For Further Information...

If You Have Questions, What Copies Of License Or Manual Contact The Radiation Safety Officer

- Phone 2-4996
- Web site:http://www.kent.edu/compliance/research/radiation-safety.cfm
- Location 323A Harbourt Hall

Radiation Safety Basic Terms

Radiation

Radiation is energy in transit in the form of high speed particles and electromagnetic waves. We encounter electromagnetic waves every day. They make up our visible light, radio and television waves, ultra violet (UV), and microwaves and are part of a large spectrum of energies. These examples of electromagnetic waves do not cause ionizations of atoms they interact with because they do not carry enough energy to remove electrons from atoms. Radiation can be ionizing or non-ionizing.

Ionizing radiation

Ionizing radiation is radiation with enough energy so that during an interaction with an atom, it can remove tightly bound electrons from their orbits, causing the atom to become charged or ionized. Examples are gamma rays and neutrons.

Non-ionizing radiation

Non-ionizing radiation is radiation without enough energy to remove tightly bound electrons from their orbits around atoms. Examples are microwaves and visible light.

Health Physics

Health Physics is an interdisciplinary science and its application, for the radiation protection of humans and the environment. Health Physics combines the elements of physics, biology, chemistry, statistics and electronic instrumentation to provide information that can be used to protect individuals from the effects of radiation,

Radioactivity

Radioactivity is the spontaneous transformation of an unstable atom and often results in the emission of radiation. This process is referred to as a transformation, a decay or a disintegrations of an atom.

Radioactive Material

Radioactive Material is any material that contains radioactive atoms.

Radioactive Contamination

Radioactive contamination is radioactive material distributed over some area, equipment or person. It tends to be unwanted in the location where it is, and has to be cleaned up or decontaminated.

Common Types of Radiation

Gamma Rays

Gamma rays are electromagnetic waves or photons emitted from the nucleus (center) of an atom.

Betas

A beta is a high speed particle, identical to an electron, that is emitted from the nucleus of an atom

Alphas

An alpha is a particle emitted from the nucleus of an atom, that contains two protons and two neutrons. It is identical to the nucleus of a Helium atom, without the electrons.

Neutrons

Neutrons are neutral particles that are normally contained in the nucleus of all atoms and may be removed by various interactions or processes like collision and fission

X rays

X Rays are electromagnetic waves or photons not emitted from the nucleus, but normally emitted by energy changes in electrons. These energy changes are either in electron orbital shells that surround an atom or in the process of slowing down such as in an X-ray machine.

Common Units - USA

These are the common units used in the United States in health physics.

Roentgen (R)

The roentgen is a unit used to measure a quantity called exposure. This can only be used to describe an amount of gamma and X-rays, and only in air. One roentgen is equal to depositing in dry air enough energy to cause 2.58×10^{-4} coulombs per kg. It is a measure of the ionizations of the molecules in a mass of air. The main advantage of this unit is that it is easy to measure directly, but it is limited because it is only for deposition in air, and only for gamma and x rays.

Rad (radiation absorbed dose)

The rad is a unit used to measure a quantity called absorbed dose. This relates to the amount of energy actually absorbed in some material, and is used for any type of radiation and any material. One rad is defined as the absorption of 100 ergs per gram of material. The unit rad can be used for any type of radiation, but it does not describe the biological effects of the different radiations.

Rem (roentgen equivalent man)

The rem is a unit used to derive a quantity called equivalent dose. This relates the absorbed dose in human tissue to the effective biological damage of the radiation. Not all radiation has the same biological effect, even for the same amount of absorbed dose. Equivalent dose is often expressed in terms of thousandths of a rem, or mrem. To determine equivalent dose (rem), you multiply absorbed dose (rad) by a quality factor (Q) that is unique to the type of incident radiation.

Curie (Ci)

The curie is a unit used to measure a radioactivity. One curie is that quantity of a radioactive material that will have 37,000,000,000 transformations in one second. Often radioactivity is expressed in smaller units like: thousandths (mCi), one millionths (uCi) or even billionths (nCi) of a curie. The relationship between becquerels and curies is: 3.7×10^{10} Bq in one curie.

Common Units - SI - International Standard

Note: These are the common units used throughout the world in health physics.

Gray (Gy)

The gray is a unit used to measure a quantity called absorbed dose. This relates to the amount of energy actually absorbed in some material, and is used for any type of radiation and any material. One gray is equal to one joule of energy deposited in one kg of a material. The unit gray can be used for any type of radiation, but it does not describe the biological effects of the different radiations. Absorbed dose is often expressed in terms of hundredths of a gray, or centi-grays. One gray is equivalent to 100 rads.

Sievert (Sv)

The sievert is a unit used to derive a quantity called equivalent dose. This relates the absorbed dose in human tissue to the effective biological damage of the radiation. Not all radiation has the same biological effect, even for the same amount of absorbed dose. Equivalent dose is often expressed in terms of millionths of a sievert, or micro-sievert. To determine equivalent dose (Sv), you multiply absorbed dose (Gy) by a quality factor (Q) that is unique to the type of incident radiation. One sievert is equivalent to 100 rem.

Becquerel (Bq)

The Becquerel is a unit used to measure a radioactivity. One Becquerel is that quantity of a radioactive material that will have 1 transformations in one second. Often radioactivity is expressed in larger units like: thousands (kBq), one millions (MBq) or even billions (GBq) of a becquerels. As a result of having one Becquerel being equal to one transformation per second, there are 3.7×10^{10} Bq in one curie.

SI Prefixes

Many units are broken down into smaller units or expressed as multiples, using standard metric prefixes. As examples, a kilobecquerel (kBq) in 1000 becquerels, a millirad (mrad) is 10^{-3} rad, a microrem (µrem) is 10^{-6} rem, a nanogram is 10^{-9} grams, and a picocurie is a 10^{-12} curies.

SI Prefixes					
Factor	**Prefix**	**Symbols**	**Factor**	**Prefix**	**Symbols**
$\mathbf{10^{18}}$	exa	E	$\mathbf{10^{-1}}$	deci	d
$\mathbf{10^{15}}$	peta	P	$\mathbf{10^{-2}}$	centi	c
$\mathbf{10^{12}}$	tera	T	$\mathbf{10^{-3}}$	milli	m
$\mathbf{10^{9}}$	giga	G	$\mathbf{10^{-6}}$	micro	µ
$\mathbf{10^{6}}$	mega	M	$\mathbf{10^{-9}}$	nano	n
$\mathbf{10^{3}}$	kilo	k	$\mathbf{10^{-12}}$	pico	p
$\mathbf{10^{2}}$	hecto	h	$\mathbf{10^{-15}}$	femto	f
$\mathbf{10^{1}}$	deka	da	$\mathbf{10^{-18}}$	atto	a

Radiation Safety Training

1. Authorized Users
   a. Requirements:
      (1) Authorization for holding and using radioisotopes is given to designated individuals, known as Authorized User (referred to as PI or user), who must be full-time faculty members , who will be held responsible for the safe and proper use, storage and disposal of all radioisotopes under their jurisdiction. (Those working with radioactive materials under the supervision of an Authorized User are referred to as radiation workers or workers.)
      (2) Authorized Users must be listed on the University Radioactive Materials License.
      (3) Authorized Users must complete annual training requirements.
      (4) To be included on the license, the faculty member must complete the Training and Experience Form, Appendix M. This provides a summary of past training and experience in handling radioactive materials. The completed form will be submitted to the RSO for review and approval.
      (5) The form will be submitted to the ODH/BRP approval and inclusion on the KSU license.
   b. Duties:
      (1) Ensure implementation of the KSU Radiation Safety Manual within the laboratories for which they are responsible.
      (2) Responsible for the health and safety of persons entering their laboratories.
      (3) Comply with corrective actions made by the Radiation Safety Officer, the Radiation Safety Committee, or the Associate Vice President of Compliance and Risk Management.
      (4) Ensure that the individuals working in the laboratories have completed the necessary training programs before beginning to handle radioactive materials.
      (5) Ensure that all personnel involved in research protocols are included in the personnel monitoring program if necessary.
      (6) Monitor their laboratories ambient condition as often as necessary to determine that exposure to radiation is maintained ALARA.
      (7) Post rooms and materials with proper warning signs.
      (8) Properly disposal of radioactive wastes and prevent the accumulation of excessive quantities of waste material in the laboratory.
      (9) Notifying the RSO of any significant changes in techniques or physical facilities
      (10) When necessary, faculty members may request the Chair of the Radiation Safety Committee to schedule an agenda item in their behalf.

2. Radiation Workers
   a. UNDERGRADUATE, GRADUATE, AND POST-DOCTORAL STUDENTS AS WELL VISITING FACULTY must meet specific requirements before beginning to work with radioactive materials.
   b. All must attend or have attended a Radiation Safety Class and pass a written examination. The examination will test the individual's knowledge of the fundamentals of radiation physics, the effects of radiation on living systems, principles and practice of radiation safety, measurement of radioactivity and monitoring techniques, the mathematics and calculations basic to the use and measurement of radioactivity, and local, State, and Federal regulations.
   c. All must complete annual training requirements.
   d. All must work under the supervision of one of the faculty members named in the license. All will be responsible for setting up and completing their experiments in as safe a manner as possible. They shall report all unsafe conditions to the faculty member responsible for that area or the Radiation Safety Officer.
   e. Visiting faculty who are listed on another NRC license as individuals who wish to use radioactive materials must supply documentation of previous training and experience and comply with all provision of this manual.
   f. Past coursework or experience gained on the job will not exempt a student from completing the

above requirements

3. Ancillary Personnel.
   a. All ancillary personnel (e.g. security, cleaning, maintenance, etc.) who enter laboratories containing radioactive materials will be briefed either by memo or by group meetings periodically by the RSO.

4. Restricted Areas

   a. Unrestricted areas are areas in which a person continually present receives less than 2 mRem in any 1 hour. (Halls, Offices, Non-Radiation Labs.) Control measures for exposure from external radiation are not required.
   b. Restricted Radiation Areas are where radioactive materials are used or stored that could result in a dose above those cited as maximum allowable for unrestricted areas.
      (1) All rooms or portion of rooms in which radioactive materials or radiation producing equipment are used must be specifically approved for that purpose. Approval for use will be given by the Radiation Safety Officer.
      (2) The RSO will consider the isotope to be used, the maximum activity expected, the volatility and dispensability of the radioactive material, and the specific procedures to be carried out in the area. Other factors which may influence a decision are the amount of bench space, fume hoods, bio hoods, shielding, storage space, and waste handling facilities.
      (3) All radioactive materials within the area must be secured from unauthorized removal unless under direct and constant supervision. This means that if the radioactive materials are not under direct and constant supervision it must be locked in suitable enclosures or all doors entering the area must be kept locked.
      (4) Portions of laboratories that are designated as restricted areas are only to be used for radioactive materials uses.
      (5) Before a restricted area in a laboratory can be used for non-radioactive materials use, it must be decommissioned by the RSO and removed from the License.
      (6) Restricted Radiation Areas are in Cunningham Hall, Cunningham annex (Department of Biological Sciences), the Science Research Building (Chemistry and Physics), Smith Hall (Department of Physics), and Williams Hall (Department of Chemistry).
   c. Before Beginning an Experiment in a Restricted Area.
      (1) Before working in a Restricted Radiation Area, all personnel must have successfully completed the training program and arranged for personnel radiation exposure monitoring including bioassay if necessary. The Faculty Licensee supervising the research project is responsible for the health and safety of personnel on the project. They must be certain that all requirements and preparations have been met before assigning someone to work with any radioactive materials or radiation producing equipment. All personnel must also know how to contact the Radiation Safety Officer in the event of an emergency, and be familiar with the emergency procedures outlined in Section 3.8 of the Radiation Safety Manual.
      (2) Before attempting any new procedures with radioactive materials, it is suggested that a "dry run" be carried out to help anticipate possible hazards during the experiment. An aid in detecting potential flaws is to perform the experiment with a fluorescent material or dye. Ultra-violet light can then be used to survey the area following an experiment to help indicate where materials have contaminated the area.

5. Posting of Signs and Labels.

   a. The door to each room in which licensed materials are used or stored will be posted with a sign bearing the radiation symbol and the words “CAUTION RADIOACTIVE MATERIALS" or “DANGER RADIOACTIVE MATERIALS.”
   b. The area within laboratories in which radioactive materials are used will be delineated and labeled with a signs or tape with the radiation symbol and the words "CAUTION RADIATION AREA."

For sealed sources: if the level 12 inches from the source container surface is not in excess of 5 millirem/hour, a sign is not required.

c. A label with the radiation symbol and the words "CAUTION RADIOACTIVE MATERIAL" is required on any container used to transport, store or use radioactive materials.
   (1) The door to the Iodination Room will be posted with a sign bearing the radiation symbol and words indicating that it is a *"RESTRICTED AREA."*

d. Emergency Procedures and phone numbers of the RSO and principal investigator will be posted in all radioisotope use areas.

6. Laboratory Monitoring Program

a. Monitoring of laboratories will be accomplished by the use of surface wipe tests or survey meter.

b. Authorized Users are responsible for monitoring his/her own operations. Many projects are of such a nature that monitoring instruments must be on hand at all times. The Radiation Safety Office has a limited supply of survey meters which can be borrowed for short periods of time.

c. Each Authorized User who under the terms of our State of Ohio Materials License is authorized to use and to supervise the use of radioactive materials will monitor all rooms under his or her supervision in which radioactive isotopes are used or stored.

d. Radiation levels will be monitored using a survey meter during operations using isotopes.

e. Surface testing will be conducted at least once during the month when radioactive materials are used and results reported to the RSO.

f. Wipes are performed to detect removable surface contamination. Special attention should be paid to bench surfaces and edges, hood aprons and window handles, refrigerator door handles, cabinet handles, door knobs, and floor areas around work areas and near the doors leading out of the room. Areas wiped with filter paper should be approximately 100 square centimeters. The radioactivity on the filter paper should be evaluated with a liquid scintillation counter using a three-window program.

g. A blank filter paper not used for a surface swipe must always be included in the scintillation count.

h. Surface wipes must be taken in all areas where radioactive materials are used, except where they are only used as sealed sources.

7. Surface Decontamination.

a. If wipe tests indicate levels of contamination above 200 dpm, above the blank, the affected areas must be decontaminated.

b. If survey meter readings exceed 10x background, the affected areas must be decontaminated and/or the sources of the radiation must be better shielded.

c. If bodily contamination has occurred, the procedures outlined in Section H.4. (Emergency Procedures) of the Radiation Safety Manual must be followed.

d. The affected area must be washed with a strong detergent (e.g., Isoclean or Radwash) and rinsed with warm water, the wash and rinse water can be disposed of in the drain. The surface must be rubbed dry with paper towels, and these towels must be discarded as radioactive waste.

e. After decontamination, the area must be monitored again, and, if contamination persists, the decontamination procedure must be repeated until the contamination level is less than 200 dpm or 10x background.

8. Storage

a. All radioactive materials must be stored in an area of controlled access to prevent unauthorized removal and/or use of the material.

b. Radioactive materials must be under the direct observation of a user at all times. The laboratory door must be locked or the radioactive material must be returned to locked storage if laboratory person must leave the laboratory. Radioactive materials must never be left unattended.

c. If any radioactive materials are to be stored in an uncontrolled area such as a hallway refrigerator

or freezer, the container must be capable of being locked to assure that no unauthorized removal can occur.

d. The Authorized User is responsible for seeing that all storage containers, vials, columns, glassware, or any other items containing radioactive material are marked with an approved label bearing the words "Radioactive Material". Containers or materials used in common facilities must also bear the user's name and lab number.

9. Use

a. All radioactive materials must be handled in designated Restricted Radiation Areas. Radioactive material should be treated as hazardous substances and handled with all cautionary procedures normally accorded such substances.

b. No eating, drinking, smoking, applying cosmetics or any other procedure that could lead to inadvertent ingestion of radioactive materials is permitted in Restricted Areas.

c. Pipetting radioactive materials by mouth is prohibited

d. Food or drink, even in sealed containers, must not be stored in the same refrigerator or cold room where radioactive materials are used.

e. Laboratory coats, eye protection and disposable gloves must be worn at all times while handling radioactive materials.

f. Monitor hands, clothing and shoes for contamination after each procedure or before leaving the area. Survey the area at the end of the day.

g. If necessary wear appropriate personnel monitoring devices at all times while in areas where radioactive materials are used or stored. These devices should be worn at the working level.

h. Finger badges should be worn when handling one millicurie or greater 32P or other energetic beta emitters.

i. Dispose of radioactive waste only in specially designated receptacles.

j. Confine radioactive solutions in covered containers plainly identified and labeled with name of compound, radionuclide, date, and activity.

k. Transport radioactive materials in shielding containers.

l. Use shielding when working with radioactive materials in the lab.

m. Clothing should be disposable in the event of a major spill. Care must be taken not to contaminate other surfaces when working with gloves. Traces of radioactive material are sometimes inadvertently transferred to refrigerator handles, telephones, sink faucets, centrifuge doors and rotors, and instrument dials by handling them with a "hot" glove. Be sure to monitor such surfaces following use to assure that no contamination has taken place.

n. Glassware, tongs, pipettes, and other similar tools used in a radiation area should be suitably marked and not used in a non-radiation area. "Hot" glassware should be disposed of or washed promptly.

o. Work should be confined to as small an area as possible. This simplifies the problem of confinement and shielding, and aids in limiting the affected area in case of an accidental contamination.

p. All work involving the likelihood of aerosol production must be done in hoods, glove boxes or similar protective devices.

q. Cover work surfaces with an absorbent paper with waterproof backing or confine the handling of materials to an impervious tray. Change paper and wash trays frequently to prevent the spread of radioactive contamination.

r. Monitor the area with a sufficiently sensitive survey meter before, during, and after an experiment to detect contamination spots and to maintain radiation exposure levels within allowable limits.

s. Minimize the duration of exposure to high activities of gamma and high- energy beta-emitting radioisotopes. Confine large quantities of such isotopes to a lead storage box or lead pig in a remote spot of the laboratory (c.g., back corner of a hood or refrigerator). Use long handled forceps or tongs if possible to reduce exposures.

10. Waste Disposal

a. Waste shall be segregated by liquid and solids for each isotope.

b. Once a bag or container is full it must be labeled with isotope, estimated activity, date, and lab #.
c. Waste must not be held for decay in a laboratory.
d. When container is full contact RSO for it to be picked up.

11. Inventory

a. The Radiation Safety Officer is responsible for maintaining inventory records of all radioactive materials on the KSU campus, and ensuring that the possession limit for each specific isotope is not exceeded. Investigators licensed to conduct research involving radioactive materials are responsible for maintaining up-to-date records of the receipt, disposal (both by drum and by drain, and decay of radioactive materials under their supervision.

b. On the 15th of each calendar month, the Radiation Safety Officer will notify each licensee to submit a Radioactive Inventory and Wipe Test Results form for the current month. The Radiation Safety Officer tracks the activity of any isotopes received through the office during that month (see Receiving), and calculates the activity of each isotope lost by decay. (Note that the duration of a month is taken as 30.438 days, the average number of days per month).
   (1) The RSO must receive the form by the 5th of the following month.
   (2) The RSO will not authorize the purchase of radioactive materials for a user unless there is a current Radioactive Inventory and Wipe Test Results form on file for that user.

c. Each licensee is to complete the sections on amounts placed into waste and amounts placed down the drain for release into the sanitary sewer system and return the form to the RSO by the first of the following month. All entries are to be made in millicuries carried to two decimal places.

d. Materials transferred from one investigator to another, with prior approval by RSO, are to be noted as a minus quantity in the receipt column of the donating investigator's form, with a notation as to whom the material was transferred to. The investigator receiving the material must note it in the receipt column and note from whom it was received.

e. On receipt of the signed personal inventory forms, the Radiation Safety Office enters the disposal data from each investigator in its inventory, and prepares for each isotope a summary of month inventory and use form. The Radiation Safety Officer will ascertain that these forms correspond with the data submitted by the licensees and with the file on Materials Received, and check them for computational accuracy. The RSO will compare the total activity present on campus (both in laboratories and in waste drums) with the possession limit for each specific isotope. If the total present on campus exceeds 90% of the possession limit, he will notify all licensees. In such an event, the Radiation Safety Officer may consider requesting an amendment from the State of Ohio to increase possession limits, or disposing of stored waste of the isotope.

Radioactive Materials Disposal and Wipe Test Results (Month/Year) _____

Please Print

Principle Investigator _____

Person Completing From: _____

Building _____Room:_____

_____ Check if no radioactive materials used during month and return.

Disposal: Report all values as **Millicuries** (0.010 mCi instead of 10uCi).

Activity	C14	H3	I125	Na22	P32	P33
Liquid Waste						
Solid Waste						

Radioactive Wipe Test Report: Wipe tests must be reported as **DPM** not CPM.

Date	Survey or Wipe	Location	MR/H for Survey DPM for Wipe	Isotope	Initials	Comments

Attach drawing of room indicting wipe locations.

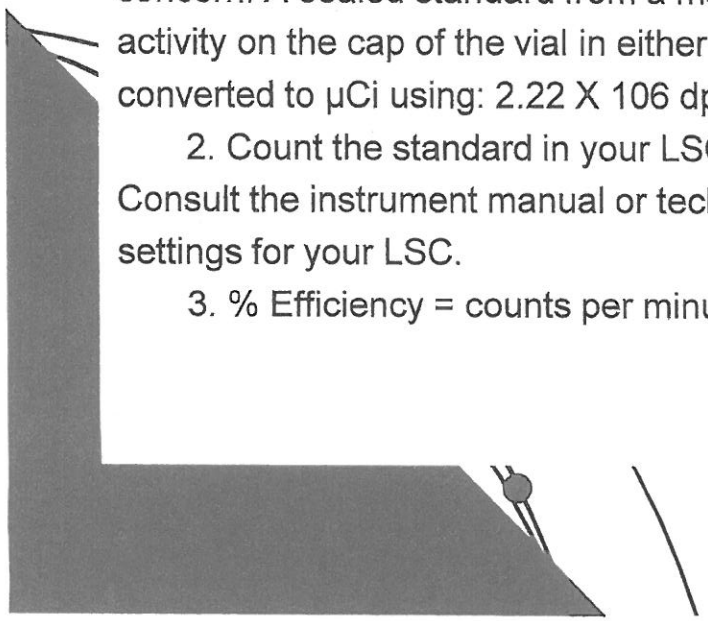
Liquid Scintillation Counter Efficiencies

Smear wipe results for routine laboratory surveys must be reported in units of dpm/100 cm2. Smear wipe results may not be reported in units of cpm. If your liquid scintillation counter does not report your results for your radionuclide in units of dpm, you must convert those results to units of dpm. In order to calculate the efficiency of your LSC for counting the radionuclide with which you are working, perform the following:

1. Obtain a sealed LSC standard with a known quantity of the radionuclide of concern. A sealed standard from a manufacturer will normally show the activity on the cap of the vial in either dpm or µCi. (If needed, dpm can be converted to µCi using: 2.22 X 106 dpm = 1 µCi.)

2. Count the standard in your LSC using the appropriate window settings. Consult the instrument manual or technical representative for proper window settings for your LSC.

3. % Efficiency = counts per minute (cpm) /disintegrations per minute (dpm)



Liquid Scintillation Counter Efficiencies

After the LSC efficiency has been determined for that radionuclide, that efficiency is then used to determine smear wipe counts per minute (cpm) when counting using the formula:

$$\frac{\text{Counts per Minute}}{\text{Efficiency}} = \text{Disintegrations per Minute}$$

Liquid Scintillation Counter Efficiencies

It is important to note that you must determine a LSC efficiency for each radionuclide that you use. When more than one radionuclide is used, the lowest efficiency of the different nuclides should be used.

This same method is used for determining efficiency of gamma counting devices.

Liquid Scintillation Counter Efficiencies

If you do not have the LSC efficiency documented in your record book, you can use the following list of efficiencies. If you are surveying for multiple radionuclides, use an open window and the lowest efficiency of the various radionuclides. These are conservative efficiencies that take into account some allowance for quenching. These efficiencies apply only to the use of LSC devices and do not apply to the use of gamma counting devices.

Radionuclide	Efficiency	Radionuclide	Efficiency
H-3	50%	Ca-45	90%
C-14	85%	Cr-51	25%
Na-22	90%	Fe-55	25%
P-32	90%	Co-57	70%
P-33	90%	Fe-59	90%
S-35	85%	I-125	70%
Cl-36	90%	I-131	90%

SAFE LIQUID SCINTILLATION & FLOW FLUID

Below is a list of approved scintillation and flow fluids. The criteria for approval includes but is not limited to a flashpoint greater than 140° F, a pH range between 4 and 10, and no other hazardous constituents in the fluid.

Manufacturer	Scintillation Fluid
American Bioanalytical	SafeScint
Amersham	BCS
Amersham	BCS-NA
Beckman	ReadySafe
Fisher Scientific	Scintisafe 30%
Fisher Scientific	Scintisafe Econo 1
Fisher Scientific	Scintisafe Econo 2
Fisher Scientific	Scintisafe Econo F
Fisher Scientific	Scintisafe Gel
Fisher Scientific	Scintisafe Plus 50%
Fisher Scientific	Scintiverse BD
ICN	BetaMax ES
ICN	CytoScint ES
ICN	Ecolume
ICN	Ecolite +
ICN	UniverSol ES
IN/US Systems	In-Flow BD
IN/US Systems	In-Flow ES
Isolab	Solvent-Free
National Diagnostics	Ecoscint
National Diagnostics	Ecoscint A
National Diagnostics	Ecoscint H
National Diagnostics	Ecoscint O
National Diagnostics	Uniscint BD
National Diagnostics	Monoflow 5
Packard (Perkin Elmer)	Ultima Gold
Packard (Perkin Elmer)	Ultima Gold AB
Packard (Perkin Elmer)	Ultima Gold F
Packard (Perkin Elmer)	Ultima Gold LLT
Packard (Perkin Elmer)	Ultima Gold MV
Packard (Perkin Elmer)	Ultima Gold XR
Packard (Perkin Elmer)	Optifluor
Packard (Perkin Elmer)	Optifluor O

Packard (Perkin Elmer)	Emulsifier Safe
Packard (Perkin Elmer)	Ultima Flow AF
Packard (Perkin Elmer)	Ultima Flow AP
Packard (Perkin Elmer)	Ultima Flow M
Packard (Perkin Elmer)	MicroScint 20
Packard (Perkin Elmer)	MicroScint 40
Packard (Perkin Elmer)	MicroScint 0
Packard (Perkin Elmer)	MicroScint PS
Research Product International (RPI)	Bio-Safe II
Research Product International (RPI)	Bio-Safe NA
Research Product International (RPI)	Econo-Safe
Wallac (Perkin Elmer)	Betaplate Scint
Wallac (Perkin Elmer)	Optiphase HiSafe 2
Wallac (Perkin Elmer)	Optiphase HiSafe 3
Wallac (Perkin Elmer)	Optiphase Supermix
Wallac (Perkin Elmer)	Optiphase TriSafe

Note: Contact vendor or website for the fluid best suited for your laboratory needs.

Radiation Safety Report
Receipt of Radioactive Materials

P.O #_____ Isotope_____

Date Ordered_____ Activity (mCi)_____

Date Received_____ Investigator_____

Shipping Label

White I ____
Yellow II ____
Yellow III ____

Other ____
None ____

Package Condition

Good_____
Other_____
(Describe Below)

Shipper_____ Carrier_____

Agreement Between P.O. and Packing Slip:

	Purchase order	Packing Slip	Agree (Y?N?)
Isotope	_____	_____	_____
Activity (mCi)	_____	_____	_____
Chemical Form	_____	_____	_____

Package Check

Surface Monitored	G/M Shielded (mR/hr)	Filter Wipe (dpm)
Blank/Bkgrd	_____	_____
Outer Box	_____	_____
Inner Box	_____	_____
Container/Pig	_____	_____
Vial	_____	_____

Inspected by: _____ Date_____

PACKAGE CHECK RESULTS MUST BE SENT TO RSO WITHIN 3 HOURS OF PACKAGE RECEIPT.
FAX 2-3662 E-MAIL TBIALKE@KENT.EDU

Radioactive Materials Inventory and Wipe Testing

Inventory

The State of Ohio Bureau of Radiation Protection limits the amount of radioactive materials Kent State may have on hand at any one time. This amount varies with the isotope. For example, we are allowed to have a maximum of 50 mCi of P-32 and 10 mCi of I-125. The maximum amounts are listed in our Radioactive Materials License issued by the State of Ohio.

To ensure that we do not exceed those amounts, it is necessary to maintain an inventory of the activity of the radioactive materials. As radioactive materials are purchased, the RSO adds the activity to each authorized user's inventory and calculates the amount of activity lost to decay each month.

To maintain an accurate accounting of the activity of each isotope, every authorized user must keep track of the activity of radioactive materials that is disposed as solid or liquid waste. These data is to be reported to the RSO every month via the Disposal Wipe Test Form 2015.

All though the NRC allows sewer disposal of minute quantities of isotopes to the sewer KSU has chosen not to allow this practice.

Wipe Testing

The State of Ohio requires that wipe testing be preformed at least once per month in each laboratory or counting room where radioactive materials are used.

Reporting and Record Keeping

To ensure that these activities are accomplished on a timely manner, a daily log of radioactive isotope usage should be kept in each laboratory listing the activity of each isotope used and its disposition.

Each laboratory or counting room should be routinely wipe test on a set schedule each month.

1. The above inventory data and wipe test results are to be reported to the RSO by the 1th of the following month. A Disposal/Wipe test form will be e-mailed to each authorized user the third week of the current month. The completed form must be signed by the user and faxed (2-2658) or sent via campus mail to the RSO. If no radioactive materials were used in the month, the appropriate box must be checked before sending to the RSO.

The RSO will not authorize the purchase of radioactive materials without the inventory data and wipe test results from the previous month.

RSP-3
08/20/13

REQUEST FOR PERSONNEL DOSIMETERS

Instructions: Each applicant must complete this form and submit it to the Radiation Safety Officer, 323A Harbourt Hall, fax 2-9561, email tbialke@kent.edu If you are a new user, submit a Statement of Training form, RSP-2.

1. NAME: _____ SEX: _____
   (First) (MI) (Last)
2. Social Security No.: _____ Date of Birth: _____
3. Principal Investigator: _____ Dept._____
4. Will you work with radiation sources longer than 6 months? _____
5. Date badge service first needed: _____
6. Type of radiation to which applicant may be exposed (X-ray, beta, gamma, neutron):

   List isotopes, x-ray equipment, etc.:

7. Building and room number where badge will be located: _____
8. Have you been monitored for occupational exposure to radiation prior to coming to Kent State University? _____

   If yes, please fill out the attached Request for Radiation Exposure History for each institution at which radiation exposure was monitored. Photocopy additional sheets as necessary

****

For Radiation Safety Program Use Only

Department: _____ Frequency: _____

Badge Type: Body: _____ Ring: _____

Date service started:_____ Date service ended: _____

REQUEST FOR RADIATION EXPOSURE HISTORY

Date: _____
Institution: _____
Address: _____

_____

Department: _____

Dates Employed: From: _____ To: _____

Attention RSO:

Please furnish the occupational exposure history of the individual named below, who may have received radiation exposure at your institution, so that we may complete our records to be in compliance with the U. S. Nuclear Regulatory Commission regulations.

Name of Employee: _____
SSN#: _____

I hereby authorize Kent State University to secure my past exposure history.

Signature: _____ Date: _____

Thank you for your prompt attention to this matter. Please send the information requested to:

Radiation Safety Officer
Kent State University
323A Harbourt Hall
615 Loop Road
Kent, Oh 44242

Sincerely,

Thomas S. Bialke
Radiation Safety Officer

How to Maintain an Inventory for Radioactive Materials in Your Laboratory

Principal Investigators (PI) are charged with maintaining records of receipt, transfer, current inventory and disposal of all radioactive materials.

Maintaining an accurate inventory of your radioactive materials will help you to:

- Plan your experiments.
- Estimate the residual activity in your radiological waste.
- Properly fill out your required quarterly inventories.

Steps to Follow When Receiving a Radioactive Shipment from the Radiation Safety Officer are:

- Maintain the radioactive material inventory sheet in a notebook near the material storage location.
- Every time material is used, update the log sheet accounting for all radioactive material used or disposed.
- Each primary vial should have an assigned inventory log sheet.

Note: Decay corrections for short-lived radioisotopes should be performed!

Below is an example of a Radioisotope Inventory Sheet. Call RSO at 2-4996 if you need assistance in implementing an inventory program for your laboratory or if you have any questions.

RADIOISOTOPE INVENTORY – Example

PI: I. B. Glowing
Radioisotope: 3H
Lot Number: H650
Date Rec'd: 9/15/98
mCi Received: 1.6
Vendor: Amersham
Storage Site: Refrigerator - Williams 111
Vial ID: 1

Date	Total mCi Received	Activity Used		Activity (mCi) Disposed		Disposal Method	Date of Disposal	Balance of mCi on Hand
.	.	ml	mCi	User	mCi	.	.	.
9/15/99	1.6	.	.	.	.	.	.	.
9/16/99	1.6	.	0.2	GDW	0.2	Dry Waste	9/16/98	1.4
9/17/99	.	.	0.2	GDW	.	.	.	.
9/18/99	.	.	0.2	GDW	.	.	.	.
9/19/99	.	.	0.1	GDW	0.5	Scint. Vials	9/19/98	0.9
9/26/99	.	.	0.3	GDW	.	.	.	.
9/28/99	.	.	0.2	GDW	0.5	Liquid	9/28/98	0.4
9/29/99	.	.	0.4	GDW	0.4	Dry	09/29/98	0.0
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.		Vial #1 disposed of 9/29/98 I. B. Glowing					
.	.	.	.	.	.	.	.	.

NOTE: Each vial received should have an inventory form completed.

A blank Radioactive Inventory sheet follows.

LABORATORY RADIOACTIVE MATERIAL INVENTORY

PI: ____________________

Radioisotope: ____________________ Vial ID: ____________________

Date Rec'd: ____________________ mCi Rec'd ____________________

Vender: ____________________ Storage Site: ____________________

Each vial received is to have an inventory form completed. After disposal of empty vial copy and send form to RSO.

Date	Total mCi Received	Activity Used		Activity (mCi) Disposed		Disposal Method	Date of Disposal	Balance of mCi On Hand
		ml	mCi	User	mCi			

Radioactive Waste Handling

1) Segregate radioactive waste by isotopes.
   - Isotopes with half-lives of less than 120 days (P32, P33, I125, and S35) are held for at least 10 half-lives before disposal.
   - Isotopes with half-lives of greater than 120 days are held in storage for off-site disposal.
2) Separate solid radioactive waste from liquid radioactive waste.
   - Solid Waste: dry contaminate laboratory materials, contaminated gloves, glassware, empty vials, empty cuvettes, empty reagent vials, paper, glass, plastic, lead shielded container
   - Liquid waste: Scintillation fluids, rinse water from contaminated glassware and laboratory equipment, and other contaminated chemicals/solvents.
   - Animals contaminated with radioisotopes.
3) Store contaminated sharps in puncture proof sharps containers. Sharps are pipettes, capillary pipettes, Pasteur pipettes, broken glass of any type, slides, needles, blades, any sharp object that may puncture the skin.
   - **DO NOT PUT SHARPS IN PLASTIC BAGS!**
   - Label puncture proof container with:
     1. Radioactive symbol
     2. Isotope
     3. Laboratory building and number
     4. Date
     5. Responsible Person
4) Solid waste disposal
   - Store in heavy plastic bags, clear is preferred.
   - Remove, deface, and cover up all radioactive signs, markings, labels, etc before putting empty containers in bags.
   - Put in second heavy plastic bag for disposal.
   - Label disposal bag with:
     1. Radioactive symbol
     2. Date
     3. Isotope
     4. Activity in mCi
     5. Laboratory building and number
     6. Responsible Person
   - Lead shielded containers (Pigs)
     1. Remove, cover up, and deface all radioactive signs.
     2. Put in hazardous chemical waste storage for disposal.
     3. If contaminated, the container must be placed in separate plastic bag for storage with radioactive waste.

5) Animals
   - Animals contaminate with radioisotopes are to be put in plastic bags and held frozen for disposal.
   - Label bag with:
     1. Radioactive symbol
     2. Date placed in freezer
     3. Isotope
     4. Activity in mCi
     5. Laboratory building and number
     6. Responsible Person
6) Liquid waste disposal
   - The EPA prohibits all liquid waste from being disposed of in normal trash.
   - Only use non-hazardous biodegradable, environmentally safe, or aqueous scintillation fluids. If have questions about hazardous nature of any fluid call RSO at 2-4996.
   - Hazardous radioactive chemicals or cocktails (toluene, xylene, pseudo-cumene based) can not be disposed of in the sewer and must be kept separate from non-hazardous fluids.
   - Non-hazardous radioactive fluids maybe disposed of in the sewer according to following limits per laboratory:

C-14	0.1 mCi/month
H-3	0.1 mCi/month
I-125	0.1 mCi/month
P-32	0.25 mCi/month
P-33	0.25 mCi/month
S-35	0.125 mCi/month

     1. Put down laboratory sink labeled for radioactive waste disposal.
     2. Empty vials into sink with water running, leave running for at least 5 minutes.
     3. Handle empty vials as radioactive solid waste per 6 above.
   - Pour scintillation fluid from vials or other non-hazardous liquids not put down the drain into half-gallon or gallon polyethylene jugs.
     1. Empty vials are to be treated as solid radioactive waste per 6 above.
   - Put hazardous radioactive liquids in separate glass containers.
   - Fill containers only ¾ full, leave head space for expansion.
   - Label container with:
     1. Radioactive symbol
     2. Chemical (ie, scintillation fluid type, solvent name, mixture ingredients)
     3. Isotope
     4. Activity in mCi
     5. Laboratory building and number
     6. Responsible Person
     7. Date when container is full
7) Record monthly disposal activity on **Radioactive Materials Inventory and Wipe Test** form.
8) Call or email RSO for pickup of radioactive waste with building, room, and isotope to be picked up.
   - 2-4996
   - tbialke@kent.edu

RADIATION SPILL

CAUTION: Spreading of radioactive contamination beyond the spill area can easily occur by the movement of personnel involved in the spill or cleanup effort. Prevent spread by confining movement of personnel until they have been monitored and found free of contamination. A minor radiation spill is one that the laboratory staff is capable of handling safely without assistance of Radiation Safety officer, typically less that 1 mCi. All other radiation spills are considered major.

Minor Radiation Spill (<1 mCi)

- Alert people in immediate area of spill.
- Don protective equipment, such as safety glassed, disposable gloves, shoe covers, and long-sleeve lab coat.
- Confine movement of potentially contaminated personnel until they are monitored and found free of contamination.
- Place absorbent paper towels over liquid spill. Place towels dampened with water over spills of solid materials.
- Pick towels with forceps and place in plastic bag. Dispose in radiation waste container.
- Monitor area, hands and shoes for contamination. Repeat cleanup until less than 200 dpm/100cm^2 is detected.
- Notify Radiation Safety Officer, Tom Bialke, 2-4996

Major Radiation Spill (>1mCi)

- Alert people in the laboratory to evacuate.
- Call Radiation Protection Officer, Tom Bialke, 2-4996, after hours call Cell Phone 330-671-6352
- Place absorbent paper towels over liquid spill. Place towels dampened with water over spills of solid materials.
- Confine movement of potentially contaminated personnel until they are monitored and found free of contamination.
- Remove and store contaminated clothing for evaluation by Radiation Protection Officer.
- Close and lock doors to prevent entrance into contaminated area. Placard door with "Do Not Enter. Spill Area"

Radioactive Material Skin Contact and Ingestion]

1. External Bodily Contamination
   a. Radioactive materials in contact with body surfaces (e.g., hands) should be removed promptly using approved decontamination products such as D-Con or Radwash. The area should be scrubbed gently and rinsed with lukewarm water.
   b. DO NOT USE HARD OR CAUSTIC SOAPS.
   c. DO NOT SCRUB THE AREA WITH AN ABRASIVE TOOL (e.g., SCRUB BRUSH).
   d. AVOID PROCEDURES THAT MAY BREAK THE SKIN CAUSING POTENTIAL TRANSFER OF MATERIAL INTERNALLY.
   e. The Radiation Safety Officer should be notified if the material in contact with the skin:
      (1) Exceeds 10,000 dpm.
      (2) Is in a chemical form that may readily be absorbed.
      (3) Gives a dose greater than 500 mR
      (4) If any of these conditions exist, the Radiation Safety Officer will determine whether decontamination can proceed on site or in the Emergency Room facilities of Robinson Memorial Hospital (Ravenna, Ohio).
   f. If decontamination is carried out on site under the direction of the Radiation Safety Officer, he will perform a urinalysis bioassay to determine whether the individual can be considered decontaminated. The Radiation Safety Officer will complete the Radioactive Contamination Report.
2. Internal Bodily Contamination
   a. Ingestion or injection of radioactive materials must be reported to the Radiation Safety Officer or his staff immediately. They will transfer the individual as a patient to the Emergency Room facilities of Robinson Memorial Hospital (Ravenna, Ohio).
3. The maximum limits suggested for fixed contamination on hands, body surfaces, personnel clothing and shoes are:
   a. Alpha activity - 200 dpm /100 cm2
   b. Beta-gamma activity - 0.2 mrad/hr at 2 cm

A. EMERGENCY PROCEDURES{ TC "Emergency Procedures" \l 2 }

1. We are all human and occasionally make mistakes. There is no shame in reporting spills or contamination. There is considerable NOT REPORTING an accident involving radioactive materials. On the recommendation of the Radiation Safety Committee, the VP & Dean for Research and Sponsored Programs may remove the privilege to handle radioactive materials from persons failing to report promptly any emergencies involving radioactive materials.
2. Low-Level Spills
   a. A low-level spill is one that is confined to a limited area and does not increase the radiation levels in the area beyond the acceptable limits of 2 mR/hr.
   b. The spill is confined to absorbent paper or an impervious tray.
   c. Radiation levels 1 meter from the center of the spill do not exceed 2 mR/hr.
   d. The total quantity of material spilled is greater than 1 uCi but less than 1 mCi.
   e. The licensed principal investigator supervising the activities in the laboratory where the spill occurred must be notified immediately. The investigator is responsible for assuring that the spilled material is collected and disposed of properly. Decontamination procedures should include the following steps:
      (1) If the spill was absorbed by bench paper, collect the paper and place it into a plastic bag. Label the bag and place it into the appropriate radioactive waste drum.
      (2) If the spill was confined to an impervious tray, wash the tray with decontamination solution. The rinse water may be disposed of in the sink if levels of radiation are within permissible limits (see Disposal). Otherwise, it must be disposed of as radioactive liquid waste and placed into the appropriate container.
      (3) Clean the surrounding area with decontamination solution.
      (4) Following decontamination procedures the area should be monitored with a survey meter and surface wipes. If contamination persists decontamination procedures must be repeated until detectable radiation levels are as low as reasonably achievable (ALARA).
      (5) The principal investigator is responsible for submitting a Radioactive Contamination Report to the Radiation Safety Officer within 7 days. The report will be retained in the Radiation Safety Office.
      (6) Remember:
         (a) NOTIFY: Notify persons in the area that a spill has occurred.
         (b) PREVENT THE SPREAD: Cover the spill with absorbent paper.
         (c) MARK OFF THE AREA: Do not allow anyone to leave the area without being monitored.

(d) NOTIFY THE RADIATION SAFETY OFFICE.

(e) CLEAN UP: Use disposable gloves and remote handling tongs. Normal cleaning agents should be adequate or use "Count-Off". Keep cleaning supplies to a minimum. Proceed from the outermost edges of the contaminated area inward. Place cleaning materials into a plastic bag and dispose of in the radioactive waste container. Also put into the plastic bag all other contaminated materials such as disposable gloves.

(f) SURVEY: With a low-range, thin-window G-M survey meter, check the area around the spill, hands, and clothing for contamination

3. Major Hazard Spill

a. A major hazardous spill is any spill that is more significant than a low-level spill A spill is a major hazardous spill if it meets lay of the following criteria:

(1) The quantity spilled is greater than 1 mCi.

(2) The quantity spilled is greater than 1 uCi and is not confined to absorbent paper or an impervious tray.

(3) Radiation levels 1 meter from the center of the spill exceed 2 mR/hr.

(4) THE RADIATION SAFETY OFFICER MUST BE NOTIFIED IMMEDIATELY WHEN A MAJOR HAZARDOUS SPILL OCCURS.

(5) The Radiation Safety Officer and the Department RSO will determine the extent of the spill by survey meter and wipes of the surrounding area. The contaminated area will be labeled with tape and cordoned off to prevent inadvertent entry into the area. Only radiation safety personnel and the principal investigator may enter the area until the decontamination procedures are completed.

(6) The Radiation Safety Office is responsible for directing the decontamination and assuring that the area is as free of contamination as reasonably achievable when decontamination procedures are completed. The principal investigator is responsible for promptly executing the decontamination procedures deemed necessary by the Radiation Safety Officer.

(7) The Radiation Safety Officer and the principal investigator will complete a Radioactive Contamination Report. A meeting of the Radiation Safety Committee will be convened to determine corrective measures to prevent, if possible, future hazardous spills of a similar nature.

(8) Reports to the State of Ohio will be made per OAC 3701-1-38-21 by the RSO.

(9) Remember:

(a) CLEAR THE AREA: Notify all persons not involved in the spill to vacate the room

(b) PREVENT THE SPREAD: Cover the spill with absorbent pads, but do not attempt to clean it up. Confine the movement of all personnel potentially contaminated to prevent the spread.

(c) SHIELD THE SOURCE: If possible, the spill should be shielded, but only if it can be done without further contamination or without significantly increasing your radiation exposure.

(d) CLOSE THE ROOM: Leave the room and lock the door(s) to prevent entry.

(e) CALL FOR HELP: Immediately notify the Radiation Safety Officer.

(f) PERSONNEL CONTAMINATION: Contaminated clothing should be removed and stored for further evaluation by the Radiation Safety Officer. If the spill is on the skin, flush thoroughly and then wash with mild soap and lukewarm water.

4. External Bodily Contamination
   a. Radioactive materials in contact with body surfaces (e.g., hands) should be removed promptly using approved decontamination products such as D-Con or Radwash. The area should be scrubbed gently and rinsed with lukewarm water.
   b. DO NOT USE HARD OR CAUSTIC SOAPS.
   c. DO NOT SCRUB THE AREA WITH AN ABRASIVE TOOL (e.g., SCRUB BRUSH).
   d. AVOID PROCEDURES THAT MAY BREAK THE SKIN CAUSING POTENTIAL TRANSFER OF MATERIAL INTERNALLY.
   e. The Radiation Safety Officer should be notified if the material in contact with the skin:
      (1) Exceeds 10,000 dpm.
      (2) Is in a chemical form that may readily be absorbed.
      (3) Gives a dose greater than 500 mR
      (4) If any of these conditions exist, the Radiation Safety Officer will determine whether decontamination can proceed on site or in the Emergency Room facilities of Robinson Memorial Hospital (Ravenna, Ohio).
   f. If decontamination is carried out on site under the direction of the Radiation Safety Officer, he will perform a urinalysis bioassay to determine whether the individual can be considered decontaminated. The Radiation Safety Officer will complete the Radioactive Contamination Report.
5. Internal Bodily Contamination
   a. Ingestion or injection of radioactive materials must be reported to the Radiation Safety Officer or his staff immediately. They will transfer the individual as a patient to the Emergency Room facilities of Robinson Memorial Hospital (Ravenna, Ohio).
6. The maximum limits suggested for fixed contamination on hands, body surfaces, personnel clothing and shoes are:

a. Alpha activity - 200 dpm /100 cm2
b. Beta-gamma activity - 0.2 mrad/hr at 2 cm.

B. **Returning Laboratories and Equipment to Normal Use.** {tc "**Returning Laboratories and Equipment to Normal Use**" \l 2}

1. For areas or equipment to be returned to general use, or for equipment to be sent out for maintenance, activity levels must be below those specified in the NRC document "Guidelines for Decontamination of Facilities & Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Material", 1987. For ß and g-emitters average surface contamination levels should be below 5,000 dpm/ 100 cm2 with removable levels less than 1,000 dpm/ 100 cm2.

The Radiation Safety Officer must be informed prior to the termination of any use of radioisotopes. Areas which are planned to be returned to general, unrestricted use, must have a final survey by the RSO with the results sent to the Decommissioning Group of the Ohio Bureau of Radiation Protection per OAC 1-40-18 (C) (2). Laboratory areas and equipment (including hoods, sinks, refrigerators, freezers, centrifuges, glassware, shielding, storage containers, benchtops, cabinets, and floors) shall be decontaminated or disposed of by the terminating user to the acceptance and approval of the RSO. Equipment and areas which have been cleared will have radioactive materials labels and stickers removed prior to release from the laboratory or disposal to public disposal facilities. When the laboratory is free of all radioactive materials and equipment and all work areas are decontaminated then the Radioactive Materials signs will be removed from the laboratory entrances. Documentation of decontamination surveys and laboratory clearance will remain on file at the Radiation Safety Office for a period of five years