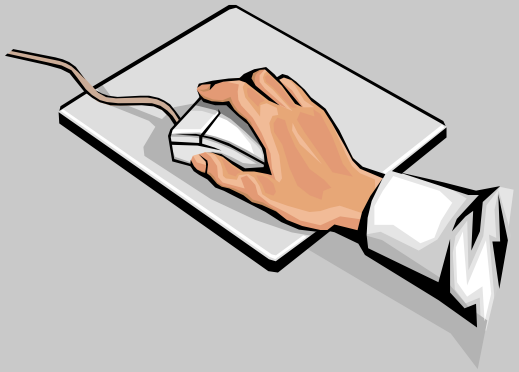
VAMC
BASIC RADIATION SAFETY TRAINING

Non-Medical Use of Radioactive Materials in Basic Sciences

2013

Course Credit



To Obtain Credit for This Course:

- Review the course slides.
- Complete the online exam.
- Mail your completed exam to EHS Training, 100 EHS.
- If you score less than 80% you will be notified to retake the exam.

Training Requirements

Initial Training

Basic Radiation Training is required for individuals who have not been previously authorized to work with radioactive material at the Veterans Affairs Medical Center (VAMC), including the Principal Investigator (PI). Individuals must complete initial training prior to being issued a dosimeter.

Annual Refresher Training

Refresher training is required every twelve months for continued authorization to use radioactive materials, except the PI. Refresher training for PIs occurs during their annual authorization-renewal meetings with the Radiation Safety Office.

Completion of this training course fulfills your initial radiation safety training requirement for radioactive materials use in the Basic Sciences.

VA's Master Materials License

The U.S. Nuclear Regulatory Commission (NRC) has delegated authority to the VA's National Health Physics Program (NHPP) to oversee and regulate the use of radioactive materials at all VA facilities nationwide under a Master Materials License agreement.

Under this agreement the VA's NHPP issues and renews permits to use radioactive materials at VA facilities and performs onsite inspections. The NHPP has issued the VAMC a broad-scope radioactive materials permit #14-00822-01, that covers all medical and research use of radioactive materials at the VAMC.

Any action that jeopardizes the VA's broad-scope radioactive materials permit, jeopardizes the permission of all individuals to use radioactive materials at the VAMC.

Radiation Safety Committee (RSC)

The Radiation Safety Committee (RSC) is established by the Medical Center Director as the administrative body for the oversight of the safe use of radiation sources within the institution. The Committee is responsible for reviewing and authorizing all proposed uses of radioactive material and setting radiation safety policy for the VAMC.

The Committee has the authority to enforce applicable regulations and radioactive materials permit conditions, including the authority to terminate any use of radiation sources determined to be a threat to human health and safety, or VAMC property.

Radiation Safety Officer (RSO)

The Radiation Safety Officer (RSO) is designated by the Medical Center Director and/or Chief of Staff to coordinate and manage the Medical Center's radioactive materials permit and all aspects of the radiation safety program under the procedures and policies approved by the Radiation Safety Committee (RSC). The RSO has the authority to terminate any use of licensed radioactive materials determined to be a threat to human health and safety or VAMC property.

The VAMC's RSO is Gordon Axt. He can be reached at 335-8503 or gordon-axt@uiowa.edu

Regulatory Inspections & Radiation Safety Audits

Regulatory Inspections:

The VA's National Health Physics Program (NHPP) and/or the Nuclear Regulatory Commission (NRC) perform periodic on-site inspections to evaluate the VAMC's compliance with our radioactive materials permit and regulatory requirements.

Radiation Safety Audits:

The VAMC's Radiation Safety Staff routinely audits user compliance with radiation safety rules and policies. The audits include evaluation of contamination control and radiation levels to maintain exposures 'as low as reasonably achievable' (ALARA). Items of non-compliance are managed using the Three Strikes Policy as described in the next slide.

VAMC Radiation Safety Office

- Posts and deposts all labs on campus.
- Performs pre-maintenance and pre-equipment disposal surveys. Contact the VAMC Radiation Safety Office (VAMC – RSO) at ext. 5753 to schedule a survey prior to maintenance or equipment disposal.

- Performs routine audits of labs to ensure compliance with VAMC policy, NHPP and Nuclear Regulator Commission (NRC) regulations.
- Receives and ships all RAM for VAMC.
- Implements x-ray and laser safety programs

Radiation Safety Non-Compliance Three-Strikes Policy

The VAMC – RSO provides a written notice of violation to the research lab's Principle Investigator (PI) with guidance for appropriate corrective action.

A second occurrence of the same violation within a 12 month period, results in a second notification and warning of use termination for continued non-compliance with copies to the AO for Research.

A third occurrence of the same violation within a 12-month period, results in termination of the PI's use authorization, which means that all RAM users under the PI's authorization will lose their privileges to work with RAM.

Reinstatement of a PI's use authorization requires the approval of the VAMC's Radiation Safety Committee (RSC).

Examples of Non-Compliances

- Eating/drinking/smoking/storing food in RAM areas.
- Inventory and survey records that do not reflect actual radioactive materials on hand and/or in use.
- Failure to secure RAM and/or rad waste from unauthorized use or removal.
- Improper radioactive waste storage.

User Responsibilities

- Keep RAM use authorization current.
- Complete radiation safety training.
- Maintain up-to-date inventory records.
- Perform and document RAM surveys frequently to control contamination and keep exposure ALARA.

- Follow required radiation safety and radioactive waste handling and disposal policies.
- Secure Radioactive Materials and Waste at all times.

Who Is Responsible For Compliance?

The principal investigator is ultimately responsible and answerable to both the NHPP/NRC and the VAMC Radiation Safety Committee regarding notices of non-compliance.

However, individuals listed on approved radioactive materials authorizations are also responsible for adhering to applicable NHPP/NRC regulations and VAMC policies.

You Have the Right to Report Radiation Safety Concerns and Violations

Report concerns or suspected radiation safety violations to your supervisor. If it is not adequately corrected, notify the RSO at 335-8503 or gordon-axt@uiowa.edu

If the violation is still not resolved, you have the right to contact NHPP at 501-257-1571.

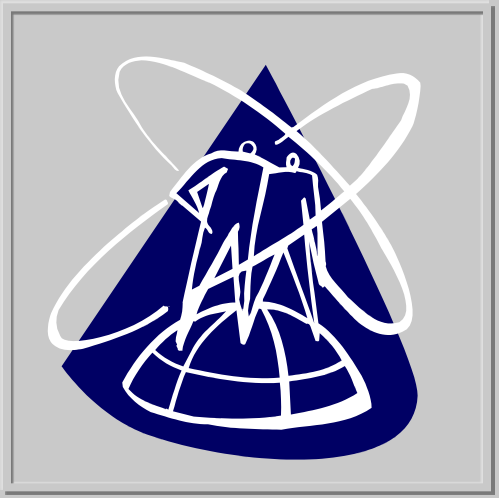
NHPP/NRC regulations prohibit academic or job discrimination against individuals who report radiation safety concerns or violations.

Amending an Initial Authorization

An amendment to a PI's existing authorization must be filed with the Radiation Safety Office whenever changes occur in:

- Personnel
- Use areas
- Shipping or on-hand limits
- Radionuclide type, chemical form, and/or methodology

Ionizing Radiation

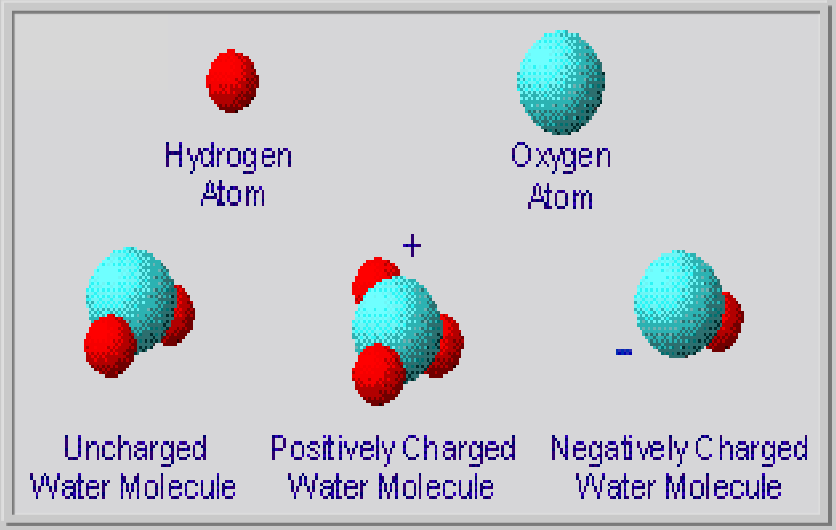


Ionizing radiation is produced by the natural decay of radioactive material. Several types that are important in research are beta, gamma, and X-ray radiation. Each type has different properties and reacts with matter in different ways.

The next slides will provide basic information about those types of radiation and how to shield them.

Ions

X-rays, gamma rays, and beta particles can remove electrons from atoms of the object they interact with. This is called "ionization."

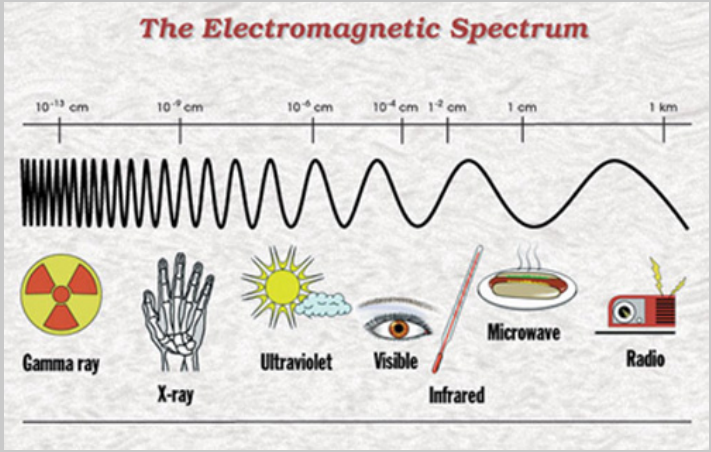


Ions (ionized atoms) are more chemically reactive than neutral atoms. They can form compounds that interfere with cell division and metabolism and cause chemical changes in tissue.

X-rays & Gamma Rays

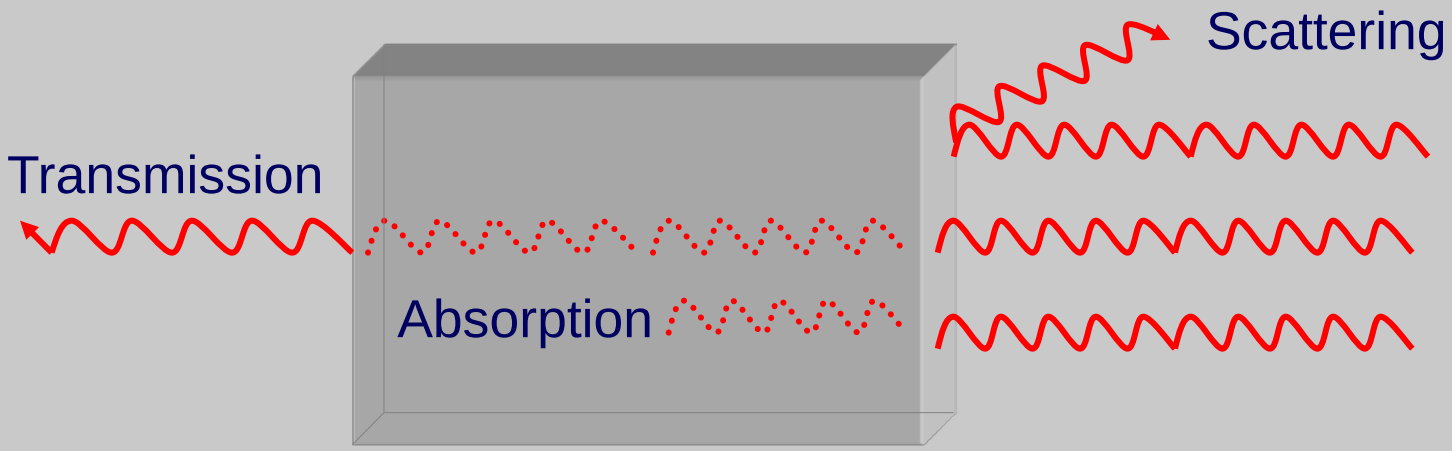
X-rays and Gamma rays make up part of the electromagnetic spectrum. Radiowaves, microwaves, IR light, visible light and UV light are not forms of ionizing radiation.

Electromagnetic radiation can act like waves of energy or streams of massless particles known as photons.

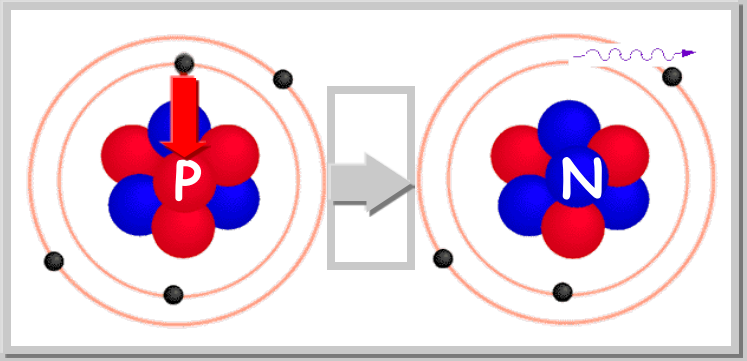


X-rays & Gamma Rays

X-rays and gamma rays can travel forever until an object is encountered, then one of three reactions occurs:



X-Ray Production

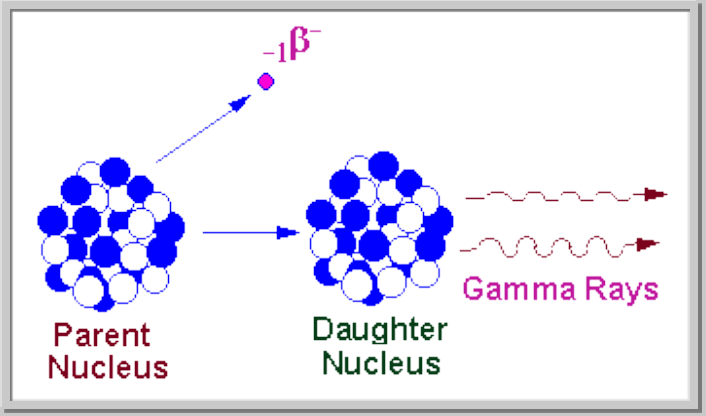


I-125 and Cr-51 decay by the electron capture

X-rays are released when an atomic nucleus stabilizes itself by capturing an electron from the electron cloud.

The captured electron combines with a proton creating a neutron. The captured electron creates a vacancy in the electron cloud and X-rays are emitted as the electrons rearrange themselves to fill the vacancy.

Gamma Ray Production



Gamma rays are released when an atomic nucleus releases excess energy after a decay reaction. Cesium-137 (Cs-137) releases gamma radiation.

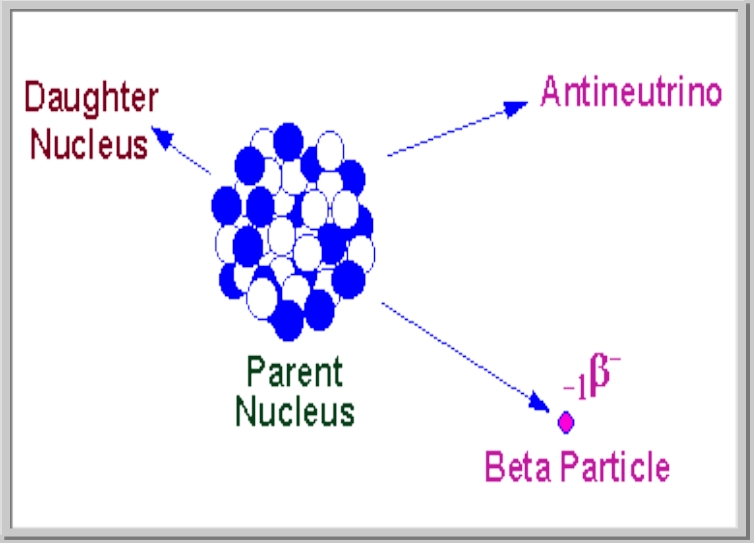
Many gamma emitters also release beta particle rays, including Cs-137. There are no “pure” gamma emitters.

Shielding X-Rays and Gamma Rays

Lead shielding reduces the intensity of gamma rays or X-rays being emitted from a source of radiation.

Each gamma or X-ray emitter has a specific thickness needed to reduce exposure by some desired percent. So it is important to remember that lead shielding does not automatically reduce exposure by 100%.

Beta Particle Production



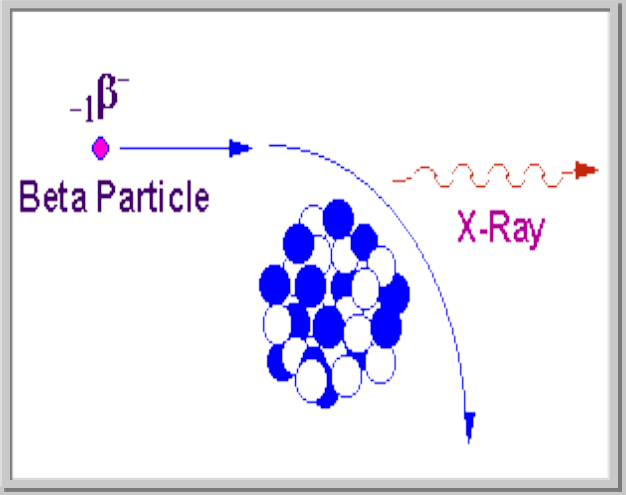
Atoms with an excess of one neutron will decay by transforming a neutron into a proton with the ejection of an electron (beta particle).

Beta Particle Production

Beta Particles (β^-):

- Have a limited range in air. Yet, the greater their energy, the further they can travel.
- Have a minus 1 charge and very small mass.
- Cannot penetrate the body to irradiate internal organs, but many can penetrate the dead outer layer of skin resulting in a dose to live skin cells.
- Low energy β^- cannot pass through cardboard. Denser materials such as Plexiglas are required for shielding high energy β^- emitted from P-32.

Bremsstrahlung Radiation and Shielding



Bremsstrahlung (or X-ray) radiation results when high energy β^- radiation interacts with high density materials such as lead.

However, the X-ray conversion yield is low, <10% for beta energies under 10 MeV (H-3, C-14, S-35, P-33 and P-32).

Bremsstrahlung Radiation and Shielding

Bremsstrahlung conversion is minimal in plastic or acrylic shielding materials.

Shielding about 1 cm thick is effective for absorption of P-32 β^- and is more than adequate for shielding lower energy beta emissions from C-14, H-3, P-33 and S-35.

Avoid shielding <1 cm thick because it breaks and cracks easily.

Non-Penetrating Radiation

Beta particles are not forms of penetrating radiation because they are not able to penetrate the body to irradiate internal organs.

However, beta particle exposure can result in basal skin and lens of the eye dose.

Internal exposure can occur if a β^- emitter is ingested, inhaled, or absorbed through the skin.

Penetrating Radiation

X-rays and Gamma Rays are able to penetrate the body and irradiate internal organs. So, X-ray and gamma ray exposure can result in external and internal doses.

Internal exposure can also occur if an X-ray or gamma ray emitter is ingested, inhaled, or absorbed through the skin.

There are two units commonly used to describe the magnitude of interaction between ionizing radiation and matter - rads and rems.

Radiation Absorbed Dose - RAD

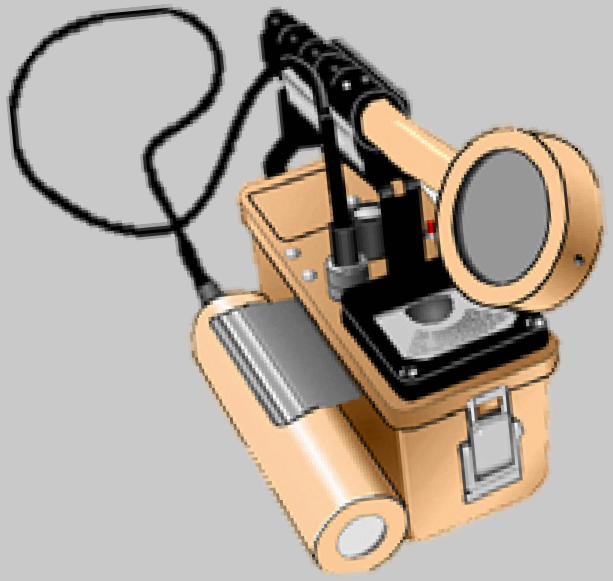
RAD is a unit used to describe the amount of energy transferred from a source of ionizing radiation to any material, including human tissue.

As a unit of exposure 1 rad means each gram of air at 0°C and 1 atmosphere has absorbed 100 ergs of energy.

As a unit of dose 1 rad means that each gram of exposed tissue has absorbed 100 ergs of energy.

	Unit Conversions	
1 rad	1,000 millirad	mrad
1 mrad	1,000 microrad	μrad
1 Gray	100 rads	SI Unit

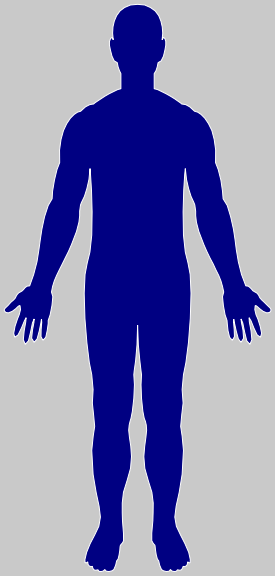
Radiation Absorbed Dose



Survey meters are used to measure radiation absorbed doses.

As a frame of reference, background radiation is about 0.05 mrad/hr. This is a very minimal dose compared to 100,000 mrad/hr, which can cause lowering of an exposed individual's white blood cell count.

Radiation Equivalent in Man - REM



Given the same amount of radiation energy transferred, different types of ionizing radiation can produce different degrees of biological effects in human tissue.

To account for this, the “rad” is multiplied by a specific quality factor (QF) to determine the dose equivalent (DE) or REM.

REM Example Calculation

Question:

Is the DE for 1 rad of X-ray exposure the same as the DE for 1 rad of fast neutron exposure?

The answer is “NO” because the quality factor is different for X-rays and neutrons, as illustrated below:

X-rays, (1 rad) x (1 QF) = 1 rem

Fast neutrons, (1 rad) x (10 QF) = 10 rem

Radiation Equivalent in Man

Dose Rate is responsible for determining biological harm.

For example, a DE of 100 rem received in 1 hour has a direct biological effect; lowering of an individual's WBC count. In contrast, a DE of 100 rem received over a working lifetime is not expected to result in adverse health risks.

Unit Conversions

1 rem	1,000 millirem	mrem
1 mrem	1,000 microrem	μrem
1 Sievert	100 rems	SI Unit

Dosimeters are used to measure a person's occupational dose equivalent.

Dosimeters Measure Dose Equivalent (DE)

Luxel™ dosimeters measure occupational whole body DE.

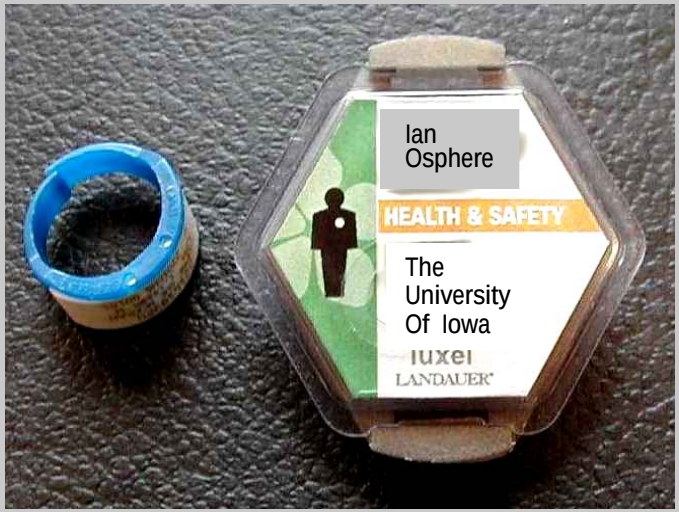
- X-rays and gamma rays from 1 - 1,000,000 mrem
- High energy beta particles from 10 - 1,000,000 mrem

Ring dosimeters measure extremity DE.

- X-rays & Gamma Rays from 30 - 1,000,000 mrem
- High Energy Beta particles from 40 - 1,000,000 mrem

Dosimeters

Dosimeters are not typically required for individuals working with tracer quantities of radioactive materials commonly used in a laboratory setting.



Dosimeters are required if you:

- Are likely to receive >10% of an occupational dose limit.
- Enter a high radiation area.
- Routinely work with >1 mCi quantities of P-32, Fe-59 or Cr-51.
- Routinely work with >5 mCi quantities of I-125.

Dosimeters cannot detect low-energy beta radiation from radionuclides such as C-14, H-3, P-33 and S-35.

Dosimeter Requests and Wear Locations

- To obtain a dosimeter or change in service, submit a completed “Dosimeter Request or Change” Form found online or go to the VAMC’s Radiation Safety Office in the department of Nuclear Medicine.
- A whole body dosimeter is worn on the to torso in a location where it is likely to receive the highest exposure.
- Ring dosimeters are worn underneath disposable gloves.

Back of Whole Body Dosimeter

On dosimeter reports you are identified by your participant number which is found on the back of your dosimeter.

Fetal Dosimeters

A fetal dosimeter and fact sheet are provided to pregnant radiation workers upon completion of the VAMC Pregnancy Declaration Form.

Contact Laurie Scholl at ext. 5753 or 353-5389 for more information.

- A fetal dosimeter is worn at waist level.
- Regulations state that fetal dose is limited to 500 mrem for the entire gestation period for all women who declare their pregnancy in writing.

Dosimeter Participants

- Dosimeters are exchanged monthly. Your new dosimeter(s) will be mailed to you or your group's dosimeter coordinator at the beginning of each month.
- **Mail your old dosimeter(s) from the previous month back to the Environmental Health and Safety Office (EHS) by the 10th day of the month following the wear date, in the return envelope provided.**
- If your dosimeter(s) is lost or returned late three times within one year, an administrative fee of $20.00 will be charged to your department.
- Your dosimeter report records are available for your review by contacting your supervisor or calling the VAMC – RSO at ext. 5753.

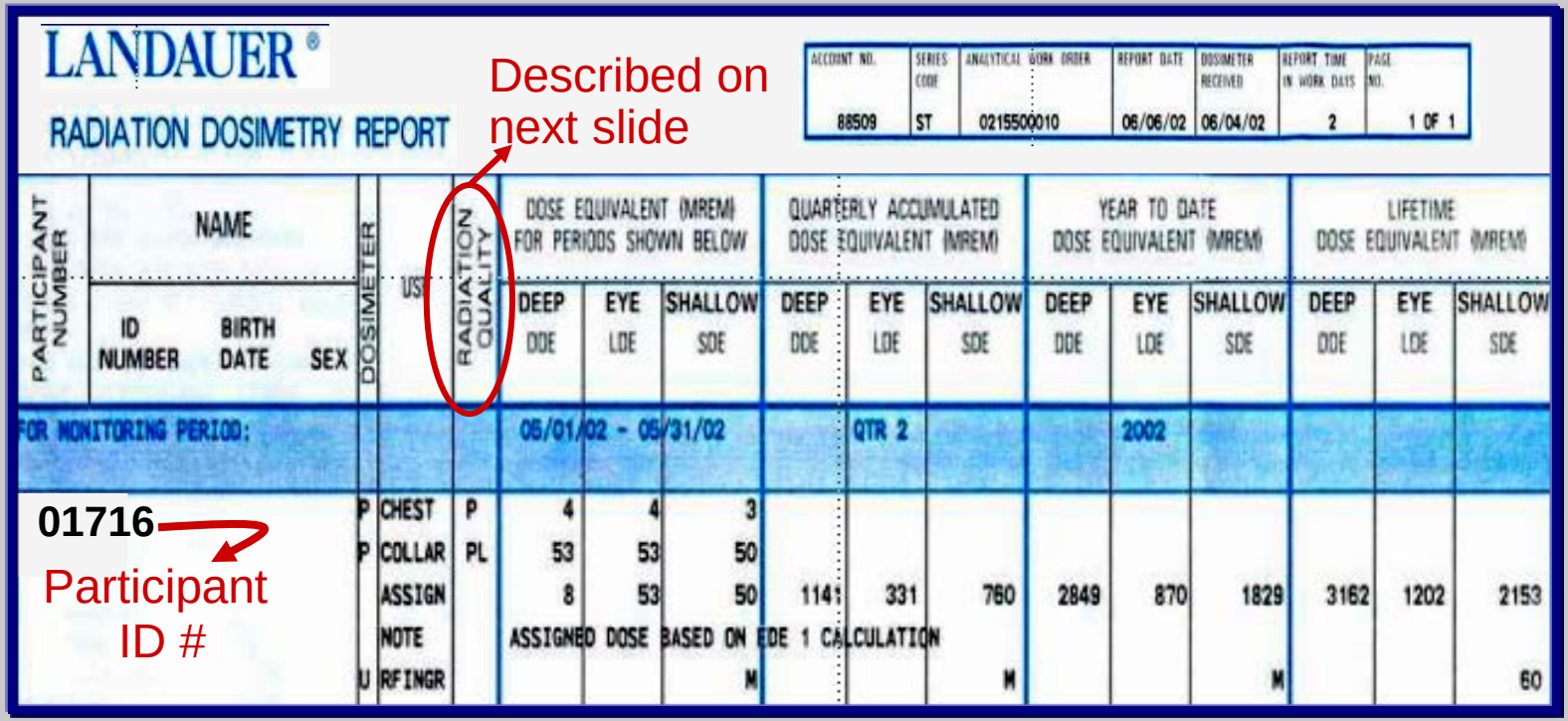
Dosimetry Reports

Monthly Dosimeter Reports are sent to your supervisor. If you are unable to locate a report contact the Radiation Safety Office at ext. 5753.

If your dose equivalent ever exceeds an ALARA action level, EHS will contact you about ways to reduce future exposures.

Whole body dosimeter dose equivalents of <1 mrem for gamma and X-ray exposure will be noted as “M” (minimal) on the report. “M” for beta exposure is <10 mrem. Minimal exposure for ring dosimeters is <30 mrem.

Dosimetry Reports



LANDAUER®

RADIATION DOSIMETRY REPORT

Described on next slide

ACCOUNT NO.	SERIES CODE	ANALYTICAL WORK ORDER	REPORT DATE	DOSIMETER RECEIVED	REPORT TIME IN WORK DAYS	PAGE NO.
88509	ST	0215500010	06/06/02	06/04/02	2	1 OF 1

PARTICIPANT NUMBER	NAME / ID NUMBER / BIRTH DATE / SEX	DOSIMETER	USE	RADIATION QUALITY	DOSE EQUIVALENT (MREM) FOR PERIODS SHOWN BELOW			QUARTERLY ACCUMULATED DOSE EQUIVALENT (MREM)			YEAR TO DATE DOSE EQUIVALENT (MREM)			LIFETIME DOSE EQUIVALENT (MREM)		
					DEEP DDE	EYE LDE	SHALLOW SDE	DEEP DDE	EYE LDE	SHALLOW SDE	DEEP DDE	EYE LDE	SHALLOW SDE	DEEP DDE	EYE LDE	SHALLOW SDE
FOR MONITORING PERIOD:					05/01/02 - 05/31/02				QTR 2			2002				
01716		P	CHEST	P	4	4	3									
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			ASSIGN		8	53	50	1141	331	760	2849	870	1829	3162	1202	2153
			NOTE		ASSIGNED DOSE BASED ON EDE 1 CALCULATION											
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Participant ID #

Dosimetry Reports - Back

Radiation Quality Explanations

Types and energies of radiation contributing to whole body dose equivalent.

P	X-ray or gamma ray exposure
PH	X-ray or gamma ray exposure greater than 100 kev
PL	X-ray or gamma ray exposure less than 100 kev
B	Beta exposure
NF	Fast Neutron Exposure
NT	Thermal Neutron Exposure

Dosimetry Reports - Back

Dosimeter Results

Deep Does Equiv.	External, whole body exposure at a tissue depth of 1 cm (penetrating radiation). Dose received by internal organs.
Eye Dose Equiv.	External exposure to the lens of the eye at a tissue depth of 0.3 cm.
Shallow Dose Equiv.	External exposure of the skin or an extremity at a tissue depth of 0.007 cm averaged over an area of 1 cm^2.

Avoid Inaccurate Dosimeter Readings

Never remove internal dosimeter elements from the protective plastic dosimeter case.

Contact the Radiation Safety Office at ext. 5753 about lost/damaged dosimeters.

Dosimeters should not be exposed to non-occupational radiation such as medical or dental x-rays.

Store your dosimeter(s) away from sources of ionizing radiation when not in use.

Do not return contaminated dosimeters to EHS via campus mail. If you suspect your dosimeter is contaminated, immediately contact the Radiation Safety Office at ext. 5753.

Notice to Employees & Students

Your dosimetry reports, radiation safety regulations, and NHPP inspection reports are required to be available for your review.

You may examine copies of these documents by calling the Radiation Safety Office at ext. 5753.

IDPH and NRC regulations are also available online.

Maximum Permissible Dose Limits

Whole body – head, neck, torso, upper arms & legs	5,000 mrem
Lens of the eye	15,000 mrem
Extremities, skin, and internal organs	50,000 mrem

State and Federal maximum permissible yearly dose limits (MPDs) for adult radiation workers are listed above. These doses are not expected to cause adverse health effects even if the maximum is received each year for a total of 50 years.

Minors are not generally permitted to work with sources of ionizing radiation.

The ALARA Program

ALARA stands for “as low as reasonably achievable.” To prevent personnel exposures from exceeding regulatory MPD limits and to help keep occupational radiation doses ALARA, EHS has a notification and investigation program to review occupational exposures.

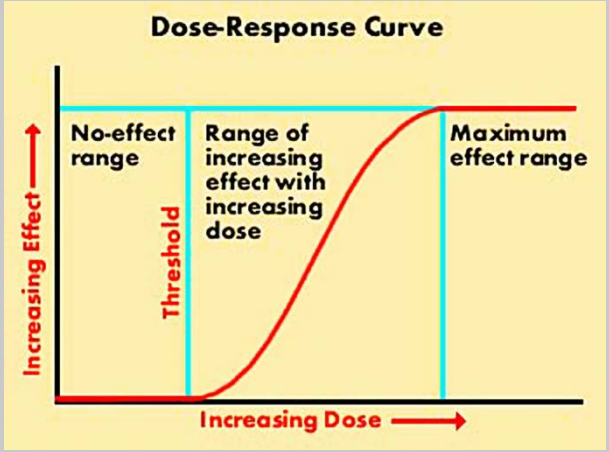
If any of the following action levels are exceeded during one quarter of a year, EHS notifies you. Corrective action may be initiated to help reduce future exposures.

- 125 mrem for whole body exposure
- 375 mrem for lens of the eye exposure
- 1,250 mrem for skin whole body & extremity exposure

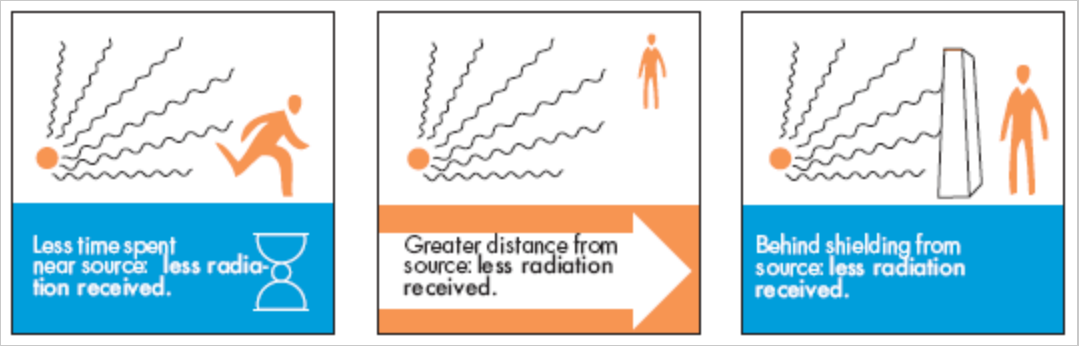
Why Practice ALARA?

ALARA is an NRC/NHPP regulation requiring radiation workers to maintain occupational exposures as far below the MPDs as practical.

Secondly, it is assumed that ionizing radiation exposure, regardless of whether it is medical, occupational, or environmental, carries with it some risk. The risks are assumed to be linear. That is, as exposure increases so does the risk of an adverse health affect due to that exposure.



Time, Distance, and Shielding



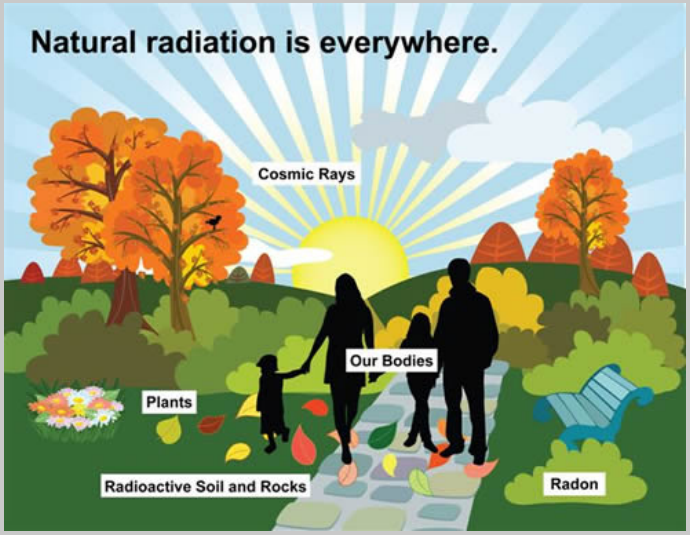
The less **TIME** spent near RAM, the less dose received.

The more **DISTANCE** between you and RAM, the less exposure received. Doubling the distance from RAM reduces exposure by a factor of ~ four. Use tongs or other remote-handling tools to reduce exposure to fingers and hands.

For **SHIELDING** β emitters use Plexiglass. Lead is best for X- or gamma radiation, but each X- or gamma ray emitter has a specific thickness of shielding required to reduce exposure – one size doesn't shield all. Contact the VAMC Radiation Safety Office at ext. 5753 to determine the proper thickness and types of shielding material to use.

Background Radiation

In addition to being used in research and industry, sources of ionizing radiation are also natural constituents of our planet and universe.



Cosmic radiation bombards our atmosphere constantly and naturally occurring radioactive materials are found in our food and water. These sources result in a radiation dose of about 300-350 mrem per person per year if you live in Iowa.

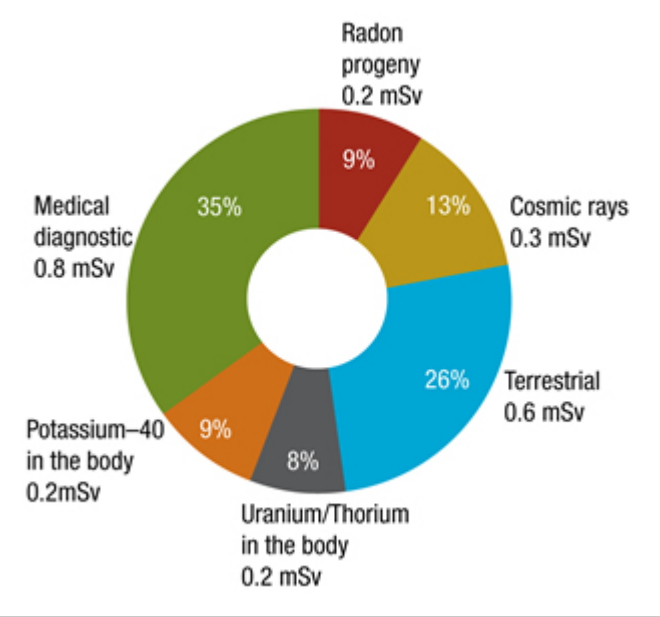
NOTE - Background radiation exposure is not added to your occupational dose record.

Cosmic and Atmospheric Radiation

Cosmic radiation originates from sources such as our sun, supernovas, and quasars. Earth's atmosphere is very effective at shielding cosmic radiation, but density variations in the atmosphere result in some regions receiving more or less radiation than others.

Tritium and C-14, two radioactive constituents of the air we breathe, are produced by cosmic ray bombardment of the upper atmosphere. Radon-222 forms during the radioactive decay of some naturally occurring heavy elements such as uranium. It's released from many soils and during volcanic eruptions and earthquakes.

Terrestrial Radiation



Naturally occurring radioactive elements such as thorium, uranium, radium, Rn-222 and K-40 are found in rocks, soil, water we drink, food we eat, and building materials

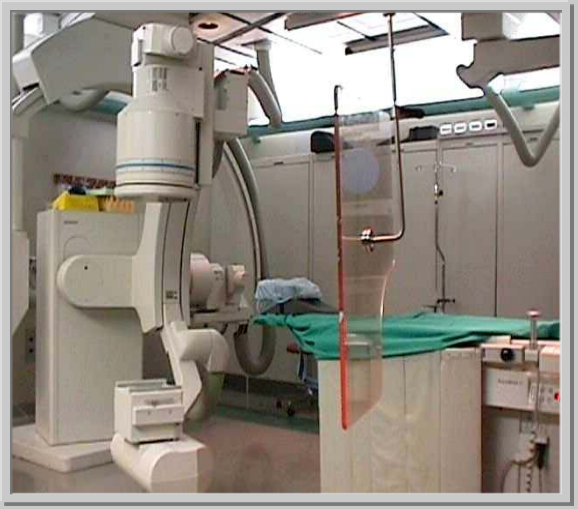
Some terrestrial sources are not naturally occurring, but were components of fallout produced by above ground nuclear testing. Fallout contributes about 1 mrem per year to your background radiation dose.

Additional Sources of Radiation

Tobacco leaves take up naturally occurring radioactive materials found in the soil and certain fertilizers as they grow.

As a result, a pack-and-a-half per day smoker receives a whole body dose of about 1,300 mrem over the course of one year. The lung dose can be more than twelve times higher. Second-hand smoke also contributes to a person's annual radiation exposure.

Sources of Medical Radiation



Each year, about one-third of all individuals hospitalized undergo medical procedures that involve sources of ionizing radiation.

The average radiation dose from man-made medical sources of radiation is about 53 mrem per year.

Much of present day biomedical research would not be possible without the use of radioactive materials.

Types of Biological Effects

Ionizing radiation exposure greater than permissible occupational levels may lead to:

Somatic Effects
Physical effects that occur in the exposed individual. The effects may be acute (immediate) or delayed.

Genetic Effects
Birth defects that occur as a result of irradiation of an individual's reproductive cells prior to conception.

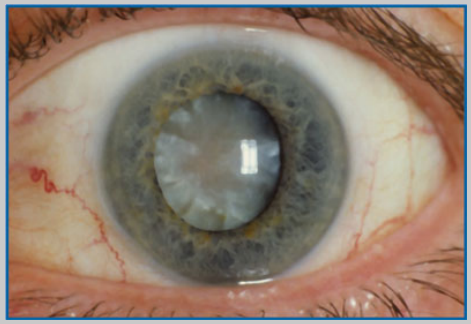
Teratogenic Effects
Effects such as cancer or congenital malformation caused by radiation exposure to a fetus in utero.

Types of Biological Effects

Threshold Effects
Certain biological effects are caused when a radiation dose greater than some threshold value is received. Below the threshold value no radiation effect is seen. Acute Radiation Syndrome and radiation-induced cataract formation are examples of threshold effects.

Non-threshold Effects
Some radiation-induced biological effects are not thought to have a threshold. Instead, the chance of occurrence of the effect rather than the severity of the effect is assumed to be proportional to the dose received. Cancer and genetic effects are examples of chance effects.

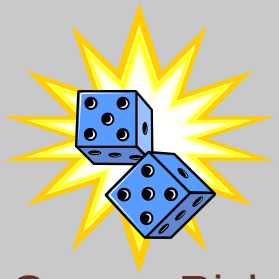
Threshold Effects



Other threshold effects:

Cataracts - 200,000 mrem (acute)
Cataracts - 800,000 mrem (chronic)
Severe skin injury - 1,500,000 mrem
Teratogenic effects - 20,000 mrem

Because your maximum allowable whole body occupational radiation exposure is 5,000 mrem per year, threshold effects are not expected to occur.



Non-Threshold Effects

Cancer Risk is estimated to be about 5 deaths per 10,000 persons -- each whom received 1,000 mrem. However, research studies have not conclusively shown an increase in the cancer rate of populations receiving doses <10,000 mrem slowly, over long periods of time. In comparison, very few researchers at the VAMC receive a whole body occupational exposure greater than 500 mrem per year.

Genetic Effects are not considered a likely result of occupational radiation exposure. This is based on the observation that an increase in birth defects was not seen in 77,000 children born between 1948-1962 to Hiroshima and Nagasaki bomb survivors. Additionally, an increase in the number of inherited birth defects has not been found in populations living in high background radiation areas.

Activity – Ci, mCi and μCi

Curie, millicurie, and microcurie are units of activity describing the rate of radioactive decay as a function of time. See the table below.

Traditional Unit	Abbreviation	Decays per Minute
1 Curie	Ci	2.22×10^{12} dpm
1 Millicurie	mCi	2.22×10^{9} dpm
1 Microcurie	μCi	2.22×10^{6} dpm

The curie is named in honor of Marie Curie who discovered radium in 1898. In 1903, Marie and her husband Peter were awarded the Nobel Prize in Physics for their discovery of natural radioactivity.

Radioactive Decay Equation

Use this equation to determine the activity of a radioactive material at any given period of time.

$$A(t) = [A_o]\,[e^{(-\lambda t/T)}]$$

A(t) = the number of radioactive atoms at time (t)
A_o = the number of radioactive atoms at time zero (originally)
e = base of the natural log
λ = a constant (0.693)
t = the number of days of decay
T= the half-life in days of the radioactive material of interest

Half-life

How fast radioactive decay occurs is known as a material's half-life. It equals the time required for one half of the radioactive atoms in a sample to decay or disintegrate.

Warning Labels

Use radiation labels to mark items used to manipulate or store radioactive material.

Label anything that is contaminated.

Remove all radiation warning labels on items that no longer contain radioactive material and are no longer contaminated.

Warning Signs

This warning sign is posted in areas to indicate that radioactive materials may be used or stored within the area.

This warning sign is posted in areas where radiation levels may be ≥5 mrem per hour at a distance of 30 cm from a radiation source or from any surface that the radiation penetrates

Posting and Deposting Areas

Posting Areas

Only the Radiation Safety Office can approve and post an area for radioactive materials usage or storage.

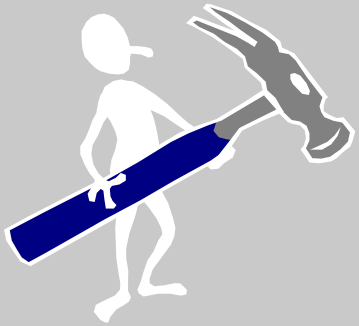
Deposting Areas

Only the Radiation Safety Office can depost an area where radioactive materials were used or stored.

Contact the Radiation Safety Office

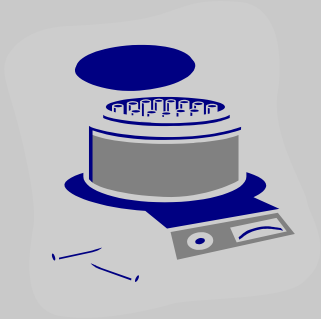
Contact the Radiation Safety Office at ext. 5753 to request posting or deposting services. Never post or depost such areas yourself.

Maintenance & Equipment Service



Maintenance & Renovation

Any facility where radioactive material was used or stored must be surveyed prior to any renovation or maintenance activities. Contact the Radiation Safety Office at ext. 5753 a minimum of one week prior to scheduled maintenance or renovation.



Service & Surplus

Any equipment that is serviced or sent to Surplus must be free of contamination. Call the Radiation Safety Office to request a contamination survey prior to release of any item used to manipulate or store radioactive material.

NO Food in Labs

Food preparation, consumption, and storage are not permitted in labs or areas posted for radioactive materials use.

Evidence of food consumption such as empty pop cans or coffee cups are considered violations of this policy.

Additionally, never heat food and beverages in microwave ovens used for research purposes.

This policy does permit storage of food items used solely in research and labeled “not for human consumption.”

Sulfur-35 Volatility Control

Users of S-35 compounds such as methionine, cysteine, and other high specific-activity thio-labeled nucleotides, are required to take measures to control contamination because of the volatile nature of these compounds.

The use of activated charcoal cartridges or filter paper during incubation procedures; opening source vials in a fume hood; using secondary containment during storage; and venting with a charcoal trap when withdrawing activity from stock vials all aid in reducing contamination from volatile S-35 compounds.

Sulfur-35 Volatility Control

How to vent volatile products from an S-35 stock vial:

- Insert the needles of both a charcoal trap and an air-filled syringe through the septum of the closed stock vial.
- Avoid touching the tips of the needles to the radioactive liquid in the stock vial.
- Gently force the air from the syringe into the stock vial. This will force the volatile products from the stock vial into the charcoal trap.
- Remove the syringe and then the charcoal trap. Do not recap the needles. Discard the used syringe and the charcoal trap into a radioactive sharps waste container.

Iodination Requirements

When working with 100 μCi of unbound forms of I-125 or 1 mCi of bound forms of I-125:

- An initial baseline thyroid bioassay must be completed.
- Use a charcoal-filtered mini-hood placed inside an operating fume hood.
- Have follow up thyroid bioassays as required. Contact the Radiation Safety Office at ext. 5753 about this.

Thyroid Bioassay Requirements

Bioassays are required for individuals who work with:

Unbound I-125 or I-131
≥1 mCi in a mini-hood/fume hood
≥0.1 mCi on bench top

Bound I-125 or I-131
≥10 mCi in a mini-hood/fume hood
≥1 mCi on bench top

Thyroid Bioassay Requirements

Baseline Thyroid Scan
Must be completed two weeks prior to using radioiodine. Call 384-4541 to schedule a scan at the Environmental Health and Safety Office.

Routine Thyroid Scan
Users must receive a scan during the quarter in which use occurs.

Final Thyroid Scan
Must be completed two weeks after terminating work with radioiodine.

Performing Iodinations

Performing Iodinations

Iodinations must be performed in an operating fume hood that has been approved by the Radiation Safety Office. The acquisition of a glove box, mini-hood, and/or in-line exhaust filter may also be required.

Notification
Notify the Radiation Safety Office at least 24 hours before performing each and every iodination.

Security is an NRC/NHPP Regulation

You must secure radioactive material and radioactive waste to prevent unauthorized access or removal.

When unattended:

- Secure radioactive materials and radioactive waste in a locked cabinet, refrigerator, or any other lockable device; OR

- Lock the doors to the area when no one is present in the lab.

Security of RAM - Lab Visitors

To maintain security, know the purpose of anyone who enters your lab.

Identify all lab visitors.

Determine why they are visiting your lab.

Make visitors aware of all lab hazards and, if necessary, special requirements for access to the lab.

Missing Radioactive Materials

Immediately report all missing sources of radioactive material to the Radiation Safety Office at ext. 5753.

Unaccounted for radioactive material can result in serious safety and regulatory concerns.

Survey Meters - Geiger Counters

Rate meter + gas-filled probe = Geiger-Mueller Detector

Pancake Probe

The probe converts ionizing radiation to an electrical signal that is sent to the meter. The meter converts the signal to a visual readout.

Pancake Probes and End-window Probes:

- Can detect P-32
- Are marginal for detecting C-14, S-35 and P-33
- Cannot detect H-3
- Are not good for gamma and X-ray detection

Geiger Counter Efficiencies

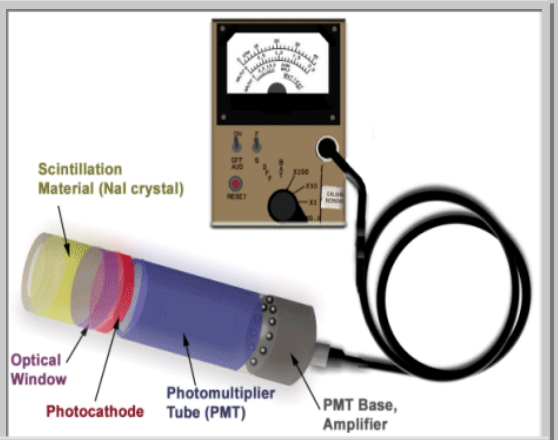
Examples of Approximate GM Probe Efficiencies
(under ideal conditions)

Radionuclide	Pancake Probe GM Efficiency at 1 cm
H-3	Not detectable
C-14 and S-25	1% - 5%
P-32	25% - 30%
I-125	<0.01%

NOTE!

Low energy beta particles are not detectable when the probe window is covered with Parafilm or other types of protective material. Efficiencies for high energy betas are also reduced. Always remove the probe's plastic cover before surveying.

Survey Meters - Scintillation Detectors

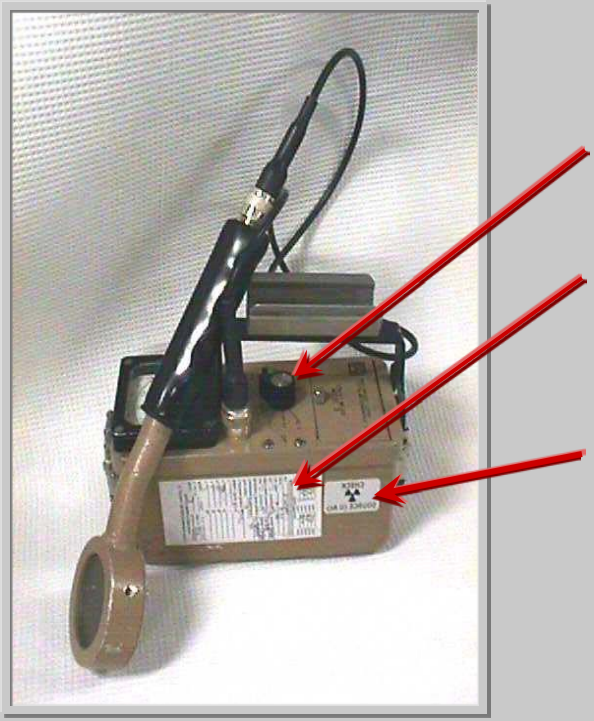


The NaI crystal emits light when struck by X-rays or gamma rays. The light is collected by a photomultiplier tube which amplifies the signal.

An X-ray or gamma ray has a higher probability of interacting with a solid probe than with a gas-filled one.

So the best way to detect photons being emitted from X-ray or gamma ray sources is to use a scintillation probe. The radiation sensitive portion of a scintillation probe consists of a sodium iodide (NaI) crystal. For I-125, this type of detector has an efficiency of 10%.

Survey Instrument Checks



Prior to using any survey instrument:

Check the battery.

Check the calibration date to ensure that the instrument has been calibrated within the last 12 months.

Perform a reference check using a dedicated radioactive source to determine if the probe can detect radiation. The cable can become defective as well as the probe.

Survey Instrument Calibration

Survey instruments used for contamination and exposure rate surveys and must be calibrated every 12 months.

Using a survey instrument that is out of calibration is a violation of NRC regulations.

EHS provides calibration services. Contact EHS at 335-8501 for more information.

Meter Surveys

Prime areas to survey include waste storage areas, source vial storage areas, frequently used areas and equipment, and the floor near work and storage areas.

Frequently Occupied Areas
Exposure rates should be <2 mrad/hour at 30 cm.

Storage Areas
Exposure rates should be <5 mrad/hour at 30 cm.

Performing a Meter Survey

To perform a meter survey slowly pass the probe over the area or object to be surveyed. Move the probe at about 2 cm per second.

Try to maintain a consistent distance of about 1 cm. Be careful not to contaminate the probe!

Remember to perform a probe check, battery check and calibration date check before using your meter.

Wipe Surveys for Contamination

Wipe Surveys are used to test for removable contamination from any type of radioactive material.

It is the best survey method for detecting contamination from low-energy beta emitters such as C-14, S-35, and P-33. It is the only way to detect H-3 contamination.

To conduct a wipe survey, all you need is a piece of filter paper or a paper towel cut into 1.5” x 1.5” strips.

Then, while wearing a disposable glove, rub the paper over the area to be checked.

Wipe Test and Action Levels

For a complete analysis, a liquid scintillation counter should be used. The amount of contamination present is the difference between the count rate of the actual wipe and the background or control sample.

Action Levels

Promptly decontaminate radioiodine levels found to be >200 dpm/100 cm^2.

Promptly decontaminate other radionuclide levels found to be >2,000 dpm/100 cm^2.

LSC Counting Fluid

Scintillation fluids based on toluene or xylene will no longer be available except by special order.

Principal investigators who are authorized to use radioactive materials or are applying for such use may petition the Executive Committee for a scintillation fluid exception.

Petitions must be submitted in writing and clearly state why the use of a scintillation counting fluid with a flash point < 140 ^{o} F is required for their scintillation counting needs.

Approved Liquid Scintillation Fluids

**** These are the only three BioChem Stores currently stock. BioChem Stores are willing to special order any other "approved" (flashpoint >140^0 F) LSC fluid.**

Cocktail Name	Manufacturer
Beta Plate Scint	Perkin Elmer (Wallac)
BCS	GE Healthcare (Amersham)
BetaMax ES	MP Biomedicals (ICN)
** Bio-Safe II	Research Products Intl
** Bio-Safe NA	Research Products Intl
CytoScint ES	MP Biomedicals (ICN)
** Econ-Safe	Research Products Intl
Ecolite (+)	MP Biomedicals (ICN)
EcoLume	MP Biomedicals (ICN)
Ecoscint A	National Diagnostics
Ecoscint H	National Diagnostics
Ecoscint O	National Diagnostics
Fluoro-Hance	Research Products Intl
Formula 989	Perkin Elmer (Packard)
In-Flow 2:1	IN/US Systems, Inc
MicroScint O	Perkin Elmer (Packard)
MicroScint 20	Perkin Elmer (Packard)
Opti-fluor	Perkin Elmer (Packard)
Opti-fluor O	Perkin Elmer (Packard)
OptiPhase HiSafe 2	Perkin Elmer (Wallac)

Approved Liquid Scintillation Fluids
con't

Cocktail Name	Manufacturer
OptiPhase SuperMix	Perkin Elmer (Wallac)
Ready Gel	Bio-Rad
Ready Safe	Beckman
Scintisafe	Fisher Scientific
Scintisafe 30%	Fisher Scientific
Scintisafe Plus 50%	Fisher Scientific
Scintisafe Econo F	Fisher Scientific
Scintisafe Econo 1	Fisher Scientific
Scintisafe Econo 2	Fisher Scientific
Scintisafe Gel	Fisher Scientific
Scintiverse BD	Fisher Scientific
Ultima Gold	Perkin Elmer (Packard)
Ultima Gold AB	Perkin Elmer (Packard)
Ultima Gold F	Perkin Elmer (Packard)
Ultima Gold MV	Perkin Elmer (Packard)
Ultima Gold XR	Perkin Elmer (Packard)
Ultima Flo AF	Perkin Elmer (Packard)
Ultima Flo AP	Perkin Elmer (Packard)
Ultima Flo M	Perkin Elmer (Packard)
UniverSol ES	Perkin Elmer (Packard)

What's a DPM?

"DPM" stands for disintegrations per minute.
To determine whether your wipe results exceed "dpm" contamination action levels, divide the liquid scintillation counter or gamma counter results given in "cpm" (counts per minute) by the counter's efficiency.

For information about counter efficiency, refer to the instrument's technical manual or contact the Radiation Safety Office at ext. 5753.

Remember to Document Your Surveys!

- Surveys must be done at a frequency to ensure that exposure to RAM is kept ALARA (as low as reasonably achievable).
- Keep your survey records in a form that the VAMC - RSO and VA's National Health Physics Program (NHPP) can audit.
- Call ext. 5753 for blank survey record forms.

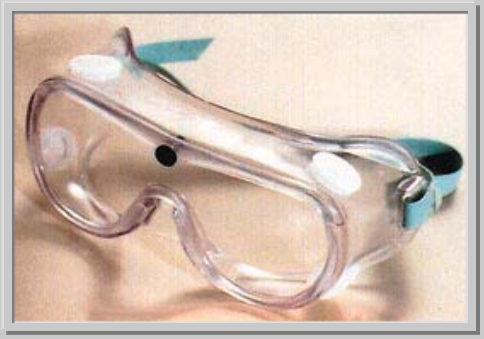
"If a survey isn't recorded, it doesn't count." – Joe Regulator

Examples of Good Practice - PPE

- Personal protective equipment is known as PPE.
- Wear the correct PPE for work with RAM and other hazardous materials.
- PPE includes gloves and lab coat (at a minimum).
- Do not wear open-toed shoes when working with any type of hazardous material or equipment.
- Never wear PPE outside the lab!

PPE

Safety glasses with side shields should be worn in the laboratory at all times when chemicals are being handled.



Chemical splash goggles should be worn if liquids may splash or generate aerosols.

It is important for contact lens wearers to use eye protection because contaminants can become trapped underneath the lens and cause eye injury.

PPE - Gloves

Chemically-resistant gloves should be selected based on the type recommended by the glove manufacturer for the material being handled.

Remember, all gloves are eventually permeated by chemicals and should be replaced as needed.

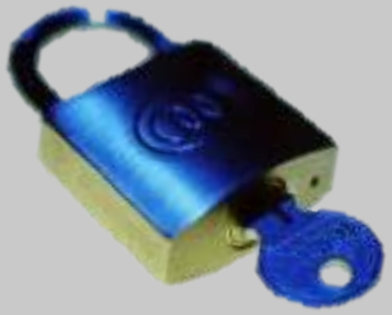
Latex gloves are not chemically resistant.
Also, latex allergic reactions can occur. Contact the University Employee Health Clinic at 356-3632 for more information regarding latex allergies.

Hand Washing

Wash your hands after working with radioactive material or any other hazard and also before leaving a posted area.

You should also check your hands, lab coat, bottom of shoes, or any other appropriate area with a survey meter before leaving a posted area or whenever the situation requires personnel monitoring.

Contamination Control and Security



- Wear PPE when working with RAM.
- Monitor hands, shoes, and PPE frequently.
- Use bench paper and spill trays.
- Use warning labels on RAM items and areas.
- Use a fume hood when working with volatile materials or materials that produce aerosols.
- Secure RAM from unauthorized removal.
- Immediately report missing RAM to the VAMC Radiation Safety Office at ext. 5753 or 335-8501.

Contamination Control

You can prevent or minimize contamination by using aerosol-resistant pipette tips and screw-top Eppendorf tubes.

You can prevent or minimize aerosolization by exercising caution when using and/or opening blenders, centrifuges and ultrasonic devices.

Acquiring Radioactive Material (RAM)

Your PI must have prior approval from the Radiation Safety Committee and the RSO for the exact chemical form and activity of the RAM you wish to order before you order and receive it.

If you don't have approval to receive the material, your PI must submit an authorization amendment to the Radiation Safety Office prior to ordering it.

Approval applies to ALL purchases, transfers from other authorized users or institutions, receipts from vendors as gifts, demonstration samples, or any other type of receipt of licensed radioactive material.

Ordering Radioactive Materials (RAM)

- Your PI must have prior VAMC Radiation Safety Office authorization for the exact chemical form and activity of the RAM you wish to obtain before you order it.
- If you have authorization, contact your vendor and place your order.
- Instruct the vendor to place your PI's name on the packing slip.

Delivery of RAM Shipments

The vendor must ship the package to:

VAMC – Iowa City
601 HWY 6
Nuclear Medicine Department
Room 2W21
Iowa City, IA 52246-2503

Delivery of Radioactive Material Shipments

RAM shipments normally arrive in the Nuclear Medicine Department during mid-morning when the weather permits.

At that time, Nuclear Medicine staff inspects each package for external damage, excessive exposure rates, and the presence of exterior contamination.

The Principle Investigator or user will be contacted to pick up the package.

Shipment Surveys by User

When you receive the shipment from the Nuclear Medicine department:

- Assume the inner packaging and the source vial may be contaminated.
- Wear personal protective equipment when opening RAM packages.
- Open unbound I-125 and volatile S-35 compounds in a functioning fume hood.
- Verify that the material you received is what you actually ordered.

Lab Receipt / Inventory Records of RAM

- Verify you received the correct RAM, chemical form, and activity.
- Wear PPE to open RAM shipment.
- Immediately include received material into your lab's RAM inventory and record activity in units of millicuries.
- Assume that the inner surfaces of the package (source vial and packaging material) may be contaminated and handle accordingly until proven otherwise by survey.
- Before discarding the packing material from the shipment, obliterate all radiation warning labels before discarding as normal trash.

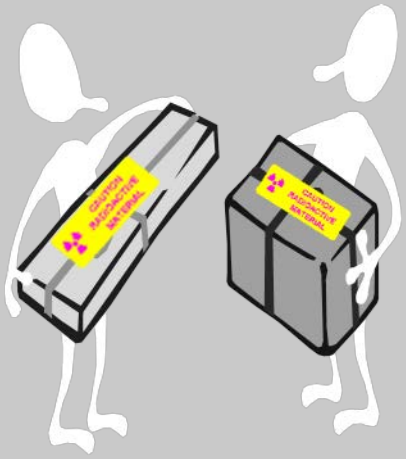
On-Campus Transfer of Radioactive Material

On-campus Transfers of Radioactive Material are only permitted between authorized Principal Investigators.

The recipient's Principal Investigator

must be approved for the radionuclide, chemical form, and activity of material you wish to give them.

An "On-Campus Transfer of Radioactive Materials" form must be completed and a copy mailed to the Radiation Safety office. This form is available at EHS's web site.



On-Campus Transfer of Radioactive Material

Remember to delete the transferred material from your PI's radioactive material inventory.

Transfer the material by foot in an unbreakable, sealed, secondary container. Place a radiation warning label on the secondary container.

Do not leave the radioactive material unattended at any time during the transfer.

Off-Campus Transport and Shipping

Transporting by Vehicle

- Contact EHS at 335-8501 if the material transferred must be transported by vehicle.
- Radioactive material cannot be transported in any vehicle without EHS authorization.

Shipping by Courier

- Radioactive material shipments must comply with federal and aviation regulations.
- Call EHS (335-8501) 24 to 48 hours prior to the date you need to ship the material.

Spill and Emergency Response

Radioactive material users must know how to handle a radiological spill or emergency.

The PI is responsible for ensuring that personnel know how to respond to spill and emergency situations that could occur when using radioactive materials.

Contact the Radiation Safety Office at ext. 5753 for help in developing spill and emergency response strategies for your lab.

Spill Response Guidance

Simple Spills are <10 μCi, <1 liter in volume, and can usually be handled by the user according to the lab's spill response plan.

Major Spills are >10 μCi or >1 liter in volume or involve the release of any volatile material. Contact the Radiation Safety Office at ext. 5753 before proceeding with cleanup. Prevent entry by unauthorized personnel.

Major Mixed-Hazard Spills involve a combination of hazards such as chemical and radioactive agents. Immediately evacuate, call 911, and wait for emergency responders. Contact the Radiation Safety Office at ext. 5753.

Spills

- Uninjured, contaminated individuals remain in the area until decontaminated (if safe). Move all others to another area.
- Handle spills according to your lab's spill response plan.
- Evacuate area of volatile spills.
- Contact Radiation Safety at ext. 5753 or 335-8501 immediately when spills occur! Contact the VAMC Police at ext. 6600 during other than normal business hours of 8:00 – 5:00.

Spill Response Guidance

Keep emergency and spill response kits and procedures up-to-date.

Make them available to personnel.

This is a requirement of radioactive materials use authorization.

Response procedures should include information about spill and emergency recognition, handling methods, first aid, containment, and clean-up.

Personal Contamination

Notify the VAMC - RSO immediately of any case of personal contamination. Call ext. 5753 or 335-8501.

Uninjured persons should remove contaminated clothing and wash or use emergency shower or eyewash as needed. Do not delay.

If an injured person is contaminated, do not delay medical attention.

The Environmental Health and Safety Office can also provide assistance by calling 335-8501.

For major injuries call 911 and provide medical care appropriate for the nature of the injury.

Radioactive Waste Disposal

Radioactive waste is collected, processed, and disposed of by EHS according to State and Federal Regulations.

The Environmental Protection Agency (EPA) regulates waste that is both a hazardous chemical and radioactive.

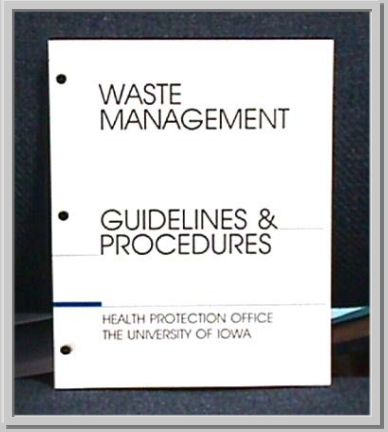
The radioactive waste pickup schedule is available on EHS's web site @

http://ehs.research.uiowa.edu/waste-pickup-schedule

Radioactive Waste Defined

Waste that contains or is contaminated with radioactive material is required to be disposed of as radioactive waste.

NOTE: Disposal of all hazardous and mixed waste must be coordinated through the VA Safety Office (ext. 6805) and is **NOT** picked by EHS.



For more information, refer to EHS's guidelines and procedures manual concerning hazardous chemical, biohazard and radioactive waste.

Radioactive Waste Management

Store all liquid waste containers within a secondary container – this is mandatory.

Use labels provided to indicate what is placed in waste containers as soon as you add waste. This prevents unlabeled and unknown waste from accumulating in your lab.

Avoid overfilling solid or liquid waste containers.

Never mix organic solvent wastes with water or other aqueous wastes.

Radioactive waste containing biological, pathogenic, or infectious material must be disinfected with biocide prior to depositing into radioactive waste containers.

Segregating Radioactive Waste

Radioactive waste must be separated by the generator into two categories based on half-life.

Short Half-Life <90 days
Fe-59, I-125,
P-32, P-33 and S-35

Long Half-Life >90 days
C-14, Fe-55,
H-3 and Sr-90

All CI-36 liquid waste must be placed in a separate liquid waste container.

Segregating Radioactive Waste

Radioactive waste is further segregated by waste type according to its form:

- Aqueous Liquid Waste
- Animal Carcasses
- Dry Waste
- Liquid Scintillation Vials
- Organic Liquid Waste
- Radioactive Sharps
- Source Vials

Aqueous and Organic Liquid Waste

Do not mix aqueous liquid waste and organic liquid waste.

- Secondary containment is required!
- Do not mix organic liquid waste with water.
- Do not put solid material in liquid radioactive waste containers.
- Include chemical composition of waste on back of waste tag when labeling.
- Keep liquid capped at all times.

Aqueous and Organic Liquid Waste

Avoid overfilling radioactive waste containers - leave at least 3” of head space.

Do not mark EHS’s liquid waste containers. If labeling is necessary, use tape.

Prior to pickup by EHS, tightly secure container cap, affix radioactive label to container, and place the radioactive waste tag under the bottle handle.

Animal Carcass Waste

Animal carcass waste includes animal body parts, excreta and bedding.

- Double-bag using bags provided by EHS.
- Package in as small a volume as possible.
- Add coagulants or absorbents to reduce liquids.
- Bags should not be punctured and outer bag must be free from blood.
- Securely close and seal bags with tape.
- Complete radioactive waste tag prior to pickup by EHS.

Dry Waste

Use dry waste containers for disposal of contaminated paper, plastic and unbroken glass.

Do not place any of these items in a dry radioactive waste container:

- Liquids
- Lead
- Needles
- Razors
- Broken Glass
- Other sharps

Dry Waste

Do not overfill waste containers!

Obliterate all radioactive symbols and wording on any item placed in a dry radioactive waste container.

Prior to pickup by EHS:

- Secure the inner liner and seal with tape.
- Complete the radioactive waste tag and affix it to the lid of the radioactive waste container.

Liquid Scintillation Vial Waste

Segregate C-14 and H-3 LSC vials in one container and place all other radionuclide LSC vials in another.

Avoid overfilling LSC vial radioactive waste containers.

Prior to pickup by EHS, complete the radioactive waste tag and affix it to the lid of the LSC vial container.

Only for LSC Vials.

Radioactive Sharps Waste

Radioactive sharps are only disposed of in a radioactive sharps containers!

- Containers are available from Biochem Stores or General Stores.
- Affix a radioactive materials warning label to any sharps container used to dispose of radioactive sharps.
- Do not overfill.
- Prior to pickup by EHS, complete the waste tag and affix it to the sharps container.

Source Vial Disposal

Vials Containing Liquid

Do not place source vials containing liquid in any type of radioactive waste container.

Simply attach a radioactive waste tag to the source vial and shield, if necessary, prior to pickup by EHS.

Empty Vials

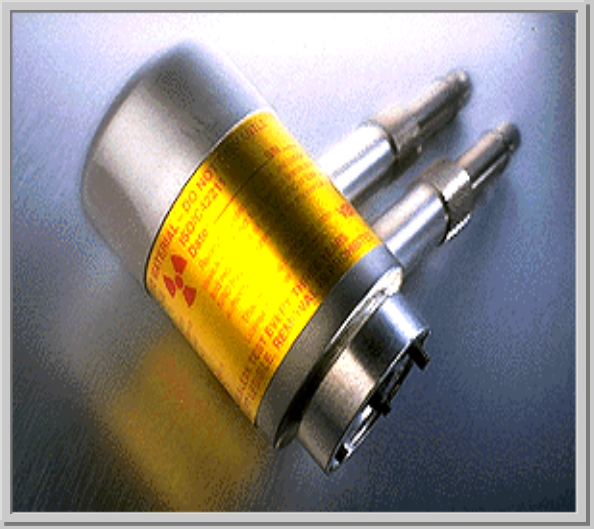
Obliterate any radioactive labels on the vial and remove lead shielding.

Dispose of empty vial in radioactive dry waste.

Sealed Sources

Do not dispose of licensed or generally-licensed sealed sources (such as electron capture detectors) in any type of EHS radioactive waste container.

Contact Laurie Scholl at ext. 5753 to arrange for proper disposal by EHS's Radioactive Waste personnel.



Radioactive Waste and Lead

Do not put lead shielding in radioactive waste containers.
To prepare lead for pickup by EHS:

- Remove any plastic, if applicable.
- Perform a contamination survey.
- If uncontaminated, deface radiation label.
- Complete radioactive waste tag and pickup request.
- Place lead in a cardboard box or other suitable transporting container.

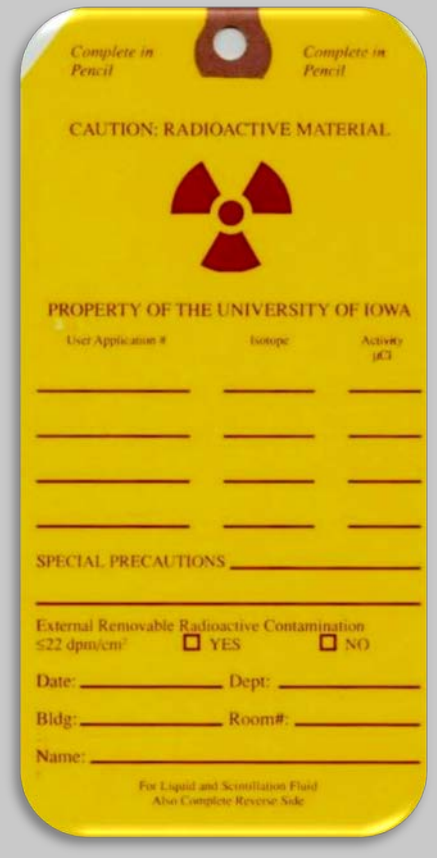
Check for Contamination

Prior to pick up by EHS, perform a wipe test of the entire surface of the external container to check for the presence of contamination.

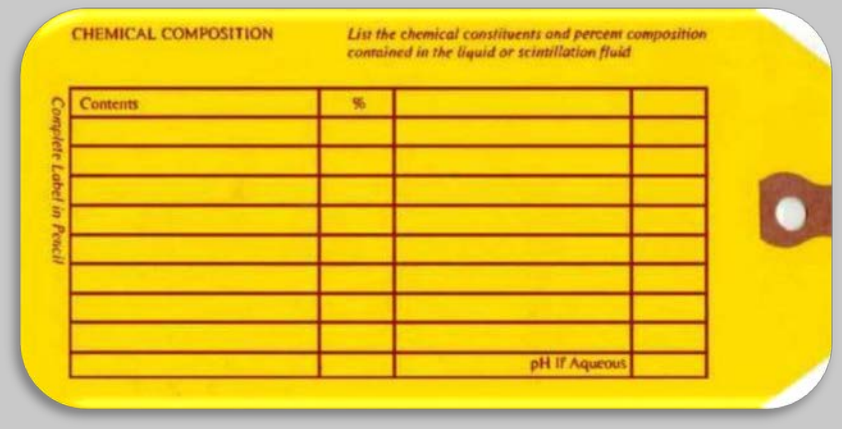
- Count the wipe in an LSC or gamma counter.
- If the result is >22 dpm/cm^2, decontaminate, re-wipe, and count.
- If the count was <22 dpm/cm^2, check the “yes” box found on the radioactive waste tag.

Completing the Radioactive Waste Tag

Front



Back



- Complete the tag in pencil.
- Complete all information required.
- Perform a contamination survey of the waste container and record results on the waste tag.
- If waste is liquid, indicate chemical composition on back of the tag.
- Affix tag securely to waste container.

To Arrange for a Waste Pick Up

EHS's waste pickup request is available online. Notify EHS at least one day in advance.

The online request can be found at:

http://ehs.research.uiowa.edu/radioactive-waste-pickup-request

Requirements for Waste Pick Up

Radioactive waste will not be collected unless you have:

- Checked the outer surfaces of the waste containers for any contamination.
- Completed a radioactive waste tag for each container or sealed source.
- Completed a “Radioactive Waste Pickup Request.”
- Prepared it properly and sealed all containers appropriately.

Waste Not Picked Up By EHS?

If Your Waste Was Not Picked Up By EHS:

- EHS will leave a note explaining why the waste items were not picked up as requested.
- For assistance in correcting any deficiencies noted, contact 335-4081.
- Once the deficiencies are corrected, EHS will pickup the waste.

Waste Minimization

Avoid ordering and storing more radioactive material than is actually needed.

Do not place items that are not radioactive or contaminated in radioactive waste containers.

Replace xylene and toluene-based liquid scintillation cocktails with ones that are biodegradable.

Congratulations!

You have completed the
VAMC Basic Radiation Safety Course.

To receive credit for this online training course, you must complete the exam and received a score of 80% or greater.

Click here to take EXAM.