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Revision 2

UNIVERSITY OF WISCONSIN



MADISON

Introduction

Radioactive materials and equipment that produces radiation are tools essential for accomplishing the teaching, research, and health care missions of the University of Wisconsin - Madison. Many Federal and state regulations have been promulgated which address the safe use of these radiation sources. To fulfill the University's missions and safely manage these sources faculty, staff, and students must be able to comply with these regulations.

Faculty committees and administrators of the University work closely with the various regulatory agencies to assure that University faculty, staff, and students, as well as the general public and the environment are protected from unnecessary radiation exposure as a result of the University's radiation work. Through the regulations and policies approved by the Radiation Safety Committee, the University has implemented an ALARA program to make sure all radiation exposures are As Low As Reasonably Achievable.

Following the University's Radiation Safety Regulations will insure that applicable regulations are addressed and that radiation exposures will remain ALARA.

This revision incorporates standards which apply to the UW Nuclear Reactor. Thus, for researchers who use unsealed radionuclides, this revision is primarily editorial. The major and most minor changes have been identified throughout the regulation by using redline (e.g., change) highlights. Please review the Table of Contents to see where the major changes are located and review changed sections when completing your renewal application or when suggested by Radiation Safety personnel.

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I. ADMINISTRATION OF THE RADIATION SAFETY PROGRAM**A. University Radiation Safety Committee (URSC)**

The URSC consists of faculty and staff appointed annually by the Chancellor (Appendix A-1). Its duties are:

1. Advise the university administration.
2. Conduct an annual review of the radiation safety program.
3. Set specific requirements necessary to insure the safe use of radionuclides and to maintain compliance with pertinent local, state, and federal regulations and promulgate these requirements via the URSC Radiation Safety Regulations.
4. Evaluate individual user requests for authorization to possess and use radionuclides under the University's NRC and State licenses.
5. Prescribe enforcement action to be taken when an individual's or group's use of radionuclides is deemed to be unsafe or in noncompliance with University, state or federal regulations.
6. Control acquisition and transfers of radionuclides to individuals on and off-campus and insure that individual and University possession limits are not exceeded.

B. Medical Center Radiation Safety Committee (MCRSC)

The MCRSC is a subcommittee of the URSC appointed by the Chancellor with input from the Chief Executive Officer, UW Hospital and Clinics Authority (UWHC) (Appendix A-2). The MCRSC is the UW's "human use" committee established under Title 10 Code of Federal Regulations, Part 35 (10 CFR 35) to review human uses of radioactivity and radiation (including byproduct, accelerator, naturally occurring and machine produced radiation) at the UW.

See Section XIII for more information about human use of radioactive materials.

C. Reactor Safety Committee (RSC)

The RSC is a subcommittee of the URSC appointed by the Nuclear Engineering Department. The RSC reviews reactor operations to assure that the facility is operated in a manner consistent with public safety and within the conditions of the facility license. Its duties include:

1. Review and approval of experiments using the reactor facility.
2. Review and approval of all proposed changes to the facility, procedures, and technical specifications.

3. Determine whether a proposed change, test, or experiment would constitute an unreviewed safety question or change in technical specifications.
4. Review of operation and operational records of the facility.
5. Review of abnormal performance of plant equipment and operating anomaly.
6. Review of unusual or abnormal occurrences and incidents which are reportable under 10 CFR Part 20 and Part 50.

D. Radioactive Drug Research Committee / Pet Regulatory Committee (RDRC/PRC)

The RDRC/PRC is a joint committee of the Veterans Administration and the University of Wisconsin Hospital. The administrator of the VA appoints VA members. The Dean of the Medical School appoints the University members. The committee reviews research proposals that involve administration of radioactive drugs to humans as specified by the Food and Drug Administration and regulates PET radiopharmaceuticals use in physiological research (Appendix A-3). This committee is authorized under 21 CFR 361.

E. University Health Physics Staff

Provides staff assistance to the URSC in carrying out procedures and policies set forth by the committee and retains all related records. Maintain the University's NRC licenses and carry out audits of facilities to assure compliance with URSC, State and Federal regulations. Advise and assist faculty and staff.

F. Authorized User / PI

Authorized users are faculty members or scientists who have written approval to use and possess radioactive materials. Approvals are secured from the URSC via the Radiation Safety Office. The authorized user is responsible for insuring compliance with regulations in his/her laboratories. This responsibility cannot be delegated. The authorized user is also responsible for the method of record-keeping used by the laboratory.

G. Radiation Worker

A Radiation worker is an individual who handles, uses, or performs work in association with radioactive materials or machine produced radiation. These individuals must be trained (Section V) and work under the supervision of an authorized user.

II. RADIONUCLIDE AUTHORIZATIONS

A. New Authorizations

Authorization to use any amount or form of radionuclides must be secured from the URSC. Complete all items on Form 99 (Appendix B). Include a Protocol Summary Sheet for each procedure. Send the original and one copy to the Safety Department.

1. Keep one copy of the Form 99 for your records; a Health Physicist will visit you to discuss procedures for ordering, safe handling, and disposal of radionuclides.
2. Written notification will be sent as soon as the application has been approved or denied.
3. If approved, your authorization is valid for up to 3 years.
4. A Health Physicist may be required to be present during first procedures to observe and answer questions.

B. Renewal Authorizations

In November, all PIs whose authorizations will expire the following January will be notified and given a renewal packet.

1. Complete all items on Form 99 (Appendix B). Include a Protocol Summary Sheet for each procedure. Send the original and a copy to the Safety Department. Keep a copy for your records. Include any desired changes or exception requests. Incorporation of information by reference to previously submitted applications is not acceptable. All exception requests, protocols, and training and experience must be resubmitted.
2. Once your application is received in the Safety Department, it is considered to be under timely renewal, and you may operate under your old authorization until it is acted upon. Renewals are usually processed during the calendar year they are due. If your renewal application contains major changes, indicate this on the cover sheet.
3. Failure to submit an application by the deadline date will result in revocation of your authorization for radioactive materials. You may call the Safety Department to extend the deadline.
4. Written notification will be sent as soon as the renewal application has been approved or denied.
5. Except for sealed source authorizations, approval may be for up to, but not exceeding, 3 years.

C. Sealed Source Authorizations

Authorizations for use of sealed sources only (e.g., gas chromatographs, etc.) are initially processed as new applications. Once approved, the authorization will be valid for up to 5 years and renewal will be initiated by the Safety Department on the 5-year anniversary.

D. Authorization Amendments

Changes to your authorization are possible by submitting a letter, an Email, or a Minor Changes to Nuclide Authorization form (Appendix D) indicating the desired change.

1. Connect to our WWW page (<http://www.wisc.edu/safety>) to download and complete the Minor Changes to Nuclide Authorization form.
2. For room deletions, see Section IX, Deletions and Final Surveys, for additional requirements.
3. Send the original form to the Safety Department. Keep a copy of the action for your files.
4. Minor actions (e.g., increase/decrease nuclide limits, room adds/drops, etc.) are done by Safety and usually require only 2 or 3 days to complete; other actions (e.g., new nuclide, animal protocols, etc.) require committee member approval and may take up to two weeks for final action.
5. Written notification will be sent as soon as the amendment has been granted or denied.

If a lab will **not** be used for radioactive material work or radioactive material storage for an extended period of time (e.g., more than 6 months) it should be deleted. This will eliminate its "radioactive" status and the need to perform monthly surveys of the room. A lab can be added to a user's list of authorized rooms in only 2 or 3 days, depending upon the user's past radiation history.

E. Authorization Exceptions

If any University regulation is impractical for your radionuclide program, you may request an exception to that regulation.

1. Send a written request for exception to the Radiation Safety Office, specify the desired exception, and why the exception is needed.
2. The exception is good only for the duration of your current authorization (i.e., it must be renewed with your authorization).
3. Exceptions may only be granted if they do not pose hazards or violate the terms and conditions of the University's NRC license or regulations.

F. Authorized User Temporary Absences in Excess of 30 Days

When an authorized user is going to be absent for more than 30 days, authorization must be temporarily transferred to another URSC-approved authorized user. Complete all items on form 99T, "Temporary Transfer of Authorization" (Appendix E), and submit it to the Radiation Safety Office. The authorized user and substitute will be notified in writing of the URSC approval or denial of the transfer request.

G. Termination of Authorization

Authorization may be terminated at the request of the PI, the URSC, Radiation Safety Office, or the Health Physics Staff. To terminate an authorization, the user must properly dispose of all radionuclides (as waste, by transfer to another authorized user, etc.), remove caution signs, perform final surveys of all radionuclide facilities and contact Radiation Safety.

1. Contact the Radiation Safety Office to terminate your authorization.
2. Contact CORD (Central, Ordering, Receiving, and Distribution) to transfer radionuclides to Radiation Safety, to an off-campus licensee, or to another authorized user on campus.
3. Submit copies of the final survey to the Health Physics staff. The final survey must indicate that the room is free of radioactive contamination.

H. Additional Information Pertaining to Authorizations

1. Pis must comply with conditions and procedures described in their authorization (e.g., if you state that laboratory surveys will be done weekly your lab must do weekly surveys).
2. If you have difficulty completing an item on the application form, call Radiation Safety. Procedures for approval of authorization include:
 - a. Safety review of the application to include a visit with new applicants to answer any questions. A visit may also occur for a renewal, amendment or exception request.
 - b. Approval of routine amendments, renewals and routine exceptions may be granted by Radiation Safety with later review by the URSC.
3. New authorizations and other non-routine requests require quorum approval during scheduled URSC meetings.

See Section XIII, Part A for information on applications for human (medical) use.

III. SOURCES OF RADIONUCLIDES

Pis can obtain radioactive materials from several sources. All radioactive materials procured from commercial vendors must be ordered through CORD (Central Ordering, Receiving and Distribution).

A. CORD

CORD places all radionuclide orders with commercial vendors and UW Purchasing. Authorized users may not place orders directly with nor receive radioactive materials directly from commercial vendors or other NRC licensee. UW Purchasing has been instructed not to process such orders.

The following explains how to order radionuclides.

1. CORD Ordering Hours: 8:00 AM to 11:30 AM &
12:30 PM to 2:00 PM
Phone: 262-6511
2. CORD Fee
 - a. The CORD fee is assessed for:
 - (1) each unique radionuclide/compound ordered
 - (2) free samples and evaluation orders
 - b. The CORD fee is not assessed for:
 - (1) replacement shipments for damages, impurities, CORD or vendor errors
 - (2) Radionuclide transfers between authorized Pis at the University
3. Placing Orders (orders may be placed by calling CORD or by using the CORD Order Form on the Safety Web Page, <http://www.wisc.edu/safety>, the information required for a complete order is the same)
 - a. Required information when placing an order:
 - (1) name of person who will work with the material
 - (2) lab telephone number (last 5 digits)
 - (3) authorized user's (i.e., professor's) name
 - (4) isotope and catalog number
 - (5) number of units (e.g., vials) and activity (in mCi) per unit
 - (6) requisition number (see 4, below)
 - (7) delivery address (i.e., room and building number)
 - (8) any instructions for special orders (e.g., special volumes)
 - (9) if requesting a fresh lot, give its ship date
 - b. Orders received before 11:30 AM will be placed with the vendor that afternoon. Orders received in the afternoon will be placed with vendors the following afternoon.

- c. CORD will notify the person who placed the order of any expected or unexpected delays in shipments
- 4. Purchasing Radionuclide Orders
 - a. Types of internal requisitions for radionuclide purchases:
 - (1) Blanket orders - money for several purchases
 - (a) Gives the blanket order number for each order for a designated period of time.
 - (b) Blanket orders expire when funds or time expire.
 - (2) One time orders - a requisition processed for a specific order. It cannot be used again.
 - b. Initiate an internal requisition made out to:
CORD/Safety Department
 - c. In the **Item Description** section on the form, fill in the ways the requisition may be used, e.g., **Purchase of radioactive material**, or **Disposal of liquid scintillation vials**, or **Purchase of radioactive materials and disposal of liquid scintillation vials**.

It takes 3 to 14 days for the Purchasing Department to process a requisition (ask your departmental secretary for details). To order immediately, mail, hand deliver, or FAX (# 262-6767) an approved copy (the FAXed Internal Requisition must have at least one signature) of the requisition to the CORD office during ordering hours.

5. CORD Deliveries

All radioactive packages received at CORD are surveyed and processed, PI inventories are updated on the CORD computer and the nuclides delivered. Any shipment received in CORD by 11:45 AM will be delivered that afternoon by CORD.

All radionuclides shipped to the University must be addressed to CORD, 30 N. Murray St., Madison, WI 53715, including exempt quantities, free samples and replacement orders.

Verify your order upon receipt. Individual vials of radioactive materials should be handled with disposable gloves because vials are not routinely checked for external contamination by CORD when they are received.

B. UW Reactor Lab

To receive materials from the UW reactor, Pis must be authorized to possess the isotope by the URSC and they must have a completed and approved UWNR 134

"Request and Authorization for Services of the University of Wisconsin Reactor" (Appendix G) in their authorization file.

C. UW Cyclotron

Specific approval must be granted to receive radioactive materials from the UW Cyclotron. Such requirements are usually addressed when a PI submits an application to use radioactive materials and indicates that cyclotron materials will be used. Details of registering receipt of such materials will be handled on a case-by-case basis by the URSC.

D. Campus Transfer from Another Authorized User at the UW-Madison

1. Material with activities **greater than** levels specified in Appendix R (10CFR30.71, Schedule B).
 - a. Before the transfer, the authorized user with the material must call CORD (2-6511) and provide:
 - (1) name of PI with the material and name of PI who will receive the material
 - (2) type of material
 - (3) quantity (activity) of material
 - (4) recipient and destination of the material
 - b. If the transfer is between campus buildings, Safety must handle the transfer.
 - c. If the transfer is within the same building, depending on the type and quantity of material, Safety may allow the user to transfer the material. However, Safety must be notified in advance.

When the transfer request is called in, CORD will complete a **Radioactive Waste Pickup** form (Appendix J-1), RSR, and adjust the inventory of both the recipient and the transferrer. Copies of these records will be given to the Pis.
2. Exempt quantities of radioactive material with activities **less than or equal to** levels specified in Appendix R (10CFR30.71, Schedule B).
 - a. The person doing the transfer should call CORD (2-6511) to verify:
 - (1) the recipient is authorized for the type and quantity of material to be transferred.
 - (2) the transfer of this material will not exceed the recipient's possession limit
 - b. The authorized person transferring the material must report the transfer on a **Radioactive Waste Pickup** form (Appendix J-1) within one week.
3. See Section XV, Transportation and Shipment of Radioactive Materials, for additional requirements.

E. Transfer from Another NRC License or Off-Campus Source

This includes material from the VA Hospital, free samples, evaluation shipments, custom syntheses, etc.

1. All radioactive materials must be ordered and shipped through CORD.
2. If the vendor / off-campus source requests a ship-to address, instruct the shipper to send the material to:

Safety Department / CORD
30 North Murray Street
Madison, WI 53715-2609

3. Call CORD and inform them of the impending shipment and any special handling necessary.
4. Upon receipt, CORD will add the activities shipped to the authorized user's inventory and deliver the material.
5. If radioactive materials are shipped to your address, contrary to these instructions, notify CORD immediately.

IV. FACILITIES FOR USE AND STORAGE OF RADIONUCLIDES

To keep radiation exposures ALARA and prevent the loss of radioactive materials, authorized users must provide adequate facilities for the proposed radionuclide use and storage.

A. Radionuclide Laboratory

An enclosed space separated from adjacent areas by floor, ceiling and walls which extend from floor-to-ceiling with built-in closures for any openings in walls, floor or ceiling.

1. If unsealed radioactive materials are used anywhere within the enclosure, the entire room is considered to be a radioactive materials use area.
2. Exceptions to this definition may be granted by the URSC on a case-by-case basis.

B. Shielding

When using high energy beta ($E_{\max} > 200$ keV) or gamma-ray emitters, the authorized user must use and provide appropriate shielding so exposures are kept as low as reasonably achievable (ALARA).

C. Fume Hoods

When performing procedures which could produce volatile radioactive effluents (e.g., ^3H , ^{14}C , ^{125}I), approved fume hoods with adequate air flow are required to ensure that restricted areas and hood effluents remain below legally allowed effluent concentrations. Call a Health Physicist for assistance. See Section XIII for additional information about using radioiodine in hoods.

D. Security

1. Radioactive materials, including waste, must be secured against unauthorized removal. See section VII for more information.
2. Anyone who suspects that radioactive material has been lost or stolen should contact Radiation Safety immediately.

E. Food, Beverages, etc. in Radionuclide Laboratories

1. The following activities are prohibited in laboratories where unsealed sources of radioactive materials are present:
 - a. Consumption, preparation and/or storage of food, beverages or medication.
 - b. Application of topical medication or cosmetics.
 - c. Smoking and tobacco chewing.
 - d. Mouth pipetting.

2. Food and beverage containers are prohibited from being stored in the same areas (e.g., refrigerators, etc.) where radioactive materials are stored.

V. TRAINING & INSTRUCTIONS REQUIRED FOR RADIATION WORKERS

For many workers, their indoctrination into the world of research using radioactive materials begins at the UW. Training is essential to insure these personnel are trained in basic general laboratory and radiation safety techniques. Minimum training requirements are detailed. Additional training may be required by the RSO or the URSC.

A. Radiation Safety for Radiation Workers (training manual)

1. All persons who will work in a radionuclide laboratory who may be expected to handle radioactive materials (e.g., stock vials, samples, waste, perform surveys, etc.) must read the booklet entitled **Radiation Safety for Radiation Workers**, attend the 4-hour Radiation Safety training class and pass the radiation safety exam before they begin actual work with radioactive materials in a radiation laboratory.
2. Radiation safety examinations are administered and graded as an integral part of the training block. Persons taking the test will be immediately notified of their test results. The authorized user will be notified of all **no pass** grades.
3. Under exceptional circumstances, alternative training may be acceptable; contact Radiation Safety with suggested outlines.
4. Rotators and other students who are sampling the expertise in various departmental labs may be exempted from this training requirement for a semester (i.e., while the student is deciding whether to pursue work involving radioactive materials). Once the student has decided to perform radiation work, the training requirement in 1, above applies.
5. Students participating in classroom laboratory exercises where radionuclides are present in total quantities **less** than those listed in Appendix R (10CFR30.71, Schedule B), and others on a case-by-case basis, may not need to take the training and exam; however, they do need to be instructed in the safe handling of radioactive materials appropriate to their classroom exercise.

B. Additional Instructions for Persons Working With or Exposed To Radiation

The PI is responsible for providing all personnel who enter the lab (e.g., dish washers, custodians, etc.) with the instructions specified in 10 CFR Part 19.12, "Instructions to Workers" (Appendix K) or 29 CFR (OSHA). Additionally:

1. Persons working in or frequenting any portion of a posted laboratory or a radiation restricted area (i.e., an area where members of the general public are restricted from entering to protect them from unnecessary radiation exposure) must be informed about the storage, transfer, or use of radioactive materials and about radiation exposure levels in various sections of that restricted area.

2. Personnel must be instructed as to the hazards associated with working with radioactive materials or radiation.
3. Personnel must be instructed as to precautions and procedures to minimize radiation exposure.
4. Persons working with radioactive materials must wear lab coats, protective eye wear, and protective gloves, as appropriate.
5. Persons working with radioactive materials must be initially trained and instructed in the handling and safe use of radionuclides, in the use of survey meters, wipe test methods, counting procedures, recordkeeping and disposal procedures used by the lab. Although the 4-hour radiation safety training block provides instruction and examples of acceptable safe use and handling procedures, the PI is responsible to provide training of workers specific to his work site. Radiation Safety will assist in additional radiation safety training upon request.
6. Personnel who will be expected to perform radioiodinations must receive additional training (Appendix T) under the tutelage of a more experienced iodinator. Aspects of this training should include:
 - a. Potential hazards of radioiodine
 - b. Observing the procedure to be performed
 - c. Additional survey requirements for radioiodinations
7. Persons only working with machine produced radiation (e.g., x-ray diffraction) should review Chapter 10, **Radiation Safety for Radiation Workers** and be briefed on the basic safety measures for the particular source they will be using.

C. Changes in Personnel

Authorized users must notify the Radiation Safety Office when a person discontinues work in their radionuclide facility.

The NRC requires posting of the NRC Form 3 (Appendix K), "Notice to Employees", at appropriate locations in the work area.

VI. PERSONNEL MONITORING

Because radiation can only be detected by special, passive devices, PIs must insure that persons working for them have and wear dosimeters if required by federal, state or University regulations.

A. Federal (NRC and OSHA) and State Requirements

The NRC (Table 1) and State require that personnel monitoring devices be issued to:

1. Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10% of the dose limit.
2. Minors (person who is under 18 years of age) and declared pregnant workers likely to receive, in 1 year from sources external to the body, a dose in excess of 10% of the dose limits.
3. Individuals entering a high radiation area (m 100 mrem in one hour at 30 cm away from the radiation source).

Table 1. Occupational Exposure Limits (rem)

Exposed Organ	Adult Radiation Worker		Minor Radiation Worker		Embryo / Fetus of Occupational Worker	
	Yearly Limit	10% of Limit	Yearly Limit	10% of Limit	Gestation Period Limit	10% of Limit
TEDE ¹ (Whole Body, both external and internal)	5	0.5	0.5	0.05	0.5	0.05
CDE ² (Organ or tissue, both external & internal)	50	5	5	0.5	---	---
Lens of the Eyes	15	1.5	1.5	0.15	---	---
Skin of Whole Body	50	5	5	0.5	---	---
Extremity	50	5	5	0.5	---	---

¹TEDE is the Total Effective Dose Equivalent as defined in 10 CFR 20

²CDE is the Committed Dose Equivalent as defined in 10 CFR 20

4. Radiation Safety will review dosimetry records for overexposures and conduct investigations as required by the **ALARA** program. During such an investigation, workers should provide as much information as possible to accurately reconstruct the exposure.

B. University Requirements

1. Dosimeters are required for workers who may use 1 mCi or more of penetrating beta, gamma, or neutron radioactive material (i.e., radioactive material which decays with product energies as specified in Table 2, below).

Table 2. University Dosimetry Requirements

Radiation	Energy	Dosimeter Type
Beta (b)	m 200 keV (max. energy)	Whole Body Extremity ¹
Gamma (g)	m 20 keV	Whole Body Extremity ²
Neutron	Any	Whole Body

¹Unless shielding will prevent extremity exposure

²If operation is such that extremity exposures could not be ascertained from the body badge (e.g., body is shielded)

2. Additional requirements for the employment of persons under the age of 18 years in radiation laboratories include receipt of parental permission (see Appendix V). Contact Radiation Safety when persons younger than 18 years of age will work in your lab.

C. Obtaining Dosimeters

1. Contact Radiation Safety or the individual responsible for administering badges to your group.
2. If required, attend the scheduled **Radiation Safety for Radiation Workers** training and successfully complete the radiation safety examination. A Form 135 may be completed at that time.
3. If you have previously worn personnel monitoring devices at the University, complete a Form 135 (Appendix L) and submit it to Radiation Safety. If badges are needed quickly, you may pick them up at the Safety Dept. between 10:30-11:30 AM and 1:00-2:00 PM.
4. If you lose a badge call Radiation Safety for a replacement and submit a missing badge report (Appendix M). Your department will be billed for badges that are lost or not returned within 30 days of the end of a monitoring period.

D. Dosimetry Records

Individual exposure histories may be obtained from Radiation Safety by submitting a written request. Radiation Safety will provide an annual exposure summary letter to each badge group leader for dissemination to workers within that group.

The authorized user is responsible for:

1. Informing personnel where dosimetry records are posted and filed; if unsure where your records are, contact Radiation Safety.
2. Providing necessary information to Radiation Safety to evaluate any reported overexposures.

E. Further Information Relating to Personnel Dosimetry

Some important guidelines to follow when wearing radiation dosimeters:

1. Store dosimeters where they will not be exposed to radiation, excessive heat or moisture.
2. Wear only your dosimeter.
3. Body badges - wear on the trunk of your body between your neck and waist, at the point where it is most likely to receive maximum exposure.
4. Ring badges - wear the ring under the glove on the hand that will receive the highest exposure, with the name label side toward the palm.
5. When wearing a lead apron
 - a. If you have a single dosimeter, wear the badge on your collar, outside of the apron.
 - b. If you have two dosimeters, wear the whole body dosimeter under the lead apron and the collar badge outside the apron.
6. Return the dosimeter to your badge group leader by the 10th of the month following the badge period (e.g., for a period ending on 31 March, return badges by 10 April). Make sure you are issued a new dosimeter before returning the old one. If you do not receive a new dosimeter call the Dosimetry office at 262-7530.
7. If you stop working with radioactive material at the University, return your badges to your badge group leader.
8. Do not wear your dosimeter when you receive medical exams or therapies which involve radiation exposure (e.g., x-rays, etc.).
9. Do not wear your University-issued dosimeter when performing non-University related work (e.g., moonlighting) at another facility.

If you have questions contact Radiation Safety, do **not** contact the vendor.

If you suspect that you or your dosimeter may have been overexposed or contaminated call a Health Physicist immediately.

F. Pregnancy Surveillance Program

Because it is believed that the fetus is more sensitive to the detrimental effects of high radiation exposure (> 10 rem), the NRC has established lower limits for exposure of the fetus of "declared" pregnant workers. Specific components of the program (Appendix S) include:

1. Declaration by the worker (in writing) to the Radiation Safety Office that the worker is pregnant and desires the University to implement the reduced exposure limits (cf., Table 1) for her fetus.
2. Radiation Safety will review the worker's past radiation exposure and the lab's use of radioactive material to gage the fetal exposure potential.
3. Radiation Safety will discuss these items with the worker and, if believed necessary, recommend work environment changes to the authorized user and worker to maintain the fetal exposure within limits.
4. The pregnant worker will be provided a copy of NRC Reg Guide 8.13 (Appendix B, *Radiation Safety for Radiation Workers*).

VII. SECURITY OF RADIOACTIVE MATERIAL

All persons working with radioactive materials are responsible for the security of the radioactive materials in their possession including radioactive waste in their labs or in a storage area. NRC regulations allow for the use and storage of radioactive materials in several types of areas:

- A. Restricted Area is any area to which access **is** controlled by the licensee for purposes of protection of individuals from exposures to radiation and radioactive materials (e.g., irradiator rooms).
- B. Controlled Area is any area to which access can be limited for any reason. Most labs on campus are controlled primarily to prevent the loss of valuable equipment.
- C. Unrestricted Area is any area to which access **is not** controlled by the licensee for the purposes of protection of individuals from exposure to radiation and radioactive materials. A controlled area is usually an unrestricted area unless it is controlled for the purpose defined in Restricted Area, above. Research laboratories have been defined as Unrestricted Areas by the URSC.
- D. Security
 1. Areas where radioactive materials are routinely used or stored are usually controlled areas. Such areas must be conspicuously posted at each entryway with three signs: first, the radiation trefoil symbol and the words **Caution -- Radioactive Material**, second **No Eating, Drinking, or Smoking**, and third **Restricted Area -- Authorized Personnel Only**.
 2. PIs are responsible for security of their rooms and the radioactive materials within these rooms. Radioactive material rooms must be supervised when unlocked (i.e., workers must be physically present in the room). Additionally, the rooms or building must be locked / secured after work hours.
 3. Sometimes, licensed materials are stored in unrestricted and uncontrolled areas (e.g., cold room, refrigerator in hallway, etc.). In such situations, the radioactive material must be secured from unauthorized removal from the place of storage. Such areas include locked and labelled (**Caution -- Radioactive Material**) refrigerators cabinets in hallways and on loading docks.
 4. Licensed materials in unrestricted and uncontrolled areas, not in locked storage, must be under the constant surveillance and immediate control of an PI's workers at all times.
 5. If a person you don't know enters a controlled area ask if you can help them in an attempt to determine their reason for being there.

6. Continuous radiation exposure in unrestricted areas (to include laboratories) must be kept below 0.05 mR/hr. Safety will verify these levels by periodic radiation exposure measurements.
7. Radioactive waste must be held in yellow bags and the container properly labeled and controlled to prevent accidental disposal.
8. Certain areas which contain very large quantities of radioactive materials may require additional security measures beyond these listed.

VIII. ACTIVITIES EXCEPTED FROM URSR

A. UW Nuclear Reactor Laboratory

The UW Nuclear Reactor will follow the regulations according to Facility License No. R-74, University of Wisconsin Research Reactor as approved by the Nuclear Regulatory Commission, the UWNR operating procedures as approved by the Reactor Safety Committee, and the University Radiation Safety Regulations as approved by the University Radiation Safety Committee. When in conflict, the UWNR operating procedures and Facility License No. R-74, University of Wisconsin Research Reactor will take precedence over the URSR regulations.

The UW-Nuclear Research Reactor is exempt from the following University regulations:

1. Section II -- Authorization to possess and use reactor byproduct material is provided by R-74, unless / until the material is transferred to the UW broadscope license.
2. Section V -- Training is as required in reactor license, and as approved by the URSC.
3. Sections IX.B.2.g, IX.D, and XII.B -- Meter action level is 5 mR/hr or more. Any area with exposure rates exceeding the action level must be identified, posted, and approved by Reactor Director, or corrective action taken to reduce radiation levels will be documented and reviewed by Safety.
4. Section X -- The Reactor conducts an ALARA program which is consistent with the Reactor License and the technical specifications of that license.
5. Section XI.A.2.c -- Meter operation is checked with dedicated check sources placed at key locations throughout the reactor facility.
6. Section XIII.5 -- Effluent monitoring is done by reactor staff and records are kept at reactor facility. Reactor or safety staff will review the records.
7. Section XIV.B -- Reactor or safety staff will review inventory records annually.
8. Section XIX.A.13, XIX.C, and XIX.D -- Records of disposal to sewer & atmosphere are kept at reactor facility only, and reviewed by reactor or safety staff.

B. Human Use Clinics

Clinical uses of radioactive material are primarily concentrated in Nuclear Medicine, Radiation Therapy, and the PET Center. The uses of these materials is under 10 CFR Part 35, the clinics each submit an application per Section II which describes their program. Obvious exemptions include:

1. Section III - The Nuclear Pharmacy may order and receive radiopharmaceuticals as needed; sealed sources will be purchased through CORD.
2. Section V - Training is commensurate with JCAHO requirements.
3. Section IX - Surveys are as prescribed in the clinic authorization.
3. Section XII - Contamination levels are detailed in each clinic's application.

C. Cyclotron / Accelerator Laboratories

Certain accelerating machines can either produce radioactive materials (e.g., cyclotron) or produce high levels of radiation (e.g., accelerator, synchrotron). These uses are specifically licensed through the authorization process. Certain exemptions for these activities include:

1. Section V - Training for purely machine sources of radiation (e.g., x-ray) is normally conducted by the PI.
2. Sections IX and XII - Surveys and contamination levels are detailed within each laboratory's authorization.
3. Sections VI and XIII - Personnel monitoring may also consist of bioassays.

D. Open-Beam Irradiators

Medical Physics and the School of Veterinary Medicine have teletherapy systems which are individually licensed under 10 CFR Part 36. These sealed sources are maintained according with Section XIII and the facilities are managed to insure compliance with Part 36.

IX. LABORATORY SURVEYS AND CONTAMINATION

As with radiation exposure, contamination is undetectable by human senses alone. Radiation workers must make a deliberate effort to detect contamination. This effort is called a survey. PIs must conduct adequate radiation and removable contamination surveys in their radionuclide laboratories approved for use or storage of unsealed sources of radioactive materials.

A. Survey Frequency

The minimum, formal laboratory survey frequency is determined by the total amount of radioactivity that a user has possessed (as recorded on the CORD inventory) in a one month (30 day) period. Receiving an order, opening a bottle, vial, etc., or having radioactive waste stored for decay contributes to possessed radioactivity. Additionally, the survey frequency may be based upon the type of laboratory (e.g., counting room, storage room, etc.). Results of the most recent survey must be posted. Surveys must be kept for a period of 3 years or until a final (close-out) survey is performed and the results submitted to the Safety Department.

1. PIs who have possessed 200 μCi or more of radioactive material in one month must perform monthly surveys.
2. PIs who have possessed less than 200 μCi of radioactive material in one month may perform semi-annual (6-month) surveys.
3. Rooms used **only** for storage of radioactive materials (i.e., packaged radioactive waste held for decay, etc.), counting rooms, and other rooms for which a PI has requested and received an exception to the monthly survey frequency must be surveyed semi-annually.
4. Laboratories where a vial containing m 5 mCi of radioiodine is opened require a survey of that room immediately after the iodine use. If vials containing m 50 mCi of radioiodine or ^3H are opened, a copy of the survey must be sent to Radiation Safety.
5. Materials received and placed in storage or materials that remain unopened and unused:
 - a. If the radioactive material will be placed in storage (e.g., refrigerator, storage-for-decay waste, etc.) with accumulated activities m 200 μCi and the radioactive material will not be used for a period in excess of 6 months, an exception to the required monthly survey frequency may be requested in writing or eMail.
 - b. Approval of the exception will specify that the user perform a radiation survey after the last use and before the material is placed into storage status.
 - c. Thereafter, the user must perform a laboratory survey of the storage area at least every 6 months and post the results.

Regardless, the authorized user is required to conduct laboratory surveys as specified in his/her authorization to possess and use radioactive materials, if that frequency is more restrictive.

Table 3 summarizes the required survey frequency based on the possessed activity.

Table 3. Survey Frequency

Frequency	On-Hand Activity
Monthly (30 day intervals)	m 200 μ Ci in any one month
Semi-annually (6 month intervals)	< 200 μ Ci or radioactive material in storage or counting room only (packaged radioactive waste, stock vials)
Immediately after use	m 5 mCi vial of radioiodine opened

B. Adequate Surveys

This section provides general guidelines for surveys of facilities where unsealed sources of radioactivity are used or stored; it covers most uses and situations. However, unusual situations will be considered on a case-by-case basis when a user renews or amends his/her authorization.

1. The types of surveys to be performed depend upon the type of radiation, the energy of the radiation emitted, and the quantity of material which a user possesses. The general survey requirements for beta (β) emitters are listed in Table 4. For example, if monthly surveys are required (> 200 μ Ci in any one month) and the lab uses ^{35}S ($E_{\text{max}} = 162$ keV) or ^{14}C ($E_{\text{max}} = 157$ keV), then both meter and wipes are required.

Table 4. Survey Requirements for Beta (β) Emitters

Energy (keV)	On-Hand Activity	Type Survey
< 100	see Table 3	wet wipe tests
100 - 200	< 200 μ Ci in 1 month	wet wipe tests
> 100	> 200 μ Ci in 1 month	meter <u>and</u> wet wipe tests

- a. Beta emitters with $E_{\text{max}} < 100$ keV (e.g., ^3H) - wet wipe tests for removable contamination.

- b. Beta emitters with $E_{\max} > 100$ keV (e.g., ^{14}C , ^{35}S , ^{33}P , ^{45}Ca , ^{32}P , etc.) and/or gamma emitters (^{125}I , ^{51}Cr , etc.) - wet wipe tests for removable contamination and a check of gross contamination and/or radiation exposure levels with a sensitive survey meter are required.
 - c. If a lab uses a combination of radioactive material (e.g., high- and low-energy beta, gamma and low-energy beta, etc.), they should count the wipe samples with a Liquid Scintillation Counter (LSC) to obtain the most accurate results.
 - d. If low energy gamma emitters are used (e.g., ^{125}I) and meter surveys are required (per authorization), a scintillation type survey meter must be used. Usually, when bound iodine (e.g., RIA kits) is used, meter surveys will not be required. When kit users are renewed, Safety will determine whether meter surveys are required.
2. Surveys for gross contamination (cpm) and/or radiation exposure levels, require use of a calibrated survey meter which is sufficiently sensitive to detect 40 cpm (see Chapter 7 and Lab 2, ***Radiation Safety for Radiation Workers*** for survey techniques). Results of the survey must be posted and include:
 - a. Location (room) and date.
 - b. Diagram of the area surveyed.
 - c. Identification of person doing the survey.
 - d. Type and serial number of survey meter used.
 - e. Background count rate (cpm or cps) measured away from potential radiation fields (e.g., hallway).
 - f. Measured contamination count rates keyed to locations on survey diagram.
 - g. If count rates exceed 650 cpm above background, the user must document corrective action taken to reduce these radiation levels and record the resultant count rates following corrective action.
 3. To survey for removable contamination, a wipe test must be performed in all areas where unsealed sources of radioactivity are handled or stored. This wipe test is usually taken with moist smears, swabs, etc., wiping an area at least 100 sq. cm (i.e., 4" x 4"). Use care not to cross-contaminate wipe tests (see Chapter 7 and Lab 2, ***Radiation Safety for Radiation Workers*** for survey techniques). Results of the survey must include:
 - a. Location (room) and date.
 - b. Diagram of the area surveyed.
 - c. Identification of person doing the survey.
 - d. Type of laboratory counter used.
 - e. Background count for wipe tests.
 - f. Measured counts for wipe tests keyed to locations on the survey diagram. LSC or AGC counter results could stand alone as a survey if they contained the necessary items on them required for a survey. These include:

- (1) room and date
 - (2) initials of the person doing the survey
 - (3) background result (highlighted)
 - (4) items surveyed
- g. Equipment used for radioactive work and work areas in a restricted lab with removable contamination in excess of the levels listed in Table 5 are considered contaminated and must be cleaned, re-surveyed, and the results posted.
 - h. The term **work area** does not include the floor, tables, lab benches, telephone, door knobs/handles, walls, refrigerator, etc. These commonly accessible areas should be maintained free of radioactive contamination unless specifically excepted in writing by the URSC.
 - i. If contamination is found, a record of the resurvey results which verify successful decontamination must be documented on the original survey form. The resurvey must contain all items included in **a - g** above.

Table 5. Action Levels for Removable Surface Contamination

Contamination Units	Type of Radioactive Emitter		
	Alpha (a)	b ¹ , g, x	Low Risk b ²
dpm/100 cm ²	66	660	2,200
Net cpm/100 cm ²	23	230	770

¹b emitter values are applicable for all b emitters other than those considered low risk.

²Low Risk have b energies with $E_{\max} < 200$ keV, e.g., ³H, ¹⁴C, ³⁵S.

4. Results of the gross contamination and/or radiation exposure levels survey and wipe test survey should be recorded on the same survey map. A sample map is included (Appendix N).
5. Surveys for radiation exposure (mR/hr) are not routinely performed by laboratory personnel because most survey meters are calibrated in the cpm mode. Instances when exposure measurements are required, the PI will be informed and trained by Safety in the proper survey techniques for exposures.

C. Deletions and Final Surveys

A final survey is a thorough survey for gross contamination and/or radiation exposure levels (i.e., meter surveys) and for removable contamination (i.e. wet wipe tests) (see Adequate Surveys, Part B above). Final surveys are required before room(s) can be deleted from restricted status and become unrestricted rooms. Submit

a Minor Changes to Nuclide Authorization form (Appendix D) along with the results of the final survey to the Radiation Safety Office.

The final survey must be approved by the Radiation Safety Office before the room can be declared an unrestricted area and radiation warning signs removed.

D. Survey Posting and Record-Keeping Requirements

1. A copy of the most recent survey must be posted in each laboratory or there must be a note indicating where the surveys are to be found. This survey or posting should be readily visible upon entering the laboratory.
2. Previous surveys must be available for review by Radiation Safety and NRC inspectors.
3. Survey records, including counter results, must be retained for a minimum of 3 years.

X. ALARA PROGRAM

The UW has a proactive ALARA program. Its goal is to maintaining radiation exposures to faculty, staff, students, and members of the general public **As Low As Reasonably Achievable**. The ALARA program has two major components: (1) to control the use of radioactivity/radiation and (2) to prevent the spread of contamination. Successful accomplishment of these two components should keep radiation exposures of UW employees, students, members of the public, and the environment ALARA. As with any safety program, the principle responsibility for worker safety resides with the individual worker. However, all persons involved with radioactive materials and radiation use at the University of Wisconsin have certain responsibilities.

A. Radiation Worker

1. Be trained in basic radiation safety principles, emergency response procedures and in the procedures employed by their particular lab (Section V and XVIII)
2. Perform contamination surveys with sensitive survey instruments after working with radioactive materials (Section VIII and XI).
3. Maintain constant surveillance or control over radioactivity within their possession (Section VII and XIX).

B. Principal Investigator

1. Responsible for the safe use of radioactive materials and radiation within their lab groups (Section II, III, V and XIII).
2. Ultimately responsible for the control and security of radioactive materials within their possession (Sections VII and XIV).
3. Insure that their workers perform their assigned radiation safety tasks (Sections IX, XI, XII, XVII and XX).

C. Radiation Safety

1. Orders, receives, and transports (with a few excepted nuclides) all radioactive material on campus (Section III and XV).
2. Maintains the UW's official NRC inventory (Section XIV).
3. Performs sealed source leak tests and training for irradiators (Section XIII).
4. Processes all PI actions involving radioactive material use for ultimate decision by the URSC (Section II, IV and XIII).
5. Conducts initial radiation safety training and training for special uses (e.g., irradiators) as required (Section V and VI).
6. Manages the radiation dosimetry and pregnancy surveillance programs to include conducting dosimetry investigations (Section VI).

7. Collects and processes all radioactive waste generated under the UW's byproduct licenses (Section XIX).
 8. Conducts audits of each PI at least annually (Section XX).
 9. Performs an audit of the entire ALARA program annually.
- D. Radioactive Drug Research Committee / PET Regulatory Committee (RDRC/PRC)
1. Review human use research protocols per 21 CFR 360.
 2. Report to the FDA as required
- E. Medical Center Radiation Safety Committee (URSC)
1. Meets at least quarterly (Section I).
 2. Reviews all human uses at the UWHC (Section I).
 3. Coordinates human use protocol review with the RDRC/PRC (Section I).
 4. Audit clinical uses of radioactive materials annually.
- F. University Radiation Safety Committee (URSC)
1. Meets at least quarterly (Section I).
 2. Has final authority for all radiation safety issues (Section XX).
 3. Establishes the CORD fee structure.
 4. Reviews the UW's ALARA program annually.
 3. Audit clinical uses of radioactive materials annually.
- G. Chief Executive Officer, UW Hospital and Clinics Authority (UWHC)
1. Provides input to the Chancellor on the appointment of MCRSC committee members (Section I).
 2. Insures Joint Commission on Accreditation of Health Care Organizations radiation safety program requirements are accomplished.
- H. Chancellor
1. Appoints the URSC and MCRSC and provides them with authority to perform their prescribed mission (Section I).
 2. Provides the resources necessary to insure radiation is used safely at the UW and that radiation exposures are ALARA.

XI. INSTRUMENT REQUIREMENTS FOR SURVEYS AND MONITORING

While a survey is a deliberate effort to measure contamination or radiation exposure, performing this effort requires proper instrumentation. Each PI must have available the instruments listed in his/her authorization.

A. Portable Survey Meters (e.g., GM, scintillation detectors)

1. **Availability** - Contamination can only be detected by the use of properly calibrated radiation survey meters.
 - a. Survey meters must be operable and within the radionuclide laboratory wherever unsealed sources of energetic beta ($E_{\max} > 100$ keV) emitters or gamma emitters are being handled.
 - b. When handling vials containing more than 1 mCi or when work involves a contamination potential (e.g., iodination, > 0.25 mCi ^{32}P , etc.) meters must be used to monitor hands and immediate environs during and immediately after the work. The meter must be placed adjacent to the work area, but away from any radiation source which could give false readings or cause contamination.
 - c. When using ^{125}I , ^{51}Cr , and other pure gamma emitters, a meter sensitive to low energy gamma radiation (e.g., Low Energy Gamma - LEG - probe) must be available.
 - d. Authorized Users who only possess sealed sources may also be required to possess portable survey meters if it is possible for their unshielded sources to produce unshielded exposure rates in excess of 2 mR/hr (see Section XIII).
 - e. Failure to have a calibrated survey meter when required by the authorization is a violation.
2. **Calibration frequency** - Meters must be calibrated at the frequency specified in your radionuclide authorization.
 - a. At a minimum, meters must be calibrated at least once per year.
 - b. The Safety Department calibrates most types of meters at no charge. PIs are notified one month in advance of the calibration due date. Bring new meters and those that are due for calibration, labeled with authorized user name and phone number to the Safety Department or Safety Department Annex (B19 Biochemistry). The meter must be in good operating condition and free of contamination or it will not be accepted for calibration.
 - c. Radiation Safety will affix an operational check source on each meter when it comes in for calibration. Users of survey meters should verify meter operability with this check source before each use.
 - d. Although new meters usually come with calibration stickers from the manufacturer, these meters are not calibrated suitably for UW laboratory

- work. Notify Radiation Safety when you purchase a survey meter so it can be calibrated and added to the calibration schedule.
- e. Some meters can not be calibrated by Radiation Safety and must be sent to an alternate calibration service; the user is responsible for these calibration fees and other charges.
 3. Radiation Safety maintains a small stockpile of meter repair parts and is able to fix common problems at material costs.
 4. The Safety Department Web page (<http://www.wisc.edu/safety>) includes a listing of acceptable survey meters, approximate purchase costs, and vendors.

B. Liquid Scintillation Counters (LSC)

PIs using low energy beta emitters must have access to a liquid scintillation counter to count wipes for removable contamination. Quenched standard sets in ^3H and ^{14}C used for calibrating LSCs are available from Radiation Safety.

C. Auto Gamma Counters (AGC)

PIs using gamma emitters may use an auto gamma to check for removable contamination. Although AGCs are specifically designed to measure gamma rays, LSCs can normally be used to measure removable contamination from low energy gamma/x-ray emitters, e.g., ^{125}I , ^{51}Cr .

XII. CONTAMINATION AND RADIATION LEVELS

A. Removable Contamination

1. An area is considered to be contaminated when removable radioactivity in excess of levels specified in Table 5, Section IX, is measured.
2. When contamination is found
 - a. Mark the contaminated area and inform lab personnel.
 - b. Clean area thoroughly.
 - c. Resurvey the area found contaminated.
 - d. Document all surveys (see Section IX, Adequate Surveys).
3. If widespread contamination cannot be cleaned, clearly label the area, prevent the spread of contamination and call Radiation Safety for assistance.
4. For spills and contamination problems, or if you are uncertain how to proceed, contact Radiation Safety immediately.

B. Radiation Levels

Radiation levels in the lab must be kept ALARA. Corrective action must be taken for all areas in which the count rate from beta and/or low energy x-rays (e.g., ^{125}I) exceeds 650 cpm above background or in which the radiation exposure from sealed gamma ray sources exceeds 2 mR/hr.

C. Survey Requirements Prior to Operations by Non-Radiation Workers

The procedures specified below must be followed before non-radiation workers, e.g., carpenters, electricians, steamfitters, etc., may be asked to perform work in radionuclide laboratories.

1. Removable Contamination - The PI is responsible to perform the required contamination surveys and provide a copy to the maintenance worker upon request. The PI should verify that the worker understands what he/she has been told about potential hazards within the laboratory.
 - a. Remove and secure all radioactivity including radioactive waste.
 - b. Survey the area or equipment to be worked in or on for removable contamination. It must be free of radioactive contamination before work may start.
 - c. Survey the room or equipment using a portable survey meter if applicable to verify radiation levels (see number 2 below for requirements).
 - d. Document all survey results. Provide a copy to the Physical Plant or Safety Department personnel if requested.

- e. Call Radiation Safety for unusual situations, i.e., work in iodination hoods.
2. Radiation Levels - Non-Radiation workers may not work in any area where exposures could exceed:
 - a. 2 mrem in any one hour
 - b. 100 mrem per year
 - c. Continuous exposures rates should not exceed 0.05 mR/hr.For such instances, the Safety Department should be contacted and they will provide an adequate safety briefing and give the worker(s) dosimetry if appropriate.

The authorized user must retain documentation of these surveys for at least 3 years.

XIII. RADIONUCLIDE USES WITH SPECIAL REQUIREMENTS

Certain uses of radioactive material require either special skills or adherence to additional conditions to reduce personnel exposures and protect patients or the public from unneeded radiation exposure. These uses include: human use, radioiodine use, tritium use, vertebrate animal use, airborne radioactivity, and sealed sources.

A. Human Use

This includes the internal or external administration of radiation or radioactive material to humans for diagnostic, therapeutic or investigative purposes. Normally, clinics are authorized human use and individual physicians are approved to practice within the clinic under criteria promulgated by the clinic. The MCRSC reviews each physician's CV and may mandate additional training before full privileges are given. Information on acceptable training and experience for human use of byproduct material may be found in Appendix F-2. The following procedures are required for obtaining authorization:

1. Submit a Form 99, **Application for Possession and Use of Radioactive Materials** (Appendix B), and Form 98, **Application for Human Use of Radionuclides** (call Safety for Form 98), to Radiation Safety.
2. The applications will be evaluated by both the Medical Center Radiation Safety Committee (MCRSC) and the URSC. Although only a simple majority is needed, it is committee policy to deny a "human use" application if two or more members oppose the proposal.
3. The clinic will be notified when a physician's CV has been reviewed by the MCRSC.

B. Radioiodine Use

Unbound radioiodine is highly volatile. Persons performing radioiodinations must have received additional training as outlined in Appendix T. Workers should notify Radiation Safety immediately of suspected inhalation, spills, excessive releases or excessive exposure to personnel. There are special monitoring requirements for users of radioactive iodine. The iodine program does this special monitoring by conducting an evaluation of derived air concentrations (DAC), allowable limits of intake (ALI), and air concentrations.

1. Use of a Fume Hood or Approved Facility

Procedures involving 100 μCi or more of unbound radioiodine or 1.0 mCi or more of non-volatile iodine must be performed in a fume hood or other facility that has been approved by Radiation Safety. Because ^{125}I limits are based on

the maximum volume of air exhausted (i.e., the air concentration) from a hood, these approved radioiodination hoods should not be turned off, but should be left running continuously. Notify Radiation Safety if the hood you use has to be shut down.

2. Evaluation of Radioiodine Concentrations in Air

Breathing Zone Air (BZA) monitoring which measures the DAC in an iodinator's work area is required during procedures involving 100 μCi or more of volatile radioiodine or 1.0 mCi or more of non-volatile radioiodine. The steps in this BZA monitoring procedure are:

- a. One activated charcoal filter is delivered with each radioiodine order. If you don't get one, call Safety, one will be delivered.
- b. Insert filter in line attached to the vacuum pump or supply source.
- c. Turn on the vacuum source and adjust the flow rate to the median range on the gauge. The vacuum supply must run continuously while the iodine procedure is being performed.
- d. Note the time and record the flow rate as indicated by the flow meter in the breathing zone monitoring line.
- e. After the radioiodine procedure is complete, turn off the vacuum pump, record the time elapsed, fill in the required information on the label, put the filter in its plastic bag (be careful not to contaminate the filter with contaminated gloves) and seal the bag.
- f. Bring the filter with you to B19 Biochemistry for a thyroid count.

3. Thyroid Bioassays

A thyroid bioassay measures ALIs and determines whether the worker has ingested any radioiodine during the procedure just performed. To insure a timely measurement, the bioassay must be done within 7 days of receipt. Do not order more radioiodine than you will use within a few days.

Table 6. Thyroid Bioassay Schedules

Bioassay Type	Time	Activity Levels	
		Volatile	Non-volatile
Background	Within 6 months prior to use	100 μCi	1 mCi
Post-use	Within 7 days of receipt ¹	100 μCi	1 mCi

¹An extension for ^{125}I may be granted upon request, but not to exceed 14 days provided the iodine was not used within 7 days of receipt.

- a. Receiving a thyroid bioassay:
 - (1) Come to the Radiation Safety Annex, B19 Biochemistry, for a thyroid count within 7 days of receipt of radioiodine. The actual count time should be at least 12 hours after the iodine was used.
 - (2) Bring your breathing zone filter when you come in for your thyroid count.
- b. If radioiodine is detected:
 - (1) The individual will be notified in writing of the uptake.
 - (2) If a thyroid uptake of ^{125}I is greater than $0.023 \mu\text{Ci}$, thyroid counts will be scheduled for the following week; then every 4 weeks until background levels are achieved. If there is an ^{131}I thyroid uptake greater than $0.0173 \mu\text{Ci}$, weekly thyroid counts will be required until background levels are reached.
 - (3) If excessive thyroid burdens are detected, the PI must evaluate the incident and submit a written proposal of action to be taken to prevent recurrence.

4. Considerations Specific to Iodine Use

Meter surveys using a (LEG) scintillation detector are required to check for contamination after each iodination. Use clean gloves to survey the hood and immediate environment. Post these results for Safety review.

- a. During iodination
 - (1) Place scintillation (LEG) meter near work area, but outside of hood and away from radiation sources.
 - (2) Place all trash and contaminated items inside the hood. Contaminated items placed outside the hood may produce volatile effluents.
 - (3) Double glove and monitor your gloves, hands, etc. during iodination procedures. Remove and replace outer gloves as necessary. Place gloves in trash container inside the hood.
 - (4) Surveys during iodination need not be documented.
- b. Surveys after iodination
 - (1) Remove and replace outer gloves, survey hood, work area, floor, lab coat, hands, and shoes immediately after work in the hood is finished.
 - (2) Survey results of procedures in which a vial of 5 mCi or more of radioiodine was opened (even if not completely used) must be documented, posted and saved for at least three years. See Part IX of these regulations.
- c. After each use of m 50 mCi of radioiodine, a copy of this special survey must be submitted to the health physics staff for review.

5. Effluent Monitoring

The Radiation Safety staff will monitor the radioiodine air concentration of the hood effluent at the point of exhaust from the building and retain all records.

- a. Notify Radiation Safety if the fan of your iodination hood breaks down or is to be turned off for any reason. Because of the way allowable air concentrations in effluent streams are determined, hoods approved for iodinating may not be turned off without written permission from Radiation Safety.
- b. The authorized user may see his/her effluent monitoring results at any time by calling Safety.
- c. An annual summary of the effluent monitoring for each radioiodine hood will be provided to the authorized user upon request.
- d. If the hood inspection is greater than 1 year old, call a Health Physicist.

C. Tritium Use

Procedures which have the possibility of producing airborne tritium must be conducted in a fume hood or other approved facility. Some uses may require the PI to provide a tritium monitoring system to assure regulatory levels for effluents are not exceeded.

Table 7. Tritium Monitoring Schedule

Bioassay Type	Time
Background	Within 6 months prior to last use
Post-use	Within 1 week during and after procedure ¹

¹If count indicates a body burden greater than 50 μCi , weekly post-use bioassays are required until the body burden drops below 10 μCi .

1. Urine bioassays are required from persons working with more than 10 mCi of unsealed tritium. "Working with" includes withdrawing any amount of the tritium from a container holding more than 10 mCi, even though the quantity used in the experiment may be less than 10 mCi. Ordering several 5 mCi vials will be treated as a single, larger order.
2. Wash vial, label the bioassay vial with your name, your authorized user's name and the sample date, place in plastic bag and bring the sample to the Safety Department or the Safety Annex in B19 Biochemistry in the labelled vial provided. Do not send samples through Inter-Campus mail.
3. A copy of the results will be sent to each person submitting a sample.

4. If more than 50 mCi of ^3H is handled, wipe surveys of the hood and other lab areas must be performed and posted upon completion of the tagging procedure.

D. Vertebrate Animal Use

To use radioactive materials in vertebrate animals, the authorized user must submit a Form 99A (Appendix C) to the Radiation Safety Office.

1. All animal protocols must be approved by the Research Animal Resources Center (RARC) and an RARC protocol number must be assigned before Radiation Safety will process the Form 99A.
2. The application must be approved by the URSC.
3. The authorized user will receive notification of approval or denial.
4. The PI's responsibilities include:
 - a. Training of animal care personnel regarding the protocol and any special hazards.
 - b. Insuring that radioactive animals are not moved to unauthorized facilities.
 - c. Proper labelling of animal rooms and cages. Each cage must be labelled as follows:
 - **Caution - Radioactive Materials** label
 - Radionuclide and amount administered
 - Date administered
 - Name and phone # of authorized user
 - d. Disposing of animals, bedding, food and waste (Section XIX) according to Safety and RARC regulations.
 - e. Permanently marking or tagging animal as having been given radioactive materials, and the animal must be given to the Safety Department upon death or sacrifice.
 - f. All applicable surveys and conditions specified in Form 99A.
5. See Appendix C for additional requirements.

E. Airborne Radioactivity

1. Procedures and/or materials with the potential for producing or releasing airborne (gases, aerosols or dusts) radioactivity (e.g., $^{14}\text{CO}_2$) must be done in a hood or a facility approved by Radiation Safety.
2. Radiation Safety must be informed of any procedures that may result in airborne radioactivity. This should be done via the **Protocol Summary Sheet** submitted with the Form 99 (Appendix B) or the **Minor Changes to Nuclide Authorization**.

F. Sealed Sources

1. A sealed source is any radioactive material that is permanently encapsulated to prevent leakage or escape of the radioactive material. Sealed sources generally meet the specifications of ANSI N542-1977, Sealed Radioactive Sources, Classification, and after extensive testing are assigned a sealed source designation. You may not fabricate a "sealed" source without proper approvals from the URSC and the NRC. Contact Radiation Safety for additional information if you desire to fabricate a sealed source.
2. Certain sealed source gages are transported to remote locations to collect data. These workers must receive additional training to address unique radiation safety and transportation aspects of this use.
3. Radiation Safety is required to perform periodic leak tests and keep records for all sealed sources. If you receive a sealed or plated source or a piece of equipment containing a sealed source (e.g., gas chromatograph, EC foils or vacuum gauges) call Radiation Safety so the source can be leak tested and added to the leak test schedule if required.
4. High activity sealed sources are normally covered by specific NRC licenses. Use of the closed-beam irradiators (e.g., J.L. Shepherd Mark 1, Model 109, etc.) require additional training and annual retraining to insure worker safety and prevent overexposures.

XIV. RECORD KEEPING AND INVENTORY

A successful ALARA program is demonstrated by complete records. These records normally cover inventories and surveys. The PI is required to maintain up-to-date records of radionuclide use, decay and disposal.

A. Authorized User Responsibility

The PI must implement a viable radionuclide inventory and record keeping method. The PI and lab personnel must know where the inventory records are kept and how these are used.

1. Retain a log book where receipt, use and disposal of radioactive materials is recorded as it occurs. A **Radioactive Material Record** (Appendix P), is provided with each order and can be used for record keeping purposes; or you may use an equivalent method.
2. Be able to ascertain total activity for each radionuclide at any time. If short lived radionuclides are used, decay should be recorded at least on a monthly basis to insure that the user's CORD inventory (see B.1., below) is not exceeded.
3. Log book must be available for inspection by Radiation Safety, Federal, and State agencies at any time.
4. Provide Radiation Safety an inventory on request and within 10 days of the user's periodic (e.g., annual) ALARA audit.
5. Keep copies of all CORD, disposal and transfer forms on file for Radiation Safety review for a minimum of three years. Discrepancies in inventory records must be resolved immediately.

B. Radiation Safety Responsibility

The Safety Department is responsible for maintaining the University's inventory of radioactive material and insuring PIs procure and hold radioactivities commensurate with their authorizations.

1. Maintain an running inventory for each radionuclide an authorized user possesses based on receipts from CORD, user disposal forms and transfer reports. This inventory does not account for decay.
2. Prevent authorized users from exceeding their possession limits or receiving unauthorized radioactive materials.
3. Assure the NRC license limits and University building limits for any one or all radionuclides are not exceeded.
4. Check user inventory records during routine Radiation Safety audits (this may involve a physical inventory).

XV. TRANSPORTATION AND SHIPMENT OF RADIOACTIVE MATERIALS

A. On Campus

The PI holding the material must call CORD (262-6511) before each transfer to another PI on campus.

1. Radioactivities less than or equal to those listed in Appendix R may be transferred between buildings by the authorized user.
2. Radioactivities greater than those listed in Appendix R must be transferred by Radiation Safety between buildings but, depending upon activity, the PI may do a transfer within the same building. Call CORD a day in advance to schedule transfers.

See Section III, Part D for more information.

B. Off Campus

Transfers to off-campus sites, including the VA Hospital, require prior approval by Radiation Safety regardless of the quantity. PIs or their personnel who have passed the transportation training (see C, below), may ship limited quantities of radioactive materials off campus, directly from their labs, provided Radiation Safety approval is secured prior to each shipment. See Appendix Q for more information about radionuclide shipments.

Transfers between users and shipments off campus will result in removal of the radioactivity from your inventory. Radiation Safety will complete and send you a waste disposal form for each approved transaction.

C. Transportation

Authorized users or radiation workers who transport radioactive materials on campus or off campus by motor vehicle must read Chapter 8, ***Transportation of Radioactive Material*** in the **Radiation Safety for Radiation Workers** manual and pass the exam initially and every two years thereafter.

Because radioactive material is considered *hazmat*, Department of Transportation requirements as detailed in 49 CFR apply. While Chapter 8, **Radiation Safety for Radiation Workers**, provides the most comprehensive guidance, some specific elements include:

1. Shipping papers

2. Package certification for **Type A** containers (**Limited Quantity** containers should have a **UN** marking).
3. Surveys for greater the Limited Quantity packages:
 - a. Prior to leaving, contamination and radiation levels must be measured and recorded.
 - b. Upon return, contamination and radiation levels must be measured and recorded.
 - c. If the radioactive material is a **sealed source**, then only radiation levels on the surface and at 1 meter (the TI) are required.
4. If the transportation results in a different NRC license receiving the radioactive material, the person preparing the material for transport must have a copy of the receiver's NRC/agreement state license.

XVI. POSTING AND LABELING REQUIREMENTS

Posting requirements are based on federal and state regulations. No distinction is made between ionizing radiation emitted by radioactive materials and machine produced radiation.

A. Signs

Appropriate **Caution - Radioactive Materials** signs will be provided whenever a lab is approved as a radioactive material use-type restricted area (e.g., when authorization is granted or amended). See Section VII for more information.

B. Other Posting Requirements

1. NRC Form 3 - Notice to Employees, Appendix K
2. Notice to Workers informing workers that the NRC license and related documents (Parts 19 and 20 of Title 10, Code of Federal Regulations - Appendices T and U) and operating procedures are available for examination at the Safety Department. This notice is usually attached to NRC Form 3.
3. A list of names and phone numbers of persons who can provide assistance or answer questions during an emergency (Appendix H).
4. **No smoking, No eating, No drinking** signs.
5. **Restricted Area - Authorized Personnel Only** signs.

C. Container Labeling

For each container of radioactive material, including waste, a durable and clearly visible (e.g., from across the room) label must be affixed, this label must clearly identify the radioactive material contents. The label should contain the radiation symbol, the words **Caution - Radioactive Material**, the activity and identity of the radionuclide and the date for which the activity was determined.

1. A single label can be used to label a group of vials.
2. For containers too small for a label with nuclide (e.g., microfuge tubes) may have the tube rack labeled or simply use the radiation symbol for a label.

XVII. GUIDANCE FOR SAFELY USING UNSEALED RADIOACTIVE MATERIALS**A. Precautions When Working With Unsealed Radioactive Materials**

1. Wear lab coats, disposable gloves, safety glasses (eye protection), and foot coverings (if appropriate). Before leaving the lab, remove these items and survey your hands, clothes and work area for radioactive contamination.
2. Cover work area with plastic backed absorbent material and/or work on a non-porous tray.
3. Assume all radioactive material containers are contaminated.
4. Perform a practice (e.g., "dry") run without radioactive materials to learn and become proficient with new procedures.
5. Radiation workers should be thoroughly familiar with the characteristics of the radionuclides they are using. If you are uncertain about the safety of a procedure call Radiation Safety. Pamphlets with useful technical information for radionuclides are available from the Safety Department.
6. Employ the three basic radiation safety principles (time, distance, and shielding) whenever working with penetrating radioactivity (i.e., beta with $E_{\max} > 200$ keV and gamma-ray with $E > 20$ keV). To reduce your radiation exposure:
 - a. decrease time (work rapidly but error-free)
 - b. increase distance (handle radioactivity at arm's length or use forceps / tongs)
 - c. increase shielding (use plexiglas for beta emitters or lead for gamma emitting radiation)
7. Monitor gloves, clothing and work area (including the floor around the lab bench) during and after each use of a beta ($E_{\max} > 100$ keV) or a gamma emitter.
8. When working with radioactive materials, especially during decontamination procedures, remove and secure your watch, ring, bracelet, and other items which may become contaminated.

B. Some Important Do Nots

1. Do not work with radioactive material if you have an open wound.
2. Do not pipette by mouth.
3. Do not bring personal belongings in active areas of the lab.
4. Do not eat, drink or smoke in the laboratory.

XVIII. EMERGENCY PROCEDURES

Emergency phone numbers and general procedures to be followed in all emergencies are located in parts A and B of this section. They are followed by detailed procedures, in part C, for the following problems:

Property Damage

1. Minor spills
2. Major spills
3. Accidents involving radioactive dust, fumes, or gases
4. Fire or other major emergency

Personnel Injury

5. Injuries involving radioactive contamination.
6. Known or suspected overexposure to radiation.

Information to be included in the required report of an accident or emergency is contained in part D of this section.

A. Phone Numbers

Emergencies: 911 (from a university phone)
Police & Security (P&S) will be able to contact Health Physicists during or after business hours.

Radiation Safety: 262-8769
Refer to Appendix H for additional emergency numbers.

B. General Procedures

1. Do not risk external or internal exposure to save equipment or an experiment. Modification of this direction should be only at the direction of a person qualified to estimate the hazards involved.
2. In all cases of (serious) physical injury, medical attention and hospitalization will take precedence over radiation or contamination concerns.
3. In an absolute life-or-death situation, or to avoid a more serious (i.e. potentially life-threatening) hazard, it is permissible to allow a rescuer to receive an external radiation exposure of up to 25 rem. There are very few radiation use areas on campus which would produce such high exposures (e.g., very high radiation area). Personnel in these areas receive training commensurate with their potential for exposure.
4. Immediately following a spill or dispersion of radioactive materials, take appropriate precautions to confine the material; i.e. control access to the area,

- turn off the ventilation system, prevent the spread of liquids and limit the movement of involved and possibly contaminated individuals.
5. In the event of any emergency involving radiation or radioactive materials, contact Radiation Safety, at the first opportunity.
 6. Always perform a survey of persons involved in the incident prior to them leaving the area.

C. Detailed Procedures

Property Damage

1. Minor Spills - no radiation hazard to personnel
 - a. Notify all persons in room and area at once.
 - b. Monitor all individuals involved in incident for contamination.
 - c. If contamination is found, have individuals change clothing and wash as necessary, then remonitor individual.
 - d. Limit access to the area of the spill to those persons needed for clean-up.
 - e. Confine the spill (wear protective attire).
 - (1) Liquid spill - drop absorbent paper on the spill
 - (2) Dry spill - dampen absorbent paper and cover the spill. Use water, or oil if a reaction generating air contamination would occur with water. Take care not to stir up dust/small particles.
 - (3) If you need assistance, notify Radiation Safety and ask for a Health Physicist.
 - (4) Decontaminate after making a plan.
 - (5) Permit no entrance into the area until it is approved by Radiation Safety or decontamination is achieved (i.e., GM survey < 650 cpm).
 - (6) If quantities of radioactivity in excess of those specified in Appendix R are involved, prepare a history of the spill and subsequent remedial or protective measures to be taken. Send the report to Radiation Safety. The authorized user and each individual involved must sign the report.
2. Major spills - involving radiation hazards to personnel
 - a. After conducting a survey, have all persons not involved in cleaning the spill leave area at once. Restrict movement of displaced persons as necessary to prevent possible spread of contamination.
 - b. If spill is liquid and the container is intact, return container to the upright position using gloves or a lever.
 - c. If spill is on skin, flush thoroughly, then wash with mild soap and water. Be careful you do not abrade the skin.
 - d. If spill is on clothing, remove contaminated clothing and survey skin under clothing.

- e. If volatile materials are involved, switch off all fans and shut off ventilation system.
 - f. Vacate and seal the room. Keep all personnel out.
 - g. Immediately notify Radiation Safety at 262-8769 or call P & S at 911 from a campus phone.
 - h. Take immediate steps to decontaminate affected personnel.
 - i. After the arrival of Radiation Safety, decontaminate the areas as directed.
 - j. Monitor persons involved in spill and clean-up with Radiation Safety's assistance.
 - k. Suspend work in area until the Radiation Safety Personnel complete monitoring and gives approval.
 - l. Prepare history of the spill and cleanup and forward to Radiation Safety within 72 hours. The authorized user and each individual(s) involved must sign the report.
3. Accidents Involving Radioactive Dusts, Fumes and Gases
- a. Have all persons leave area at once. Restrict movement of displaced persons as necessary to prevent possible spread of contamination.
 - b. Close off ventilation system and seal off area.
 - c. Notify Radiation Safety (262-8769) or Protection and Security (262-2957) or use the phone list in Appendix H.
 - d. Close and lock doors and/or post guards to prevent entry into area.
 - e. Monitor all persons suspected of being contaminated.
 - f. Report all known or suspected inhalations of radioactive material to Radiation Safety. With the aid of Safety:
 - (1) Evaluate hazard and necessary safety devices for reentry.
 - (2) Determine cause of contamination and rectify the condition.
 - (3) Decontaminate.
 - (4) Perform area survey. Do not allow work in area to be resumed until approval from Radiation Safety is obtained.
 - g. Prepare a history of accident and subsequent action and submit to Radiation Safety.
4. Fire or Other Major Emergency
- a. Notify all other persons in room and building at once.
 - b. Call 911 on a university telephone and report the problem.
 - c. Attempt to put out the fire if it is relatively containable and a radiation hazard is not immediately present.
 - d. Following the emergency, monitor the area and decontaminate if necessary.
 - e. Monitor all personnel involved in the emergency.
 - f. Do not resume work in the area until approved by Radiation Safety.
 - g. If a radiation hazard was involved, prepare a history of the incident and forward to Radiation Safety.

Personnel Injury

5. Injuries to Personnel Involving Radioactive Contamination
 - a. If contamination is a possibility, wash minor wounds immediately.
 - b. Contact University Hospital Emergency Service for medical attention and/or advice.
 - c. Report incident to Radiation Safety as soon as possible.
 - d. Prepare a history of the incident and forward to Radiation Safety.
6. Known or Suspected Overexposure of Personnel
 - a. Immediately eliminate cause of suspected overexposure or keep people away from area where a high radiation level exists.
 - b. Send overexposed personnel to University Hospital Emergency Service (hospital telephone operators have a Radiation Emergency Notification list).
 - c. Notify the Radiation Safety Office, the University Radiation Safety Committee Chairman or, if these people are not available, any member of the URSC (Appendix A-1).
 - d. Collect dosimeters, TLD badges, and submit to Radiation Safety for immediate reading and estimation of the dose. If not available, get sufficient information to calculate exposure.
 - e. The URSC will determine whether or not it is necessary to report the incident to the NRC.
 - f. A written report of all overexposures must be sent to Radiation Safety describing the cause of such overexposure, whether or not reporting to the NRC is required.

D. Written Histories and Reports

1. The following is a guide to preparing histories or reports as required above:
 - a. What happened (i.e., type of accident, cause, how discovered, etc.).
 - b. When (time and date).
 - c. Where (building, floor, area, etc.).
 - d. Who was involved (names and responsible staff members).
 - e. Who was exposed to radiation or physically injured (name and extent of exposure or injury).
 - f. Damage to facilities (University and non-University).
 - g. Whether radioactive contamination was a problem.
 - h. Corrective action taken.
2. Reports are to be sent to Radiation Safety. These reports will be reviewed by the University and/or Medical Center Radiation Safety Committee.

XIX. DISPOSAL OF RADIOACTIVE MATERIAL

Radioactivity is removed from a user's inventory when reported for disposal or transfer on a Waste Disposal Form. There are six methods by which a user can have radioactivity removed from their inventory: disposal to Safety (Safety Department pickup service), release to the sanitary sewer (aqueous liquids), exhaust to the atmosphere (volatilization in a hood), decay, transfer to another authorized user or to another licensee (off-campus), and administration to patients (medical users only). Releases to the sanitary sewer and/or to the atmosphere as well as all other methods of disposal must be reported to CORD at least quarterly. Lastly, PIs may not burn radioactive waste or other radioactive material in any UW incinerator.

A. Cardinal Rules for Radioactive Waste Disposal

The following requirements help maximize disposal options and minimize disposal costs. Follow these rules when collecting and preparing wastes for disposal.

1. Minimize radioactive waste volumes - keep non-radioactive wastes separate from radioactive wastes, pack waste efficiently and, whenever possible, clean/recycle reusable "wastes" (e.g. glassware).
2. Keep waste types separate - solids, lead pigs, aqueous liquids, organic solvents, LSC wastes and animals.
3. Except for ^3H and ^{14}C , which may be mixed, keep radionuclides separate whenever possible.
4. Package concentrated "hot" wastes in small containers separate from relatively dilute, voluminous "cold" wastes.
5. To the extent possible, don't mix radioactivity with other hazardous materials (hazardous wastes, infectious agents, biohazards, pyrophorics, etc.).
6. Sterilize infectious materials
7. Do not use boxes which exceed 24" length by 17" width by 14" height. Larger boxes will not fit on the shelves in our storage facility. Boxes which conform to these standards are available through stores.
8. All boxes must weigh less than 50 pounds.
9. Decay correct your radioactive waste materials when using short lived materials and report the decayed activity along with the residual radioactivity on a Waste Disposal form.
10. Clearly label all liquid scintillation media with cocktail brand name, nuclide, and activity.
11. Do not put lead pigs in solid waste containers, pack separately.
12. Radioactive waste in labs must be properly labeled and controlled to prevent accidental disposal.
13. Radioactive solid waste and radioactive animal tissue must be placed in a yellow plastic bag designated for radioactive waste.

14. When utilizing complete or total radioactive decay and disposal of your wastes to normal trash, you must deface all radioactive labels, hold the waste in storage for at least 10 half-lives, survey the package with a sensitive radiation detector (e.g., GM for ^{32}P , LEG for ^{125}I) and record the results in a waste decay logbook (counts different than background indicate that there is still radioactivity present), and report the decay to the Safety Department.

B. Disposal to the Radiation Safety Office (preferred)

The Safety Department provides five gallon carboys for aqueous and organic ^3H , ^{14}C and ^{35}S wastes. In some cases, Safety also provides bottles for small volumes of liquid waste. All other waste containers and/or boxes must be provided by the user.

Prepare and package the waste according to the waste type in **steps** 1 - 5. Follow **steps** 6 - 9 beginning on page 5 of this section for final preparation of all wastes for pickup. Wastes will not be picked up if improperly packaged. Authorized users must correct waste disposal inadequacies before additional pickups will be made.

1. **Solids**

Place solid wastes in a yellow plastic bag designated for radioactive waste, seal, and put in a labelled radioactive waste box.

- a. Use strong packaging tape to secure the bottom and top of these boxes.
- b. Package and seal sharps (syringes, blades, pasteur pipette tips, etc.) inside an impenetrable container before adding to the other solid waste.
- c. Package small volume, concentrated wastes (e.g. stocks, hot products or wastes, sealed sources, etc.) into small boxes separate from large volumes of dilute, contaminated wastes.
- d. Then follow **steps** 6 - 9 of this section.

2. **Lead Pigs**

Do not put lead pigs in solid waste boxes. Lead is accepted with other waste only when needed to shield very hot, concentrated wastes; in small boxes only. Meter lead pigs with an appropriate instrument to determine whether a. or b. applies.

- a. Safety will pick up clean surplus lead for recycling.
 - (1) Pack in small box (i.e., < 50 lbs).
 - (2) Write **Lead Pigs** on box.
 - (3) Write **Lead Pigs** on disposal form.
 - (4) Put out with other radioactive wastes.

- b. Contaminated Lead Pigs
 - (1) Place in plastic bag, then separately pack contaminated pigs in small box.
 - (2) Identify the nuclide.
 - (3) Write **Contaminated Lead** on the box.
 - (4) Then follow **steps 6 - 9** of this section.

3. Liquids

Keep aqueous and organic solvent wastes separate and collect in plastic or shatter-proof glass containers, of at least 500 ml., but not more than 4 liters; use an appropriate size for the actual waste volume. Five gallon carboys may be used for large volumes of dilute ^3H , ^{14}C or ^{35}S liquids (see activity limits in Table 8); when requested, carboys are delivered during waste pickups.

- a. Neutralize aqueous liquids: 5.5 [pH [8.5.
- b. Very concentrated wastes (e.g. stocks), not exceeding 50 ml, should not be diluted (and need not be neutralized). Tightly seal vials and package separately in a small box.
- c. Document in proper section of disposal form (i.e., organic liquid or aqueous liquid).
- d. Do not put solids in liquid waste containers.

Table 8. Activity Limits for Carboys

Carboy Shape	Waste Type	Activity Limits (mCi)		
		^3H	^{14}C	$^{35}\text{S}^1$
Round	Organic	2	2	2
Square	Aqueous	15	2	2

¹Because of disposal methods, do not mix ^{35}S with ^3H or ^{14}C

- e. Fill containers b - $\frac{3}{4}$ full; do not over-fill containers; allow room for thermal expansion.
- f. Seal containers securely by wrapping parafilm around a tightly closed twist-type cap (do not use foil, cracked caps, etc.).
- g. Complete and attach a Radioactive Liquid Waste tag to each container > 50 ml. List all constituents, including water, methanol, etc.
- h. Cushion and place no more than four containers, into each box.
- i. Then follow **steps 6 - 9** of this section.

4. **Liquid Scintillation Cocktail Wastes**

Sewer disposable LSC solutions may be poured directly to the sewer (see Disposal to the Sanitary Sewer, of this section). For pickup by Safety, sewer disposable LSC solutions may either be poured into aqueous liquid containers (see above) or kept in their vials and repackaged in cases (preferred). Organic hydrocarbon cocktails (e.g. toluene, xylene, pseudocumene, etc.) must be kept in their original counting vials for pickup by Safety. If you generate these cocktails in bulk, request an exception. When disposing of LSC wastes in vials follow these procedures:

- a. Keep organic hydrocarbon cocktails separated from sewer disposable cocktails.
- b. Keep vials separated by size and type (e.g. plastic, glass).
- c. Place vials upright in trays and package in full cases only (20 ml vials - 500/case, mini-vials - about 1700/case).
- d. On each case mark the LSC cocktail brand name and any biological or chemical hazard that might make sewer disposal inappropriate.
- e. There is a \$6/case processing fee for sewer disposable cocktails. The processing fee for organic cocktails is dependent on the storage and processing costs (currently about \$30 case).
- f. Unless specifically stated (e.g., **Purchase of radioactive material and disposal of LSC vials**), you cannot charge vial processing to your CORD internal requisition account used for **Purchase of radioactive materials**. Call CORD for information.
- g. Then follow **steps** 6 - 9 of this section.

5. **Animals**

All animals which have been injected with or administered radioactive materials must be disposed through Safety when sacrificed or expired. Double bag and box all animal tissue and contaminated bedding/waste (UW Stores stocks these supplies).

- a. Activity limits: [15 mCi ^3H and/or ^{14}C
(per package) [2 mCi any other nuclide
- b. Carcasses must be placed in a plastic bag, boxed, and frozen.
- c. Weight limit is 50 lbs/package (larger animals must be sectioned).
- d. Blood, urine and feces should be diluted and disposed via the sewer system, (see Disposal to the Sanitary Sewer, page 6 of this section).
- e. Then follow **steps** 6 - 9 of this section.

Call the Radiation Safety Department in advance to discuss any exceptions for animal disposals.

6. Complete the Radioactive Waste label for each waste box. Complete a Radioactive Liquid Waste tag for each liquid container, tie or tape the tag securely to the container. Always report activity in millicurie (**mCi**) units. Do not use "trace" or "less than X". Note other hazardous chemicals including biohazards and toxic materials and state precautions needed for safe handling.
 - a. Measure or estimate the waste activity. The higher the activity, the more precise the estimate must be.
 - b. Waste activities should be accurately recorded if possible. Sub-sample, count, correct for efficiency (cpm to dpm), and convert from specific activity ($\mu\text{Ci/ml}$ or $\mu\text{Ci/g}$) to total activity (Specific activity times (x) volume).
 - c. Correct waste activities for decay when significant (i.e. 20% or more of the original activity); report decay in the lower right corner of the disposal form (Appendix J-1). Decay graphs for various isotopes are available from Radiation Safety.
 - d. CORD will subtract the activities disposed by a lab from that lab's received inventory balance.
7. Seal all containers. All wastes, except carboys, must be packaged in sealed boxes. Liquids must be cushioned.
8. Complete the appropriate Radioactive Waste Disposal form - use the blue form (Appendix J-2) for animal tissue and the orange form (Appendix J-1) for all other wastes (Appendix I, Radioactive Waste Disposal Guidelines).
 - a. One form may be used for all wastes being disposed. List each box on a separate line.
 - b. Keep the original for your records and attach Safety's copy to a waste container.
 - c. Go to Rm 19, Biochem or call the Safety Department for additional disposal forms.
 - d. Maintain all receipt and disposal records for at least 3 years after final disposal.
9. Call the Safety Department (262-8769) or use the waste disposal request on the Safety Department web page, <http://www.wisc.edu/safety>, to schedule the waste pickup. Radioactive waste pickups are scheduled, animals on Wednesday and Friday mornings beginning at 8:30 AM and all other waste on Monday and Wednesday afternoons beginning at 12:30 PM.
 - a. Lock wastes in the designated cabinet or freezer on pick-up morning.
 - b. After placing the lab's waste inside, insure the count rate is [650 cpm on contact with cabinet or freezer.
 - c. Wastes that exceed the 650 cpm exposure limit or do not fit into the cabinet, should be kept in your lab, until Radiation Safety arrives.

- d. Inform Safety when you schedule the pickup that you need to be called because you have waste in your lab and the reason. When called, promptly take waste to pickup area.

C. Disposal to the Sanitary Sewer

As part of the authorization process, authorized users may be allowed to dispose of up to 2 mCi/year to the sewer for all radionuclides combined. This limit may be increased if necessary or deemed practical; authorized users must apply for any exceptions. In addition, radioactive liquids must satisfy the following criteria for disposal to the sanitary sewer:

Table 9. Aqueous Concentration Limits

Nuclide	Concentration Limit	
	dpm / ml	μCi / liter
³ H	22,200	10
¹⁴ C	666	0.3
³² P	200	0.09
³³ P	1,770	0.8
³⁵ S	2,220	1
⁴⁵ Ca	444	0.2
⁵¹ Cr	11,100	5
¹²⁵ I	44	0.02
Others	10 CFR 20 Appendix B, Table 3	

1. Concentrations must be at or below the limits listed in Table 9 prior to discharge to the sewer. Keep records of concentrations and activities disposed.
2. Neutral pH: 5.5 [pH [8.5
3. Materials must be aqueous and readily soluble in water.
4. Other chemical and biological waste constituents must be safe for sewer disposal (check the Disposal Guide for chemical restrictions).

Always use the lab's designated (i.e., labelled) "hot" sink and run additional water during and after release to flush the drain and pipes. Survey the sink after use. Maintain a log of disposals at the sink (e.g., Appendix P, Radioactive Material Record). Report releases to the sewer, at least monthly, in the lower right corner of the **Waste Disposal** form.

D. Exhausting Radioactive Material to the Atmosphere

Call Radiation Safety in advance if any procedure may result in a radioactivity release to the atmosphere. Releases to the atmosphere require evaluation of radionuclide air concentrations and special approval of the designated exhaust system (i.e., hood). Air monitors are installed in hoods approved for volatile iodine releases (see Section XIII, Part B). The Safety Department measures and documents releases from procedures involving volatile iodine. All other releases must be measured and/or evaluated and documented by the authorized user. Report releases to the atmosphere, excluding iodine, in the lower right corner of the **Waste Disposal** form. Atmospheric releases must be reported within the same year as the release.

E. Natural Decay

1. Decay

Users of radionuclides with short half-lives (e.g., ^{32}P) who do not dispose of these wastes via routine pickups, must periodically (at least 4-times per year) record disposal by decay. This is done by completing the lower right block (**Other Disposal Methods**) of the Radioactive Waste Disposal form.

2. Decay and Disposal to Normal Trash

The amount of radioactive material on hand continually decreases because of radioactive decay. If the waste has an isotope with a half-life less than 65 days (e.g., ^{32}P , ^{125}I), it may be convenient to wait until the natural decay process removes most of the radioactivity. As a rule, after ten (10) half-lives there will be approximately 0.1% of the original remaining. This may be low enough so that there is essentially no activity remaining; however, a 1 mCi solution of radioactive material will still have approximately 1 μCi of material remaining after 10 half-lives. It is crucial for disposal by natural decay to do the following:

- a. Hold the waste for at least 10 half-lives
- b. Survey with a sensitive survey meter (see Section IX.B.1 or Section XI.A.1) for detectable radiation and/or radioactivity before disposal via normal trash. Survey should show less than 100 cpm net when surveyed with a thin window GM or LEG survey meter in contact with the trash or less than 0.05 mR/hr (essentially background).
- c. Document the decay (i.e., date waste was generated and date of the survey - there must be at least 10 half-lives between the two dates) on the Radioactive Material Record form, the results of the survey (must be less than 100 cpm above background for β/g emitters), and the type and serial number of the meter used for the survey.

- d. Deface/remove all radiation symbols before disposal to normal trash.
- e. Report the decays to the Safety Office by completing the Radioactive Waste Disposal form at least quarterly.

F. Transfers

Although transfers are not "waste disposal," it is reported to CORD by an annotation on the **Waste Disposal** form.

Transfers to other authorized users (on-campus) or to other licensees (off-campus) will be accomplished as follows:

1. Safety will complete a waste disposal form and a copy will be sent to you.
2. Transferred materials will be removed from CORD computer inventory.

See Section XV for more information.

Call Radiation Safety for additional radioactive waste disposal information.

Disposal information for chemical / hazardous wastes is given in the Disposal Guide for UW-Madison. Copies are available from the Safety Department.

G. Administered to Patients

Although patient administration is not "waste disposal," it is reported to CORD by an annotation on the **Waste Disposal** form.

XX. HEALTH PHYSICS AUDITS**A. Audits**

Radiation Safety will audit the reactor lab monthly and all other radionuclide facilities at least once a year. Inspections are required to assure compliance with URSC policies, State and Federal regulations. In addition:

1. Facilities containing large quantities of radioactive materials may be audited more frequently.
2. Where regulatory violations are found, follow-up audits will be conducted.

B. Enforcement of University Radiation Safety Committee Regulations

1. Radiation Safety will inspect (facilities, surveys, inventories, etc.) for compliance. See Appendix O for the types of items inspected. The inspection is actually an ALARA audit of each user's radiation safety program. The audit considers specific procedures crucial to protecting the public from unnecessary radiation exposure and documenting that exposures are being maintained ALARA. Although the URSC Form 313a (Appendix O) designates only "Go / No Go" status, some items are more important than others, based upon the potential repercussions to the University.
 - a. **A** type deficiencies are the most serious from the point of view of potential damage/injury to the environment, radiation workers, and general public and, repetition of these, could result in the NRC fining the University or perhaps suspending or severely restricting some aspect of the program.
 - b. **B** type deficiencies appear to be issues which document the authorized user's safe use for NRC inspectors.
 - c. **C** type deficiencies are primarily posting / other administrative type issues.
2. Response to violations depends upon the type of deficiency and the success the Safety Department auditor has in correcting the problem. In all instances, the authorized user will be given a copy of the inspection results on the spot. Depending on the class of violation, the prescribed response is:
 - a. **C** The authorized user will be given a copy of the URSC Form 313a and the surveyor will describe the deficiency. Because these problems are minor, they can often be corrected on the spot. The surveyor and user will discuss corrective mechanisms and the surveyor will insure that the problem is corrected in a timely manner (e.g., 30 days).
 - b. **B** The authorized user will be told immediately of the deficiency and will also be given a copy of the URSC Form 313a. Radiation

Safety will discuss the problem with the user and will suggest procedures to correct the deficiency. The authorized user will then have 30 days (or a time period specified by the RSO or URSC) to correct the problem. If the deficiency is a repeat from a previous survey or is one in a series of similar infractions (over the past 3 years) indicating a possible lack of understanding of URSC regulations, the RSO will inform the Chairman, URSC, and, with the consent of the authorized user's URSC representative, may suspend the authorized user's radionuclide ordering privileges until the RSO or URSC representative deems that the problem(s) is corrected. Failure to correct, or repeated occurrences over the past 3 years as documented on the periodic ALARA inspections, may result in the deficiency being elevated to an A level.

- c. **A** The authorized user will be told immediately of the deficiency and RSO will notify both the appropriate URSC committee member and the Chairman, URSC of the findings. Radiation Safety personnel will insure that steps are taken to promptly correct any potentially hazardous situation and prevent a recurrence. The authorized user will be given the URSC Form 313a detailing the problem and copies will be sent to the URSC chairman and other appropriate URSC members. Depending upon the potential impact of the violation on the University's NRC license, the user's ordering privileges may be suspended until the deficiency is corrected. The user's ordering privileges may remain suspended pending instructions from the appropriate URSC committee member (or the entire URSC) after a review of the incident. The review may ultimately recommend that the authorized user's permission to use radioactive materials remain suspended, however, termination of the user's authorization will only occur by majority vote of the URSC.

DEFINITIONS

Accelerator - Machine capable of accelerating electrons, protons, deuterons, or other charged particles to produce particulate or other radiation at various energies.

ALARA - Acronym for the radiation protection philosophy that radiation exposures and effluents to the environment should be maintained "As Low As Reasonably Achievable". The NRC requires that ALARA be considered in the design of all experiments where radioactive material is used.

Alpha (a) Particle - Electrically charged particles emitted from a nucleus. An alpha particle is composed of two neutrons and two protons, and is identical with the nucleus of a helium atom.

Amendment - A written request to change condition(s) (e.g. nuclides, activity limits, labs, etc.) to an authorized user's radionuclide authorization.

Annual limit of Intake (ALI) - The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year.

Authorized User - An individual member of the teaching or research faculty or staff who has been approved by the University Radiation Safety Committee (URSC) to use or supervise the use of radioactive material under conditions specified in an application for authorization. All activities involving radioactive material must be conducted under the authorization of an authorized user.

Beta (b) Particle - Electrically charged particles emitted from a nucleus. Beta particles have the same mass and charge as electrons. Positively charged beta particles are called positrons and positrons emit two 0.511 MeV annihilation photons when they combine with free electrons.

Bioassay - Monitoring and biological sampling to determine the quantity or concentration of a radionuclide in an individual's body.

Bremsstrahlung (Braking Radiation) - Electromagnetic radiation in the form of x-rays produced by the sudden deceleration of electrons passing through the intense electric field near an atomic nucleus.

Carboy - A four or five gallon plastic container for liquid waste. Carboys for ^3H , ^{14}C , and ^{35}S are available through the Safety Department.

Central Ordering, Receiving, and Distribution (CORD) - The University's major source of radionuclides. CORD personnel perform all the ordering, receiving, and distribution of radionuclides on campus.

Committed Dose Equivalent (CDE) - The sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

Committed Effective Dose Equivalent (CEDE) - The sum of the products of the weighing factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues.

Contamination - The presence of radioactive material where it is not supposed to be. A surface is considered to be contaminated when levels in excess of the limit set by the URSR is measured (Table 4, Section IX, Surveys and Contamination).

Controlled Area - Any area, access to which can be limited for any reason.

Curie (Ci) - A physical unit of radioactivity equal to 3.7×10^{10} disintegrations per second (dps) or 2.22×10^{12} disintegrations per minute (dpm). The SI unit for activity is the Becquerel (Bq) where $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$.

Decay - The spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide. The process results in a decrease, with time, of the original radioactive atoms in a sample.

Derived Air Concentration (DAC) - The concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one Annual Limit of Intake.

Dosimetry - A measure of the external and/or internal radiation dose equivalent to individuals, stated in rem or mrem ($1 \text{ mrem} = 0.001 \text{ rem}$).

Exception - A modification of a specific University Radiation Safety Committee regulation. Exception requests which violate NRC regulations or conditions of the University's NRC license or URSC policy cannot be approved.

Effective Dose Equivalent - The sum of the products of the dose equivalent to the organ or tissue and the weighing factors applicable to each of the body organs or tissues that are irradiated.

Exempt Quantity - Radioactive product or byproduct material with activity less than or equal to the quantity listed in 10 CFR Part 20.1001 - 20.2401, Appendix C. Exempt quantities are exempt from specific requirements of the NRC (see Sections III part D, V part A, and VIII in the URSC Regulations).

Exposure History - A summary report of radiation exposure of a radiation worker for the term of employment, in terms of the dose equivalent received.

Food and Drug Administration (FDA) - Federal agency established to enforce the Food, Drug, and Cosmetic Act (FD&C Act) and to ensure industry's compliance with Federal laws regulating products in commerce (see also, Radioactive Drug Research Committee).

Gamma (g) Ray - Electromagnetic radiation of short wavelength emitted from the nucleus of an atom. Gamma rays are indistinguishable from X-rays of equal energies.

Geiger-Mueller (GM) counter - A portable, gas-filled radiation detection instrument especially adapted for surveying or inspecting an area to establish the existence and estimate the amount of radioactive material present.

Half-Life ($T_{1/2}$) - Most commonly used is physical half-life, which refers to the time period that a radioactive substance decays to 50% of its initial activity. The formula to find the activity remaining (A) of a radionuclide with a half-life (T) at any time (t) when the initial activity (A_0) is known is: $A = A_0 e^{-(\ln 2 * t/T)}$.

High Radiation Area - An area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 100 rad (1 gray) in 1 hour at 1 meter from a radiation source or from any surface that radiation penetrates.

Inventory - An authorized user's detailed records of receipt, use, and disposal of his radionuclides. Inventories must be kept for a minimum of 3 years.

Ionizing Radiation - Radiation capable of displacing electrons from atoms or molecules, thereby producing ions.

Isotope - Nuclides with the same atomic number (i.e. same number of protons) but with different atomic weights (i.e. different number of neutrons). Tritium (^3H) is an isotope of hydrogen.

Limited Quantity - A quantity of radionuclide in activity less than or equal to those listed in 49 CFR Part 173.423 that is exempt from all Department of Transportation (DOT) specification packaging, marking, and labeling requirements.

Liquid Scintillation Counter (LSC) - A radiation measuring instrument designed to quantify the amount of radioactivity in samples or wipes.

Medical Center Radiation Safety Committee (MCRSC) - A subcommittee of the URSC appointed every two years by the Vice Chancellor of the Center for Health Sciences. The MCRSC evaluates procedures for "human use" (internal or external administration to humans) of ionizing radiation.

Neutron - An uncharged elementary particle found in the nucleus of every atom heavier than Hydrogen (H-1).

Nuclear Regulatory Commission (NRC) - Federal agency established by the Atomic Energy Act of 1954 and the Energy Reorganization Act of 1974 to regulate the use of radioactive material through its Licensing, Inspection and Enforcement, and Standards Development activities.

Plated Source - Radioactive material deposited on a surface or matrix such that there is no window or other covering between the radioactive material and the open air. Plated sources may contaminate work surfaces if allowed to contact them.

Quality Factor (QF) - A factor by which adsorbed doses (i.e., energy) are multiplied to obtain the dose equivalent, a quantity that expresses the biological effectiveness of the adsorbed dose on a common scale for all ionizing radiations.

rad - The rad is a measure of the absorbed dose from any ionizing radiation in matter in terms of the energy absorbed per unit mass of the matter. One rad is the dose corresponding to the absorption of 100 ergs per gram of matter and also equals 0.01 Gy (Gray) or 0.01 J/kg. The SI unit for adsorbed dose is the Gray (Gy). One Gray is equal to an adsorbed dose of 100 rad (1 J/kg).

Radiation Area - Any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem in one hour at 30 cm from the source or surface that the radiation penetrates.

Radiation Hazard - Any condition under which persons might receive a radiation dose in excess of the maximum permissible dose equivalent.

Radioactive - Any unstable isotope which spontaneously emits ionizing radiation.

Radioactive Drug Research Committee (RDRC) - A joint VA-UW committee. Members are appointed by the administrator of the VA or the Vice Chancellor for Life Sciences, respectively. The RDRC reviews research proposals that involve administration of radioactive drugs to humans as specified by the Food and Drug Administration (FDA).

rem - A unit for measuring the dose equivalent to body tissue from any ionizing radiation in terms of its estimated biological effect relative to a dose of one rad of x-rays. Dose equivalent (rem) = Dose (rad) x Quality Factor. The SI unit for dose equivalence is the sievert (Sv), where 1 rem = 0.01 Sv (or 1 Sv = 100 rem).

Renewal - An application for radionuclide authorization submitted every 3 years to continue an authorized user's license. This must be done in advance of the expiration date of a current license. (See Section II, part B of the URSC Regulation).

Research Animal Resources Center (RARC) - A committee that regulates aspects of animal care, monitors animal use, and approves research and experiments done on vertebrate animals.

Restricted Area - An area where access is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

Roentgen (R) - A unit of exposure to x- or gamma radiation. One roentgen is equivalent to the production of one electrostatic unit of charge of either sign from interactions in 0.001293 gram of air (1 ml of air under standard conditions). $1 \text{ R} = 2.58 \times 10^{-4} \text{ Coulomb per kilogram (C/kg)}$ of air.

Sealed Source - Radioactive material permanently enclosed in a specially constructed capsule designed to prevent leakage or escape of the radioactive material; there is no contact between the radioactive material and the open air.

Solvent - Any substance that dissolves other substances.

Survey - An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

Timely Renewal - The period between the expiration date of a current authorization and the approval date of an authorization renewal. During this time the authorized user may continue to use radioactive materials (under conditions in the most current authorization). The renewal application must be submitted by the expiration date of the current authorization.

ThermoLuminescent Dosimetry (TLD) - A method of determining radiation dose by using radiation sensitive "crystals" which, when heated, emit a quantity of light that is a function of the amount of radiation the crystals were exposed to.

Total Effective Dose Equivalent (TEDE) - The sum of the deep dose equivalent from external sources and the committed effective dose equivalent from internal sources.

University Radiation Safety Committee (URSC) - A committee consisting of faculty and staff appointed annually by the Chancellor. Its duties are to advise the university administration; set policy to insure compliance with local, state, and federal regulations; prescribe enforcement action in radiation safety; evaluate authorizations and requests for exceptions from radiation safety regulations.

Unrestricted Area - An area where access is neither limited nor controlled by the licensee.

Unsealed Source - Radioactive material in a form other than plated or sealed such that the material is directly accessible to the user. Unsealed sources are capable of contaminating their surroundings.

Very High Radiation Area - An area, accessible to individuals, in which radiation levels could result in an individual receiving an adsorbed dose in excess of 500 rad (5 grays) in 1 hour at 1 meter from a radiation source or from any surface that radiation penetrates.

Violation - A breach of any NRC or URSC regulation or of any condition or limitation of an authorization granted by the URSC.

Volatile - A substance capable of evaporating in air as a dust, fume, mist, vapor or gas.

X-Ray - A form of electromagnetic radiation identical to a gamma ray except that an x-ray originates outside the nucleus of an atom.