Radiation Safety Training

Kent W. Scheller, Ph.D.
Radiation Safety Officer
USI

Why Train?

- NRC requirements for AU's
- NRC requirements for certain expected radiation levels
- To promote safe lab practice
- To inform users/non-users
- To prevent mistakes
- To prevent misinformation

First, some jargon:

- Nuclear Regulatory Commission, NRC
- Radiation Safety Officer, RSO
- Authorized User, AU
- Radioactive Isotope
- Radiation
- "As Low As Reasonably Achievable", ALARA

MATERIALS LICENSE **SUPPLEMENTARY SHEET**	License Number 13-32233-01 Docket or Reference Number 030-35365

G. through I. To be used for Research and Development as defined in, 10 CFR 30.4; radiation detector studies and teaching and training of students.

CONDITIONS

10. Licensed material shall be used only at the licensee's facilities located at 8600 University Blvd., Evansville, Indiana.

11. The Radiation Safety Officer for this license is Kent W. Scheller, Ph.D.

12. Licensed material listed in Item 6 above is only authorized for use by, or under the supervision of, the following individuals for the materials and uses indicated:

Authorized Users	Material and Use
A. Kent W. Scheller, Ph.D.	All
B. Marlene Shaw, Ph.D.	Carbon-14, phosphorus-32, phosphorus-33, sulfur-35, iodine-125 and hydrogen-3.
C. Jeannie Collins, Ph.D.	Hydrogen-3, phosphorus-32, phosphorus-33 and sulfur-35.
D. Jeanne Barnett, Ph.D.	Phosphorus-32, phosphorus-33 and sulfur-35.
E. Eric McCloud, Ph.D.	Carbon-14, phosphorus-32, phosphorus-33, sulfur-35, iodine-125 and hydrogen-3.

13. A. Sealed sources and detector cells shall be tested for leakage and/or contamination at intervals not to exceed 6 months or at such other intervals as specified by the certificate of registration referred to in 10 CFR 32.210.

B. Notwithstanding Paragraph A of this Condition, sealed sources designed to emit alpha particles shall be tested for leakage and/or contamination at intervals not to exceed 3 months.

C. In the absence of a certificate from a transferor indicating that a leak test has been made within 6 months prior to the transfer, a sealed source or detector cell received from another person shall not be put into use until tested.

D. Sealed sources need not be leak tested if:

(i) they contain only hydrogen-3; or

(ii) they contain only a radioactive gas; or

(iii) the half-life of the isotope is 30 days or less; or

NRC FORM 374

U.S. NUCLEAR REGULATORY COMMISSION

MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 36, 39, 40, and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee

1. University of Southern Indiana

2. 8600 University Boulevard
Evansville, IN 47712

3. License number 13-32233-01

4. Expiration date June 30, 2010

5. Docket No. 030-35365
Reference No.

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
A. Hydrogen-3	A. Any	A. 5 millicuries
B. Carbon-14	B. Any	B. 5 millicuries
C. Phosphorus-32	C. Any	C. 5 millicuries
D. Phosphorus-33	D. Any	D. 5 millicuries
E. Sulfur-35	E. Any	E. 5 millicuries
F. Iodine-125	F. Any	F. 5 millicuries
G. Cesium-137	G. Sealed sources (registered pursuant to Section 32.210 of 10 CFR part 32 or an agreement State)	G. No single source to exceed 5 millicuries
H. Cobalt-60	H. Sealed sources (registered pursuant to Section 32.210 of 10 CFR part 32 or an agreement State)	H. No single source to exceed 5 millicuries
I. Strontium-90	I. Sealed sources (registered pursuant to Section 32.210 of 10 CFR part 32 or an agreement State)	I. No single source to exceed 5 millicuries

9. Authorized Use:

A. through F. To be used for Research and Development as defined in, 10 CFR 30.4, involving in vitro studies and teaching and training of students.

By law, our training must include the following:

- **Characteristics of Ionizing Radiation**
  i. α, β^-, γ –emission
  ii. Penetrating power and Halflife
- **Units of Radioactive Dose and Quantities**
  i. Curies, Roentgens, Rads, and REM
  ii. Permissible Limits and 10% Rule
  iii. Naturally-occurring radiation
- **Radiation Protection Principles**
  i. Time, Distance and Shielding
  ii. ALARA
- **Instrumentation**
  i. Different Radiation, Different Detector
- **Bio-Hazards of Exposure**
  i. Somatic, Genetic and Embryonic
- **Hands-On Use**
  i. Safety/Emergency Procedures
  ii. Ordering, Receiving, Opening Packages
  iii. Disposal
  iv. In-House rules and Postings

Characteristics of Ionizing Radiation

Alpha (α) Particles

Massive Size - He^4 nucleus

Charge of +2e

Slow Speed

Beta (β) Particles

Very small - electron

Charge of +e

High Speed

Gamma (γ) Ray

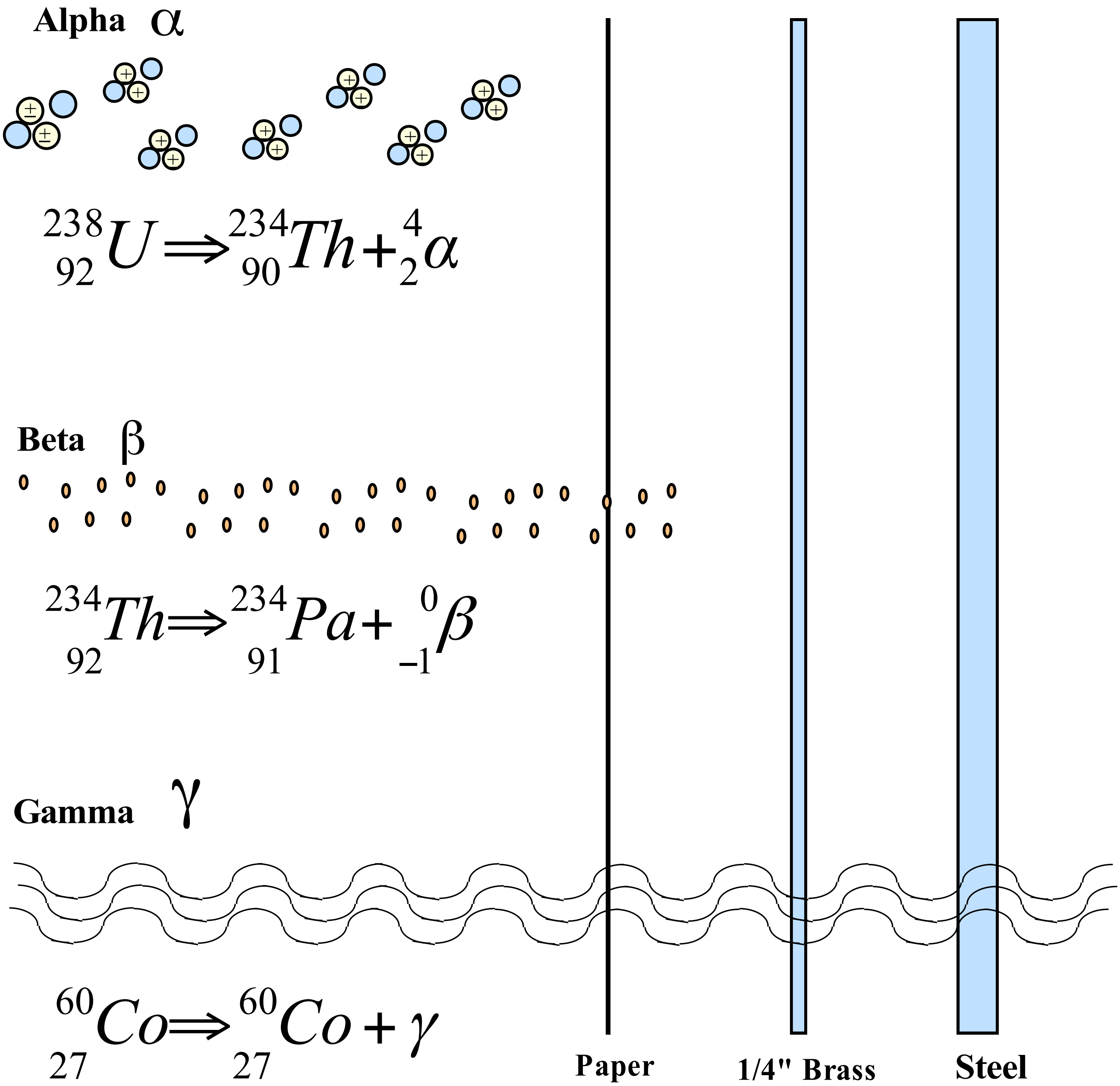
No mass

No Charge

Speed of Light

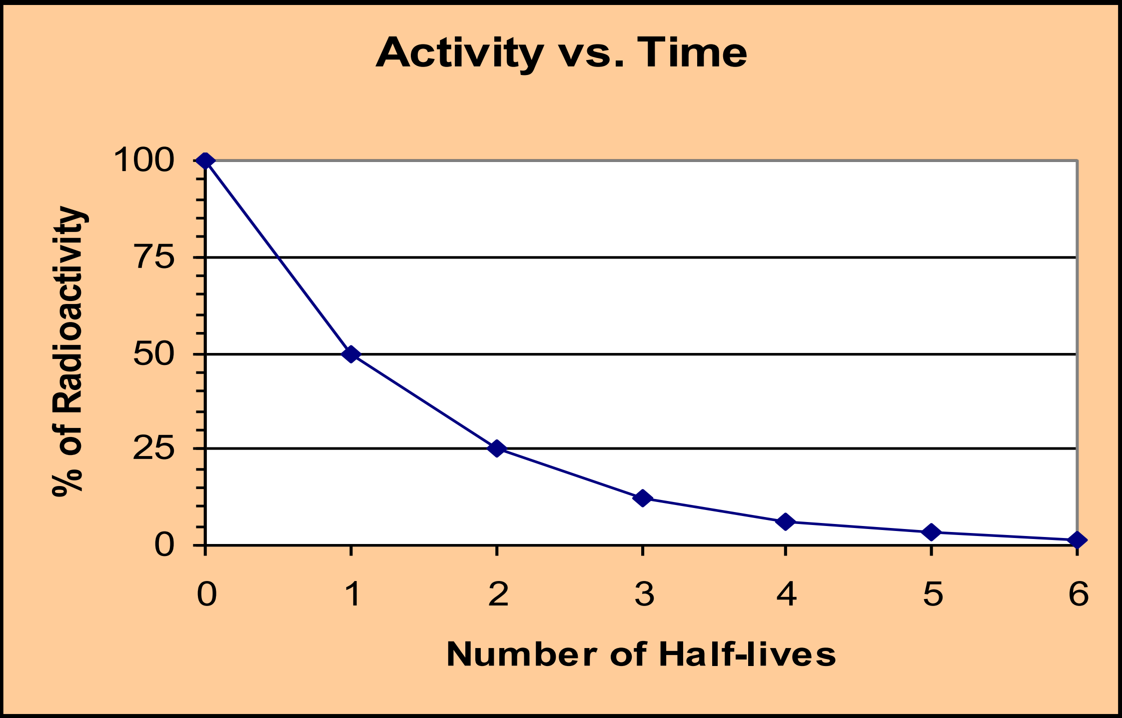
Called a Photon

Penetrating Power of Ionizing Radiation



Halflife

The time it takes for a level of radioactivity to decay to 1/2 of its initial value



For example:

Starting with 60 mCuries of ^{32}P, $t_{1/2}$= 14.3 days, the activity after 3 half-lives (42.9 days) will be 7.5 mCuries.

Units of Radioactivity

Curie- a measure of decays per unit time

1 Ci = 37 x 10^9 decays per second

1 mCi = 37 x 10^6 dps

1 µCi = 37,000 dps

Roentgen- a measure of the charge produced in air from ionization by x-rays and gamma rays

R, mR, µR,-- coulomb/kilogram

rad- a measure of the absorbed dose, the energy deposited by ionizing radiation in a unit mass of material

1 rad = 100 ergs/gram

rem- Dose equivalent - scale which equates the relative hazards of the various radiations: 1 rem = Q x (#rad) where,

$Q = 1(\gamma, \beta)$ and $20(\alpha)$

So, what do we use to quantify radioactivity?

REM

-Reflects the dose absorbed by the body

-Characterizes the levels which indicate safe vs. unsafe physiological conditions

The NRC designates various allowable dose limits for respective organs:

Internal organs - 50 rem/year

Lens of the eye - 15 rem/year

Extremities & Skin - 50 rem/year

Whole Body (TEDE) - 5 rem/year

In real practice, we try to conduct our programs such that the levels at any time would yield <5 rem in one year.

5 rem/year = 5000 mrem/2000 hrs

or

2.5 mrem/hr

Additional Limits

Occupationally exposed minors:

500 mrem/year or 0.25 mrem/hr

Declared, pregnant personnel :

500 mrem during gestational period

Members of the public :

100 mrem/yr or

2 mrem in any one hour

Personal Monitoring

-Required if individual is likely to receive a dose >10% of limits or 500 mrem in a year or 0.25 mrem/hr

****

For comparison, our readings should never read above .05 mrem/hr!

Naturally-Occurring Radiation

Every year you receive 360 mrem of dose from Natural and Man-made sources!

Natural	Man-made
Cosmic-27 mrem	Medical-53 mrem
Terrestrial-28 mrem	Weapons-1 mrem
Airborne-200 mrem	Reactor-0.4 mrem
Internal-40 mrem	Occupational-4 mrem

Consumer Products

Tobacco - Pb^{210}, Po^{210}
Illumination - H^{3}, Ra^{226}
Smoke Detectors - Am^{241}
Fuels - $Radon^{222}$
Building Materials - U, Th
Fiesta Ware - U
Lantern Mantles - Th
Lite Salt - P^{40}

Radiation Protection Principles

To safely utilize isotopes in the lab, you must appreciate the concepts of:

Time

Distance

Shielding

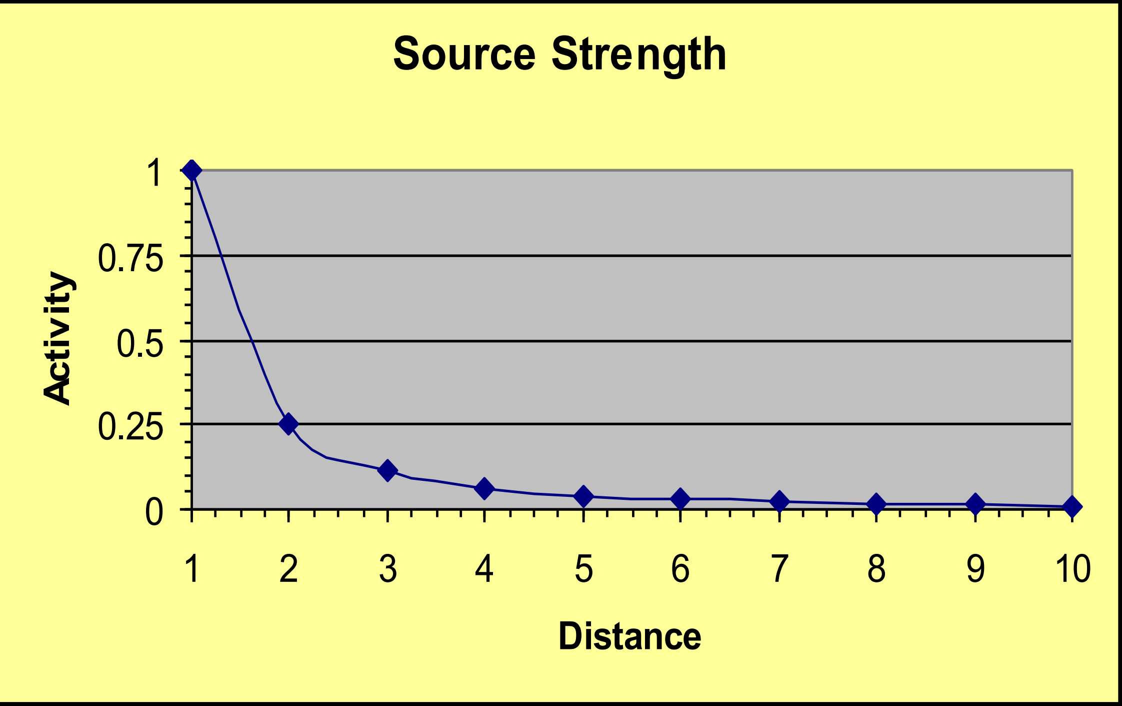
Constant awareness of these principles will allow you to keep external exposures ALARA!

Time

- Radioactivity, by nature, is time dependent.
  - The source you finish a study with is not the source you began with.
- Rates of external exposure are linear with the time spent near the source.
  - Double the time, Double the exposure.
- There are a variety of ways to limit the time (exposure) to radioactive sources.
  - Dry runs and training
  - Separate work and documentation areas
  - Efficiency and design of experiment
  - Automation

Distance

The strength of a radioactive source decreases with the square of the distance from it.



So, spend less <u>time</u> at short <u>distances</u> and more <u>time</u> at long <u>distances!</u>

Shielding

Everyone knows that lead is the best shield for any type of radiation.

Right?

WRONG

The shielding you employ should be radiation-specific

<u>Using the wrong shielding can</u>:

-Cause unnecessary weight

-Take up unnecessary space

-Introduce new, undesirable radiation

Shielding

- Alpha (α) particles are totally absorbed by a few centimeters of air or few sheets of paper
- Beta (β) particles are stopped in a few meters of air or a few centimeters of plexiglass.
  - Absorption is energy dependent
  - Use of lead, unless sufficiently thick, can bring about unabsorbed x-rays.
  - Plexiglass absorbs β's without the x-ray production
- Gamma absorption requires lead or other High-Z material
  - Absorption is exponential

ALARA

The concept of ALARA is really a frame of mind. Any user of radioactive material should be aware at all times that radiation is present.

Limits exist that indicate "safe" levels, but they aren't necessarily ALARA.

Examples:

-Lab conversations, where?

-Diversions from immediate use

-Lead brick

Instrumentation
Different Radiation, Different Detector

At our disposal for the detection of radioactivity is:

-Geiger-Mueller Pancake Probe

-Geiger-Mueller Normal Probe

-Bicron μR Survey Meter

-NaI Gamma (γ) Probe

-Liquid Scintillation Counter

Now each of these detectors has its own application and only one measures exposure. They cannot be depended on to detect all types of radiation.

Let's look at the applications…..

Isotope Inventory

Isotope	Radiation Type	Energy (keV)	Halflife	Monitor	Exposure
H^{3}	β^{-}	18.6	12y	LSC	–
C^{14}	β^{-}	157	5730y	GM/LSC	μR
P^{32}	β^{-}	1709	14.3d	GM	μR
P^{33}	β^{-}	249	25d	GM	μR
S^{35}	β^{-}	167	87.2d	GM/LSC	μR
I^{125}	γ	36	60d	NaI	μR
Cs^{137}	γ	662	30y	NaI	μR
Co^{60}	γ	1173, 1332	5.3y	NaI	μR
Sr^{90}	β^{-}	546	29y	GM	μR

Now, how do we use each detector and what are we reading when we do?

Detectors

- GM Probes
  - Detect γ/β radiation
  - Reads out milli-roentgen (mr)/hr
  - Only used for surveys, not for exposure
- Bicron Survey Meter
  - Only detector that measures exposure
  - Detects all radiation
- NaI Gamma (γ) Probe
  - Primarily a γ−detector.
  - Will indicate presence of β decays through secondary x-rays
  - Need thin window probe for I^{125}
- Liquid Scintillation Counter
  - Used primarily to detect presence of H^3, C^{14}, S^{35} and other low energy radiation.
  - Requires "Swipe-Test"

Bio-Hazards of Exposure

We will group the physiological affects of radiation exposure into three groups:

-Somatic (individual)

-Genetic (passed on)

-Embryonic (in utero)

Let's discuss radiation risk factors and the prevalence of each effect due to radiation exposure...

Radiation Risk Factors

- Type and quantity of radiation
- Rate and duration of exposure
- Part of body exposed
- Gender and age at exposure
- Time since exposure

Somatic Effects

- Large doses of radiation may cause leukemia, cancer.
  - Evidence from animal studies, radiologists, uranium miners, dial painters, medical patients, atomic weapons.

- Prompt Effects (early)
  - Result from high doses in a short time (e.g. 100 rem in few hours)
  - Damage results from killing cells
  - Vomiting, diarrhea, fever, hair loss
  - Weight loss
  - 450 rems—LD for 50% in 60 days

- Delayed Effects
  - Result from low doses over time
  - Effects are statistical over long period

Somatic Effects

Since it is impossible to attribute a single individual's cancer to a single cause, the only way to designate radiation as a cause is to look at statistics with large sample populations.

Data

Normal incidence of cancer is ~30%

Normal death rate due to cancer is 20%

Cancer risk due to radiation

0.04% / rem (for high dose rate)

So if you were to absorb 1 rem in a rapid manner the overall risk grows to

20.04%

(Data from Committee on the Biological Effects of Ionizing Radiation, National Academy of Sciences)

Genetic Effects

Our only data, similar to somatic studies, is of large populations that have been exposed.

Of all the Japanese survivors of the Hiroshima and Nagasaki A-bombs, 77,000 births have been recorded.

No genetic effects have been observed in this population.

No Genetic effects expected at NRC limits

Embryonic Effects

Effects suffered by an individual due to exposure while still an embryo/ fetus

Remember that the NRC limit for the duration of a pregnancy is 500 mrem or 10% of the normal yearly dose limit if declared.

Childhood Cancer

-At 1 rem maternal dose

-Excess deaths = 0.6/1000

Mental Retardation

-Single dose of 1 rad at 8-15 wks

Risk = 4/1000

Hands-On Use

- Safety/Emergency Procedures
- Ordering, Receiving, and Opening Packages
- Real-time Inventory & Disposal
- In-house rules and postings

APPENDIX B

Operating Procedures
for the
Safe Use of Radioactive Isotopes

1) All use of radioisotope material shall be conducted under the supervision of a faculty member certified as an Authorized User (AU).

2) The AU shall limit the quantity of radioactive material used by students under his supervision so as not to exceed the maximum dose allowed by regulation.

3) Adequate personal protection equipment must be worn or used by all individuals using radioactive material. This shall include, but is not limited to, rubber gloves and a laboratory coat.

4) Active participation in laboratory exercises during which radioactive isotopes are utilized by students that are known to be pregnant is strictly prohibited.

5) Eating, drinking or smoking in the laboratory is not permitted.

6) When liquid sources are used, the worker will conduct a body scan and a survey of the work area when the work is completed. Pipetting, or the performance of any similar operation, will be done by remote pipetting. If contamination is found, the radiation safety officer will be notified, and the contained area will be cleaned before the worker leaves the radiation laboratory. If spillage occurs, the radiation safety officer will supervise the decontamination of the area. Rubber gloves and lab coats will be worn, the spillage will be blotted up in an absorbing material, the area will be washed with soap and water and the contaminated materials will be stored in designated containers. Disposal will be in accordance with regulations governing the disposal of ionizing radiation.

7) If, in the course of work, personal contamination is suspected, a survey with a suitable instrument will be made immediately. This will be followed by the required cleansing and a further survey.

8) No person shall work with liquid radioactive materials if he has any breaks in the skin without first covering the break with some form of protective equipment All such breaks shall be reported to the instructor in charge before work begins.

9) Active liquid wastes shall be poured into labeled containers or into approved "hot" sinks in concentrations conforming to state guidelines. They shall never be poured into a standard drain.

10) Active solid wastes and contaminated materials should be placed in trash cans labeled "contaminated" or in designated containers.

11) Active materials and contaminated materials are to be retained within the radioisotope laboratory and at specific points within the laboratory.

12) All wounds, spills and other emergencies shall be reported to an approved user immediately.

13) Before leaving the laboratory, all written records of isotope usage, clean-up, surveys and emergencies (if any) must be completed by an Authorized User.

14) No ancillary personnel will be allowed in a radiation area without direct supervision.

Emergency Procedures

In emergency or accident situations involving radioactive materials, the following steps should be taken:

1) RESTRICT ACCESS: Persons in the immediate area not contaminated in the incident should be asked to leave the area. Establish a restricted area boundary, limiting access to the area to authorized personnel only.

2) MAINTAIN SURVEILLANCE: The restricted area must be kept under constant, direct supervision by an Authorized User (AU) or the Radiation Safety Officer (RSO) until area is deemed safe for occupancy.

3) NOTIFY: The Authorized User directly supervising the use of material involved in the accident should be notified immediately. In the case of spills, assessment of the accident should be made to determine if accident is minor or major and the proper procedures for which should be followed.

Minor Spills of Liquids and Solids

--Notify persons in the area that a spill has occurred.
--Prevent the spread of contamination by covering the spill with absorbent paper. (Paper should be dampened if solids are spilled).
--Clean up the spill, wearing disposable gloves and using 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. Put contaminated gloves and any other contaminated disposable material in the bag.
--Survey the area with an appropriate low-range radiation detector survey meter or other appropriate technique. Check the area around the spill for contamination. Also check hands, clothing and shoes for contamination.
--Report the incident to the RSO promptly.
--Allow no one to return to work in the area unless approved by the RSO.
--Cooperate with the RSO and AU (e.g., investigation of root cause, provision of requested bioassay samples).
--Follow the instructions of the RSO/AU (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

Emergency Procedures

<u>Major Spills of Liquids and Solids</u>

--Clear the area. If appropriate, survey all persons not involved in the spill and vacate the room.
--Prevent the spread of contamination by covering the spill with absorbent paper (paper should be dampened if solids are spilled), but do not attempt to clean it up. To prevent the spread of contamination, limit the movement of all individuals who may be contaminated.
--Shield the source only if it can be done without further contamination or significant increase in radiation exposure.
--Close the room and lock or otherwise secure the area to prevent entry. Post the room with a sign to warn anyone trying to enter that a spill of radioactive material has occurred.
--Notify the RSO immediately.
--Survey all personnel who could possibly have been contaminated. Decontaminate personnel by removing contaminated clothing and flushing contaminated skin with lukewarm water and then washing with a mild soap.
--Allow no one to return to work in the area unless approved by the RSO.
--Cooperate with the RSO and AU (e.g., investigation of root cause, provision of requested bioassay samples).
--Follow the instructions of the RSO/AU (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

Note: Do not handle unattached or unshielded sources of radioactive material. Decontamination and recovery operations should only be attempted by properly trained individuals, under the direct supervision of the Radiation Safety Officer and using proper handling tools.

<u>Minor Fires</u>

--Immediately attempt to put out the fire by approved methods(i.e., fire extinguishers) if other fire hazards or radiation hazards are not present.
--Notify all persons present to vacate the area and have one individual immediately call the RSO and fire department (as instructed by the RSO).
--Once the fire is out, isolate the area to prevent the spread of possible contamination.
--Survey all persons involved in combating the fire for possible contamination.
--Decontaminate personnel by removing contaminated clothing and flushing contaminated skin with lukewarm water, then washing with a mild soap.
--In consultation with the RSO, determine a plan of decontamination and the types of protective devices and survey equipment that will be necessary to decontaminate the area.
--Allow no one to return to work in the area unless approved by the RSO.
--Cooperate with RSO/RSO staff (e.g., investigation of root cause, provision of requested bioassay samples).
--Follow the instructions of the RSO/RSO staff (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation.).

Ordering, Receiving and Opening Packages

The presence, form, and disposition of any licensed radioactive material on the campus of USI must be documented.

Documentation begins with the order of the material and concludes when that material is completely used and/or disposed of.

Procedures are in place for:

--Ordering isotopes

--Receiving and opening packages

Ordering Radioactive Material

- All orders begin with a completed PO submitted to the RSO for approval
  - PO will not be forwarded without sign-off by RSO
- Original PO is forwarded by the AU to Purchasing
- Copy of PO is maintained by RSO
- Upon receipt of package, a copy of each of the following must be forwarded to the RSO:
  - Shipping Manifest
  - Radioactive Shipment Receipt/Usage Report

Receiving and Opening Packages

Care is taken in the receipt and opening of packaging for multiple reasons:

-To assure integrity of packaging

-To assure that the isotope you received is the isotope you ordered

-To assure that how much you received is how much you ordered

-To assure that the form of the radiation you purchased is the form that you received

Receiving and Opening Packages

- Receipt of material is the responsibility of the AU in accordance with procedures in Appendix A of our application
- Once a package is delivered and the AU is notified of such, receiving procedures should take place as soon as possible
- Required for proper receipt is a GM pancake probe and a Radioactive Shipment Receipt/ Usage Report

RADIOACTIVE SHIPMENT RECEIPT/USAGE REPORT

1. **ISOTOPE__________ ACTIVITY__________(mCi, µCi) Volume________(L, mL)**

2. **P.O. No.______________________ Survey Date_________________ Time_________**

   Surveyor___________________________ Signature____________ ________________

3. **CONDITION OF PACKAGE**
   Comment____

4. **RADIATION UNITS OF LABEL ______________________________Units (mR/hr)**
   Label: White I______ Yellow II______ Yellow III______

5. **MEASURED RADIATION LEVELS**
   a. Package Surface _____________mR/hr
   b. Three feet from surface ____________mR/hr

6. **DO PACKING SLIP AND CONTENTS AGREE?**
   a. Radionuclide _____yes _____no, Difference_____________________
   b. Amount _____yes _____no, Difference_____________________
   c. Chemical Form _____yes _____no, Difference_____________________

7. **IF NRC/CARRIER NOTIFICATION REQUIRED, GIVE TIME, DATE AND PERSONS NOTIFIED.**

MATERIAL USAGE

					Disposal Method/Place	
User	**Date**	**Quantity Used**	**Quantity Remaining**	**Experiment Swipe Test**	**Solid**	**Liquid**

Real-time Inventory & Disposal

- Notice that the Radioactive Shipment Receipt/Usage Form serves a dual role:
  - Records the receipt of material
  - Records the real time use and disposal of the contents of that shipment
- Each container of a shipment requires a form
- When a container is emptied, the form is completed and returned to RSO

Disposal of Radioactive Waste

- The methods of disposal of radioactive material depend on:
  - Form (solid or liquid)
  - Type (α, β, γ)
  - Half-life (short- vs. long-lived)

- Items requiring special storage consideration are:
  - Used/Unused portions of isotope material
  - Contaminated items such as gloves, absorbent paper, LSC vials, etc.

- Methods of disposal available to us are:
  - Decay-in-storage (DIS)
  - Release into sanitary sewage
  - Disposal as if not radioactive

Decay-in-storage

- Isotopes with half-lives of 65 days or less have been designated by the NRC as appropriate for DIS
- What goes into DIS?
  - Used/unused portions that qualify
  - Objects contaminated with qualifying isotope material
- What is the rule?
  - Waste must be held for at least 10 half-lives of the longest lived isotope in the waste AND until the container's radiation levels are indistinguishable from background
    - Keep separate the various halflife materials!

Disposal in Sanitary Sewers

- All of our permitted levels of radiation which are liquids or soluble forms can be disposed of in designated "hot-sinks"
  - 5 Ci of H^3, 1 Ci of C^{14}, 1 Ci of all others
- Disposal of these forms must be accompanied by adequate dilution by running water during disposal
- Disposal must be limited to designated hot sinks
  - Provides notice to any maintenance personnel of potential radioactivity
  - Provides containment of waste to specified areas

Disposal of Waste as though Non-radioactive

- LSC media (vials and other items contaminated with LSC media) can be disposed of in regular waste as long as:
  - It contains no more than 0.05μCi of ^{3}H or ^{14}C per gram of the medium.

So, let's say that a vial with a mass of 35 grams has a measured activity of 1.68 μCi.

1.68 μCi / 35 grams = .048 μCi/g

This vial can be disposed of in the regular trash with no signage attesting to radioactivity.

In-House Rules and Postings

- Surveys of Labs / Records
- Wipe tests / Records
- Bi-annual Inventory / Records
- Student Training and Use of isotopes during Pregnancy / Records
- Postings

Surveys / Records

- Places to Survey
  - Facilities
  - Equipment
  - Personnel
  - Restricted and Unrestricted areas
- Types of Surveys
  - General Area
  - Contamination
    - Fixed vs. Removable
  - Leak Tests

General Area Surveys

- Using appropriate monitor (GM or μRem), scan area with probe looking for hot spots.
  - Floor / Benchtops
  - Equipment
  - Individuals
  - Restricted and Unrestricted areas
    - Restricted levels should be <2.5 mrem/hr
    - Unrestricted levels should be <2 mrem in any one hour
- Contamination surveys should be completed on a periodic basis or:
  - After a spill
  - When processes have changed
  - Before leaving a radiation area
  - Near areas adjacent to presence or storage

Fixed vs. Removable Contamination

- Once you have found an area of contamination, you must determine if it is fixed or removable through the application of a wipe test.
  - Wipe area with cloth disk
    - 100 cm^2 area per disk
  - Place in vial with liquid scintillation material
  - Place vial in LSC for measurement and record
- If contamination is removable, proper cleanup procedures should be followed

Bi-annual Inventory / Records

- All isotope material must be inventoried twice a year
- On April 15th and October 15th of each year must identify and document on provided forms the type and quantity of radioactive material on hand

Student Training and USI Pregnancy Policy

- Before any student may use radioactive isotopes, he or she must undergo documented training
- It is the policy of USI not to allow students that have declared their pregnancy to us use radioactive isotopes
- A student's disposition to use isotopes must be affirmed through a signature on Appendix D

APPENDIX D

Student Training Certification
and
Disposition to Safely Handle Radioactive Material

Name:______________________________ Age:____ Gender: __M __F

Address:____ Phone:___________

Class for which certification is required:_______________________Semester/Year_______

Isotopes to be used:_________________________________

Instructor:_____________________________________

By signing below I affirm that I have received training on the safe handling and use of radioactive isotopes. I understand that my participation in exercises utilizing radioactive material requires the highest levels of safety and that any breach of safe operating procedures on my part will result in my dismissal from said exercises. I affirm that I am not pregnant at this time and that if this disposition changes I am obliged to inform my instructor before further participation in exercises using radioactive materials.

Signature:____Date:_______________

Postings / Signs

- Required by Code of Federal Regulations (CFR) are the following postings:
  - 10 CFR Part 21
  - Section 206 of the Energy Reorganization Act of 1974
  - Procedures
  - NRC Form 3
  - Notices of Violation
  - Copies of NRC Regs (19 and 20)

Signs

Wherever you have radioactive material present, there must be a sign indicating as such

The type of sign you post is significant, if not to you, to the NRC

"Radioactive Materials"

indicates < 2.5 mrem/hr

"Radiation Area"

indicates >2.5 mrem/hr