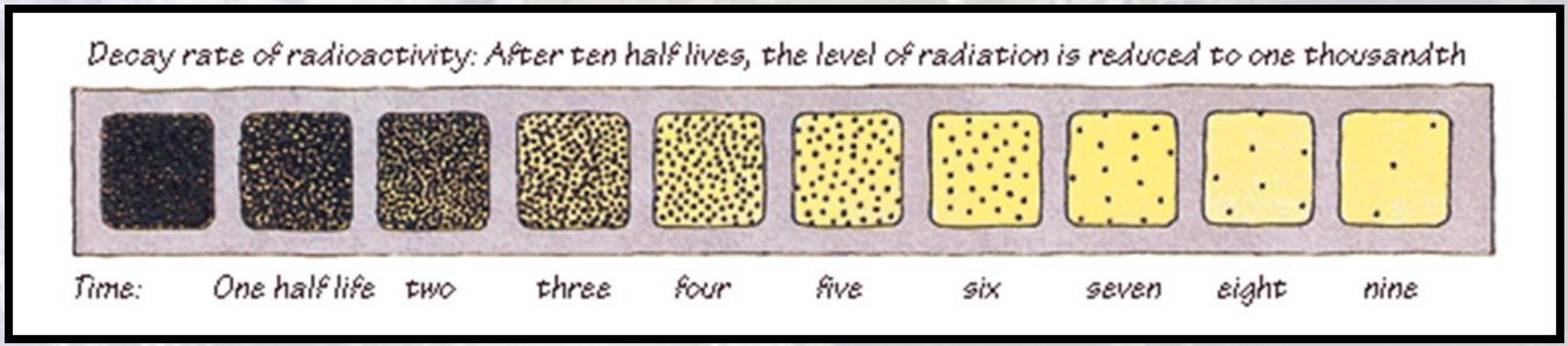
- Emit high speed electrons
- β particles have a short range
- β emitters are an external and internal hazard
- β particles can be shielded with low atomic number (Z) material such as plexiglass
- Typical beta particles - H-3, C-14, S-35, P-32

Gamma ray

- Gamma (γ) rays - photons emitted from within the nucleus of an atom, frequently mono-energetic or several discrete energies
- Almost no attenuation in air and shielded with high Z materials
- Example - Am-241, Tc-99m, Ba-137m, Co-60

Half-life

Half-life is the time it takes for any quantity of radioactive material to decrease its activity to half the original value



Quantity of Radioactive Material

- Radioactivity
- The traditional unit of activity is the curie (Ci)
- The SI unit of activity is the becquerel (Bq) = (dps)
- 1 Ci is the quantity of radioactive material that undergoes **3.7×10^{10}** disintegrations per second (dps)
- Approximately equal to 1 g of radium-226

Exposure

- Defined only for photons, not for other types of radiation
- Traditional unit - röntgen or roentgen (R)
- SI unit - C/kg
- Comparison
- 1 R = 2.54×10^{-4} C/kg
- 1 C/kg = 3876 R

Absorbed Dose and Dose Equivalent

- Results from all types of radiation

- Absorbed Dose
  Traditional unit - rad
  SI unit - gray (Gy)
  Comparison
  1 Gy = 100 rad
  1 rad = 0.01 Gy

- Dose Equivalent
  Traditional unit - rem
  SI unit - sievert (Sv)
  Comparison
  1 Sv = 100 rem
  1 rem = 0.01 Sv

Absorbed dose x Radiation Weighting Factor = Dose Equivalent

Sources of Background Radiation

Natural	~ 310 mrem
- Radon	~ 200 mrem
- Cosmic ray	~ 35 mrem
- Rocks and Soil	~ 40 mrem
- Food and drink	~ 35 mrem

Man-made	~ 315 mrem
- Medical	~ 300 mrem
- Consumer products	~ 13 mrem
- Research	~ 2 mrem

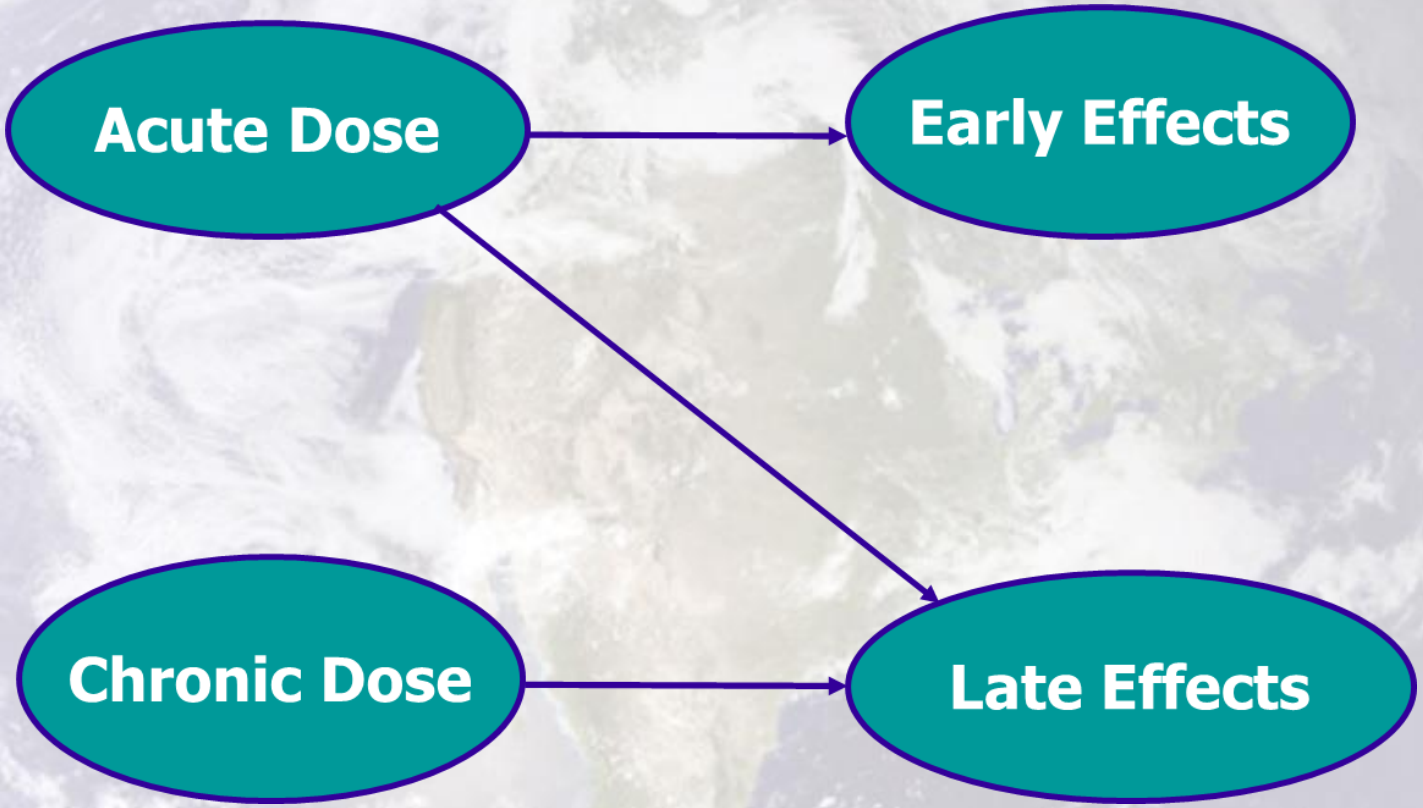
Total Background Radiation

625 mrem/year

Biological Effects

- Radiation causes damage in tissue
- No known effects have been found in humans from low level exposure
- Effects depend on many factors
  - The dose
  - The portion of body exposed
  - The rate at which exposure was accumulated
  - The health of the person

Biological Effects of Radiation



Biological Effects of Radiation

- Acute Dose – Primarily Concern is Early deterministic Effects
- Stochastic Effects Later in Life
- An individual receives a large, short-term, dose. Early deterministic effects may be observed within a few minutes to days
- In research set up, Whole body acute doses are almost impossible unless intentional or in major accident
- Most common injuries are to skin or eyes
- Same long term hazard as chronic dose

Acute dose (continued)

- Acute Radiation Syndrome - Deterministic Effect
- symptoms : nausea, vomiting, diarrhea, general malaise, loss of appetite, infections, fever, hemorrhage, and sometimes death
- These early effects only occur for massive doses, which are usually a result of industrial accidents, cancer treatment exposure, or war-related exposures

Biological Effects of Radiation

- Chronic Dose – Primary Concern is Later Stochastic Effects
- An individual receives a dose over an extended period
- Chronic dose may cause cancer or genetic defects
- Cataracts (a deterministic effect) resulting from doses to the lenses of the eyes threshold is around 50 rem and typically show the signs around 100 rem

ALARA

- The guiding principle behind radiation protection is that radiation exposures should be kept “As Low As Reasonably Achievable (ALARA)”
- Economic and social factors are taken into account
- Radiation doses for both workers and the public are typically kept lower than their regulatory limits. URI action level is 500 mrem (10 percent of the regulatory limit)

Protection From External Sources

- Achieving ALARA

- Time
- Distance
- Shielding

Time

Less time means less dose.
Time x Dose Rate = Dose

Example:

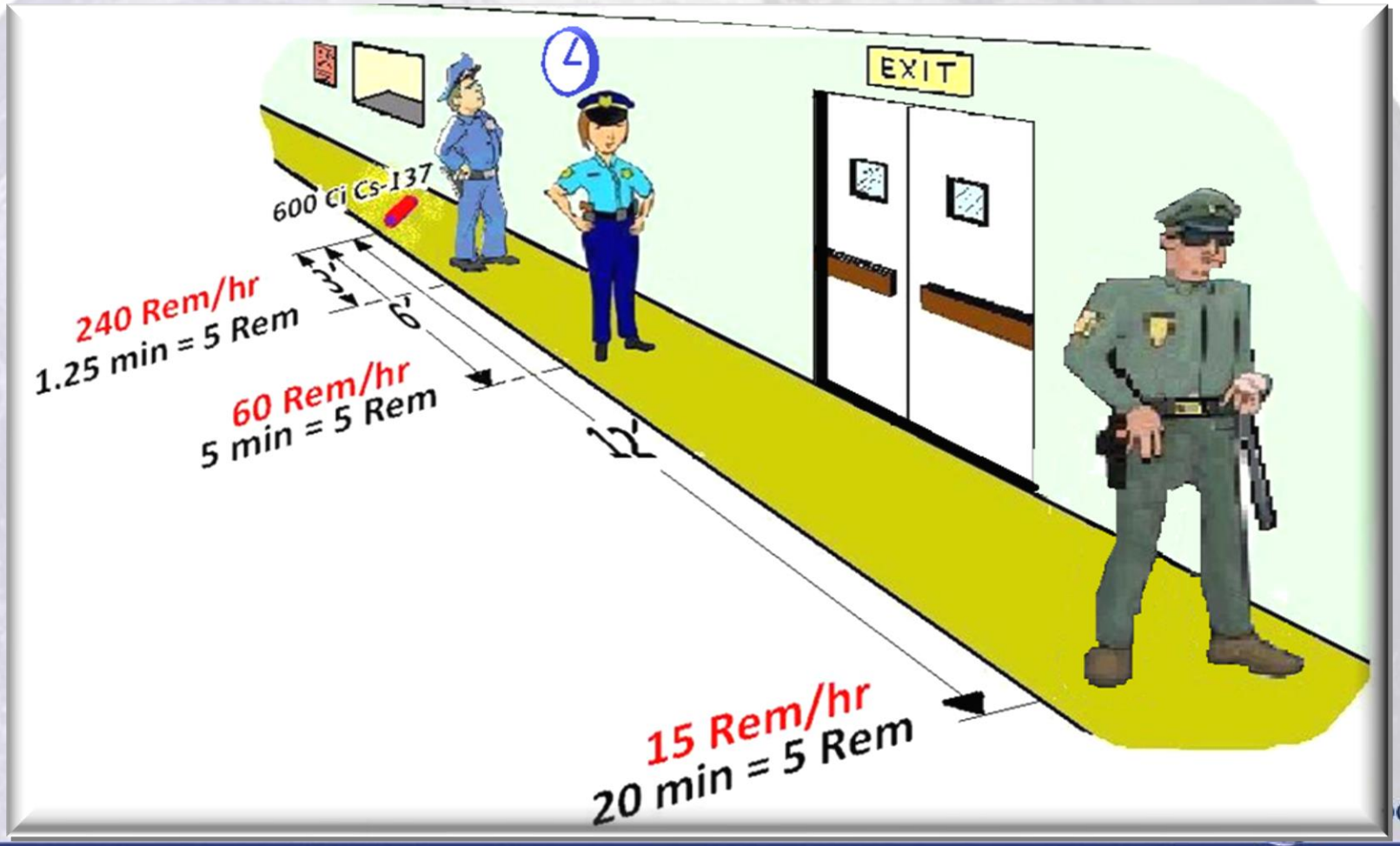
If you spend 2 hours in a

5 rem/h radiation area,

your dose is 10 rem.

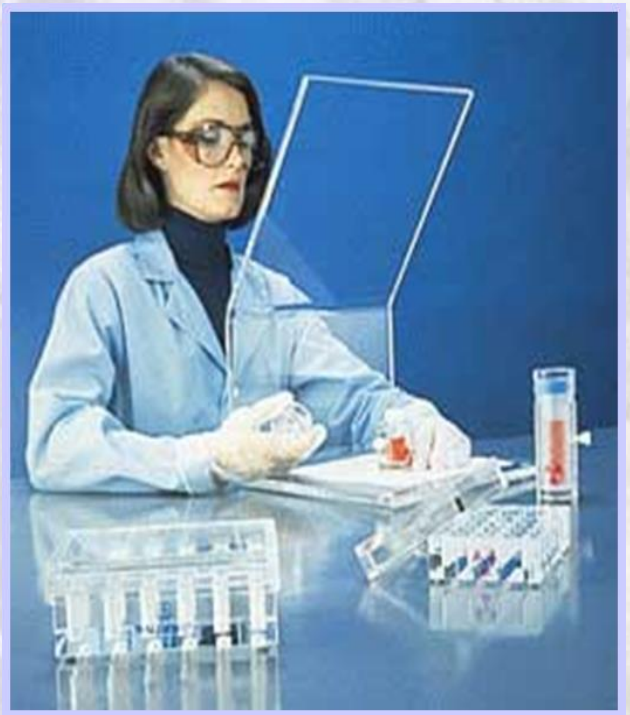
(2 hours) X (5 rem/h) = 10 rem

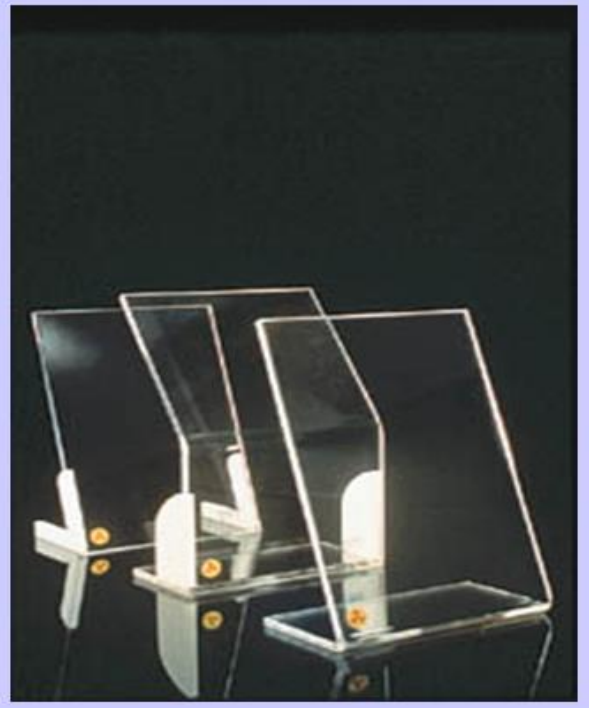
Distance


EXIT
600 Ci Cs-137
3'
6'
12'
240 Rem/hr
1.25 min = 5 Rem
60 Rem/hr
5 min = 5 Rem
15 Rem/hr
20 min = 5 Rem

Shielding

- Used when time and distance are not enough





Safety Equipment to be Used

- Remote Handling Devices
  - Tongs
  - Forceps
  - Tweezers

- Personnel Protective Equipment (PPE)
  - Disposable gloves
  - Lab coats
  - Safety glasses

Principles of Radiation Protection

- Injection
- Ingestion
- Inhalation
- Absorption through the Skin

Maximum Permissible Exposure Limits

• Whole Body	5 rem/year
• Any individual organ or tissue	50 rem/year
• Eye	15 rem/year
• Skin or extremity	50 rem/year
• Minor (Under 18 years old)	0.5 rem/year
• Individual member of public	0.1 rem/year
• Embryo/Fetus (During pregnancy)	0.5 rem

Basic Safety Practices

- Wear your lab coat and keep it closed
- Wear gloves and change them regularly
- Wear eyewear if necessary
- Wear close toed shoes
- Leave your PPE in the lab
- Label work area and equipment with RAD tape
- Use and check your survey meter regularly
- Survey your work area after every RAM use including the floor
- Survey yourself after every RAM use
- If you find contamination, clean it up ASAP or contact radiation safety office immediately
- Use and change out plastic backed absorbent papers regularly

RAM Laboratory Safety Guidelines

- Wear laboratory coats or other protective clothing at all times in areas where radioactive material is used
- Wear disposable gloves at all times while handling radioactive material
- Do not eat, drink, smoke, apply lip balm, or apply cosmetics in any area where radioactive material is stored or used
- Do not store food, drink, or personal effects with radioactive material
- Dispose of radioactive waste only in specially labeled and properly shielded receptacles
- Never pipette by mouth

RAMs Laboratory Safety Guidelines

- Absorbent paper shall cover workbenches, trays, and other surfaces where radioactive material is handled
- Monitor hands and clothing for contamination after each procedure or before leaving the area
- Survey areas where radioactive material is used in unsealed form after each procedure and/or at the end of the day (Decontaminate immediately if necessary)
- Radioactive material in liquid form should be stored and transported in double containers
- Work should be planned ahead, and whenever possible, a practice run should be performed to test the procedure

RAM Laboratory Safety Guidelines

- The laboratory should be kept clean and orderly at all times
- Survey meters should be checked routinely with a source of radiation to see if they are responding properly and a battery check should be performed before each use
- Radiation Badges shall be worn at all times while in areas where radioactive material is stored or used if assigned
- All radioactive material shall be securely stored

Incident Notification

- Individuals working with radiation must assume the responsibility for their own safety and must ensure that their actions do not result in a hazard to others.
- In the event of a suspected or known exposure, immediately stop work and notify your Authorized User and the Radiation Safety Officer.
- If it is determined that there is an acute localized exposure, seek medical attention as soon as possible.

Radiation Spill, Accident, Decontamination, and Emergency Procedures

- **Spill – DO NOT PANIC!!!!!**
- **If you rather not to clean up, please call the Radiation Safety Office immediately!!**
- Notify all personnel in the area
- Contain or secure the radioactive material if possible
- Take care of injuries and remove injured personnel from the area when possible
- Notify the Radiation Safety Officer as soon as possible
- Permission from the Radiation Safety Officer must be obtained to continue or return to work
- Apply decontamination procedures when possible
- The Radiation Safety Officer will notify the appropriate agencies of any incidents if reporting is required

Radiation Spill, Accident, Decontamination, and Emergency Procedures

- **Decontamination**
  <u>Area</u>

  All persons not involved and not contaminated should leave the area

  Put on lab coat, protective eyewear, gloves and shoe covers if available before entering the room or area

  Prevent liquids from spreading by placing any absorbing material over it

  Monitor the spill, equipment, and people involved to determine the radiation exposure levels

Radiation Spill, Accident, Decontamination, and Emergency Procedures

Personnel

- For contamination of the skin, use light pressure with mild soap.
- Rinse and monitor and use care not to scratch or erode the skin
- Use warm not hot water, and avoid reddening the skin
- Contaminated clothing, including shoes, should be removed before the individual leaves the area
- This clothing shall be labeled and held for storage until decayed, decontaminated, or properly disposed
- Thorough washing, preferably showers, should be accomplished immediately where major personnel contamination has occurred
- Monitor personnel after washing. Repeat if necessary
- Minor cuts should be encouraged to bleed, thereby reducing absorption
- Treatment of major cuts should be considered before decontamination

Missing Materials

- If the material is suspected of or confirmed to be missing, report to the Radiation Safety Officer immediately!

Radioactive Waste

- Three types of waste
  - Dry
  - Liquid
  - Scintillation

Radioactive Waste Disposal Procedures

Radioactive waste must be segregated according to radioisotope except for Tritium (3H) and Carbon-14 that can be placed in the same container.

Radioactive waste must be segregated into following basic physical forms:

Solid

- Solid radioactive waste includes work surface coverings, gloves, tubing, etc.
- Dispose only labeled radioactive material bags
- The radioactive waste bags must be placed in closed waste receptacles
- Deface or remove all radioactive labels before put in the waste bag
- Do not place anything in the bags in such a way that may tear it
- Inspect the plastic waste bag for leaks and use a second yellow bag to if necessary
- Do not mix liquid scintillation vials, lead pigs, and stock vials in with the solid waste

Radioactive Waste Disposal Procedures

Liquid

- Radioactive liquid waste can be divided into aqueous, acids and bases, and pump oils
- Aqueous liquids are water-based liquids with a pH between 5.5-9.0, such as saline and buffer solutions

  - Dispose generally in plastic containers and the containers are not to be filled more than 4/5th full
  - No radioactive liquid is to be poured down the sink
  - Sinks will be checked during the radiation safety's routine lab surveys and wipe tests
  - Pipettes and other such items must not be placed in the container
  - All biological material in the waste must be properly deactivated
  - Do not mix liquid waste types in the container except H-3 and C-14.

Radioactive Waste Disposal Procedures

- Double containment of the container on a tray or pan is recommended against leakage or a spill
- This will also control accidental overflow and drips due to pouring
- At a minimum, plastic backed absorbent paper shall be placed under all liquid waste containers
- Containers should be kept as free of contamination as possible

Radioactive Waste Disposal Procedures

Liquid Waste Containers

- Glass containers must never be used for storage of radioactive liquid waste unless plastic incompatible contaminated acids or bases are used

Radioactive Waste Disposal Procedures

Liquid Scintillation Vials

Liquid Scintillation Vials are glass or plastic vials containing organic or aqueous based liquid scintillation fluid

Dispose in the original cardboard trays if available and place in a radioactive waste bag or container

Loose vials must be double bagged

Check that vial tops are on tight because all scintillation fluids will dissolve plastic in time

Radioactive Waste Disposal Procedures

Source Vials

- These are the original vials that the radioactive material came in and includes full, partially full, and empty disposed vials
- All source vials must be disposed by Radiation Safety, even if decayed
- Radiation Safety will do a final survey on all source vials prior to disposal
- Source vials must be kept separate from the solid waste
- A Radioactive Waste Disposal Form is not required
- Segregation by radioisotope does not apply to source vials

Radioactive Waste Disposal Procedures

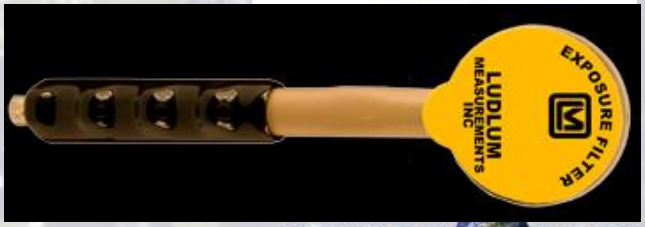
Lead Pigs

- These are the original lead and lead impregnated shielding containers surrounding the source vials
- Lead is a hazardous waste and must be disposed accordingly
- Lead pigs and lead impregnated shielding containers must be kept separate from the solid waste
- A Radioactive Waste Disposal Form is not required
- Segregation by radioisotope does not apply to lead pigs.

Survey Meters

G-M Portable Survey Meter

- Respond to the emissions from a radioactive source or machine source
- Responds with an audible tone
- Two types of probe:
  - pancake-style probe measures surface contamination (in cpm)
  - pancake-style probe with exposure rate filter measures exposure rate (in mR/hr)



Laboratory Survey & Wipe Test

- Any area found to have count rates of twice background or greater consistently with a survey meter is considered contaminated
- This area must be immediately decontaminated and then resurveyed to confirm that the area is below twice background
- Calibrations of survey meters are performed annually through Radiation Safety
- A calibration is also required after a repair or the replacement of parts (e.g. probe)
- Radiation Safety will pick-up the meter and provide a loaner meter while yours is being calibrated.

Laboratory Survey & Wipe Test

Frequency

- Authorized Users with active use of radioisotopes are required to perform are surveys and wipe tests after their work with radioactive materials **all the time**
- All labs, including storage rooms, counting rooms, cold rooms, shared rooms, and other rooms where radioactive material work or processing is performed are included
- Radiation Safety also performs lab surveys and wipe tests on a quarterly basis to verify compliance

Survey & Wipe Test :Contamination

- RADIOACTIVE CONTAMINATION – radioactive material in an undesirable location
- Two types:
  - Fixed – not readily removed
  - Can not be detected by wipe tests but may be by GM survey meter
  - Removable – can be easily removed
  - Can be detected by wipe test and maybe by GM survey meter

Survey & Wipe Test Documentation

Documentation

- Lab surveys and wipe tests must be recorded
- If you prefer Radiation Safety Office survey form to use please contact the Radiation Safety personnel to obtain the form
- The location of each survey and wipe test must be properly identified on the survey form
- Information on the form must be completely filled out.

Package Receipts

- Receipts - **The shipment must be delivered to the CBLS dock at the main campus or the Radiation Safety Office at the bay campus, and the Radiation Safety Staff will deliver to the radioactive material use lab or designated location only!**

- Packages are NOT accepted before or after normal business hours on weekends or holidays unless previously arranged with the Radiation Safety

Protection & Regulations

Regulatory Agencies

- **Rhode Island Department of Health (RIDOH) Radiation Control Program (Agreement State)**

- Nuclear Regulatory Commission (NRC)
- Occupational Safety and Health Administration (OSHA)
- Environmental Protection Agency (EPA)
- Food and Drug Administration (FDA)

RAM Regulations

- **RULES AND REGULATIONS FOR THE CONTROL OF RADIATION** [216-RICR-40-20]

- General Provisions for Radioactive Material
- Standard radiation safety protection
- Appendix DAC and ALI
- Notices and instructions
- Exemption, GL, labels, wastes, etc.
- Licensing
- NORM
- Medical and Veterinary Use of Radioactive Material
- X-rays

Signs and Postings

Signs and Postings

RADIATION EMERGENCY PROCEDURES

IN CASE OF RADIOISOTOPE SPILL:

1. STOP WORK IMMEDIATELY
2. NOTIFY PERSONNEL IN AREA
3. CALL RADIATION SAFETY

DAY: 789-9391 NIGHT : 874-2121

URI Procedures and Policies

RI Radiation Safety Regulations

Radiation Safety Training Requirements

- All AUs and radiation workers of radioactive material, Class IIIb and IV lasers, X-ray machines, must attend and pass the applicable radiation safety training course
- There is a test with each course which requires at least 70% to pass. If you do not pass, you can retake the test after additional study. This test is used to fulfill the requirement for users to demonstrate competence.
- Completion is not enough to become an radiation worker and start radiation work. You must be specifically added by your AU to the authorization.
- Annual Refresher Training is required for all radiation workers of radioactive materials and X-ray machines. There is a test with each course which requires at least 80% to pass.

Emergency Information

- The Radiation Safety Office hours: Monday through Friday, 8:30 a.m. – 4:30 p.m.
- For assistance with a radiation emergency or incident during normal office hours call the radiation Safety Office.
- In the event of an after hours radiation emergency, contact the URI Public Safety.
- emergency information is available in the Radiation Safety Manual at http://www.uri.edu/radiation
- If you call after normal office hours about a non-emergency incident, you may leave pertinent information on the radiation safety office's telephone voicemail.

Emergency Telephone Numbers

• Environmental Health and Safety	(401) 874-7993
• Environmental Health and Safety (Emergency)	(401) 874-2121
• **Radiation Safety Office**	**(401) 874-2600**
• **Radiation Safety Officer**	**(401) 874-9439**
• **Health Physicist**	**(401) 874-9451**
• URI Health Service	(401) 874-2246
• URI Public Safety (Emergency)	(401) 874-2121
• URI Public Safety (Non-Emergency)	(401) 874-4553
• Medical Emergencies	(401) 874-2121

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