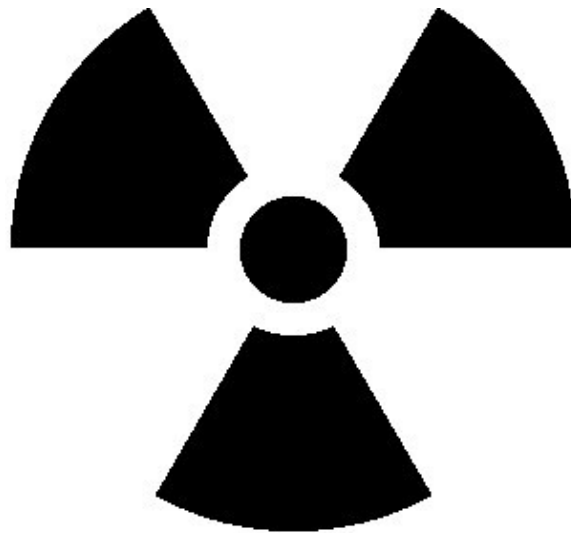


AUBURN UNIVERSITY

RADIATION SAFETY



MANUAL

2022 Edition

Rev. 1/2022

Auburn University
Risk Management and Safety
1161 W. Samford Avenue
RMS Building 9
Auburn, AL 36849
(334) 844-4870

TABLE OF CONTENTS

| | | |
|------------|--|----|
| Section 1. | GENERAL INFORMATION | 3 |
| Section 2. | AUTHORIZATION TO POSSESS AND USE RADIOACTIVE MATERIAL | 7 |
| Section 3. | PROCUREMENT AND TRANSFER OF RADIOACTIVE MATERIALS | 13 |
| Section 4. | POLICIES AND PROCEDURES FOR RADIONUCLIDE USE IN THE LABORATORY | 16 |
| Section 5. | RADIATION-PRODUCING MACHINES | 23 |
| Section 6. | RADIATION DOSE LIMITS AND PERSONNEL MONITORING | 28 |
| Section 7. | EMERGENCY PROCEDURES | 35 |
| Appendix A | CLASSIFICATION OF RADIONUCLIDES ACCORDING TO RELATIVE HAZARD POTENTIAL | 39 |
| Appendix B | WORKPLACE STANDARDS FOR OPERATIONS WITH UNSEALED RADIOACTIVE MATERIAL | 40 |
| Appendix C | CONTAMINATION LEVELS AND REQUIRED ACTIONS | 41 |

Section 1. GENERAL INFORMATION

INTRODUCTION

This manual describes Auburn University's commitment to providing a safe and healthful environment for our faculty, staff, students, and visitors regarding the use of radioactive materials and radiation-producing machines.

It is the policy of Auburn University to comply with all applicable federal and state regulations and all conditions of licenses and registrations issued by the state.

Auburn University is also committed to keeping radiation doses to all individuals as low as is reasonably achievable consistent with our mission to serve the citizens of Alabama through our instructional, research, and outreach programs.

RADIATION SAFETY COMMITTEE

The Radiation Safety Committee (RSC) establishes radiological safety policies for Auburn University and oversees the use of radioactive materials and radiation-producing machines controlled by Auburn University.

MEMBERSHIP

RSC members are appointed by the Auburn University President. Members include:

- The Radiation Safety Officer (RSO).
- A representative of the Physics Department.
- A representative of the Facilities Management.
- The Executive Director or Associate Director of Risk Management and Safety.
- Five or more "at-large" faculty or research staff members appointed on the basis of their knowledge and experience in the safe use of radioactive materials or radiation-producing machines.

The Chair of the RSC is appointed from the at-large members who have served at least one year on the Committee.

The RSO serves as Secretary of the RSC.

AUTHORITY AND RESPONSIBILITIES

Authority over issues pertaining to radiological safety has been delegated to the RSC by the President. The RSC has authority and responsibility to:

- Establish radiological safety policies and procedures.
- Ensure radioactive materials and radiation-producing machines are used in accordance with applicable federal and state regulations and Auburn University policies and procedures.
- Review applications for the possession and use of radioactive materials and radiation-producing machines. The RSC may approve, approve with specific conditions, or disapprove each application.
- Amend or rescind previous approvals for the possession and use of radioactive materials and radiation-producing machines.
- Immediately suspend any operation which represents a serious radiological hazard or violation of applicable regulations and policies. Each member of the RSC has the individual authority to order such suspension. Following a suspension by an individual member, the full committee must confirm or rescind the suspension.
- Advise the President on matters concerning radiological safety.
- Interact and coordinate policies and actions with other University committees, as necessary.
- Meet to conduct business as described below.

MEETINGS

The RSC has regular meetings once each calendar quarter. The RSC Chair or Secretary may also call special meetings when necessary to carry out urgent business. A simple majority of members shall constitute a quorum for regular or special meetings. A motion is considered approved when a majority of members present at a meeting vote in favor of the motion.

The RSC Chair may cancel up to one regular quarterly meeting each calendar year if no pressing Committee business is pending.

The RSC may also vote on matters requiring prompt attention between meetings. For a motion to pass, the Secretary must solicit votes from all available members and obtain "yes" votes from a majority of members.

RADIATION SAFETY OFFICER

The Radiation Safety Officer (RSO) is appointed by the Executive Director of Risk Management and Safety. In addition to being Secretary of the RSC, the RSO implements and manages the Radiation Safety program.

AUTHORITY AND RESPONSIBILITIES

In addition to the authority and responsibilities as a member of the RSC, the RSO has authority and responsibility to:

- Officially represent Auburn University in all matters pertaining to the possession and use of radioactive materials and radiation-producing machines.
- Implement the policies and procedures established by the RSC and make periodic reports to the RSC.
- Review applications for the possession and use of radioactive materials and radiation-producing machines and make approval recommendations to the RSC.
- Direct and supervise the activities of Risk Management and Safety staff engaged in radiological safety activities.
- Provide radiological safety advice, assistance, and training to members of the Auburn University community.
- Respond to radiological emergencies and investigate radiological incidents.
- Review radiation dose monitoring results.
- Maintain records required by federal and state regulations and university policy.

RISK MANAGEMENT AND SAFETY STAFF

The RSO or other staff members in Risk Management and Safety working under the direction of the RSO perform the following services and activities.

- Receive, process, and deliver incoming radioactive material shipments.
- Prepare outgoing shipments of radioactive materials to ensure compliance with applicable regulations.
- Conduct surveys and reviews of facilities where radioactive materials or radiation-producing machines are used.
- Collect and analyze environmental samples as needed.
- Pick up and process radioactive waste from laboratories.
- Test sealed sources for leakage.
- Calibrate radiation survey instruments.
- Evaluate facilities and equipment.
- Issue and collect dosimetry.
- Perform bioassay measurements as needed.
- Provide advice and aid in decontamination following spills.

- Provide advice and aid in complying with university policies and procedures.

PHYSICAL PROTECTION OF CATEGORY 1 & 2 QUANTITIES OF RADIOACTIVE MATERIAL

In the aftermath of the September 11, 2001, terror attacks, the Nuclear Regulatory Commission (NRC), national security personnel, and Agreement States decided that Increased Control (IC) measures be undertaken to secure certain radioactive sources that could be potentially used for malicious purposes. Toward this end, the following orders were issued:

On 14 November 2005, the NRC issued Order No. EA-05-090, **Order Imposing Increased Controls (Effective Immediately)**, which ordered increased security measures for certain radioactive sources of special concern. This guidance was ambiguous at best and included a Question-and-Answer document. This was followed by two additional Supplemental Question and Answer documents, one in February 2007 and the other in October 2008.

On 4 April 2008, ADPH issued Order No. RC-08-1, **Order Imposing Fingerprinting and Criminal History Records Check Requirements for Unescorted Access to Certain Radioactive Materials (Effective Immediately)**, which clarified the process to institute the IC measures and procedures for Alabama licensees.

New rules were implemented on March 19, 2016, to provide the requirements for the physical protection program for any licensee that possess an aggregated category 1 or 2 quantity of radioactive material. These requirements provide reasonable assurance of the security of category 1 or 2 quantities of radioactive materials by protecting them from theft or diversion. Rule 420-3-26-.15, Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material replaces previous security orders referenced by condition on Auburn University's Radioactive Materials License.

Due to the sensitive nature of the information, Physical Protection information has been marked: "Withhold from Public Disclosure." Physical Protection documentation is available in the Radiation Safety Officer's files.

Section 2. AUTHORIZATION TO POSSESS AND USE RADIOACTIVE MATERIAL

INTRODUCTION

Licenses to possess and use radioactive materials have been issued to Auburn University by the Alabama Department of Public Health-Office of Radiation Control (ADPH-ORC). One is a "broad scope" license which allows for the flexibility required at a dynamic and diverse institution such as Auburn University. As such, it requires the university to maintain a well-managed and documented radiation safety program to ensure that radioactive materials are used safely. Under the terms of the license, the Radiation Safety Committee is delegated the responsibility for authorizing qualified individuals to use radioactive materials. The other licenses issued by ADPH cover certain specific materials and uses.

AUBURN PERMIT

APPLICATION

Faculty members who wish to acquire and use radioactive materials must submit an [*Application for Possession and Use of Radioactive Materials*](#) form to the Radiation Safety Committee (RSC) via the Radiation Safety Officer (RSO). A [*Principal Investigator's Statement of Training and Experience*](#) must accompany the application form for a new Principal Investigator (PI). In rare cases, the RSC may approve a qualified non-faculty employee as a PI.

Each application must be completed in sufficient detail for evaluation by the RSO and RSC:

- Applications must include the name and contact information for the Principal Investigator, the radionuclide(s), the chemical or physical forms, the maximum possession limits and the locations of use and storage.
- Use protocols must accompany each application, including a description of radiological safety precautions to be taken. Significant non-radiological hazards must also be identified.
- The RSC may require additional information such as facility design, type of radiation detection equipment available, emergency procedures, waste disposal methods, and relevant training and experience of personnel.

INTERIM REVIEW AND APPROVAL BY RSO

The RSO will review each application submitted. As part of this review, the RSO may inspect the proposed use locations and equipment, interview the PI and other individuals listed on the application, request additional written information from the PI, confer with RSC members or other individuals knowledgeable in the protocols to be followed or the hazards involved, or take any other action necessary to evaluate the proposed use.

After reviewing the application, the RSO will submit it to the RSC for review and action. Along with the application, the RSO will submit recommended approval conditions or a recommendation that the application should not be approved.

For most proposed uses, the RSO can approve an application on an interim basis until the next regular RSC meeting. This interim approval may include specific approval conditions which must be followed. Once interim approval has been granted, the PI will be notified that an interim permit has been issued. The PI may then obtain and use radioactive material in accordance with that interim permit. Note, however, that interim approval by the RSO does not guarantee final approval by RSC or that final specific approval conditions will be identical to the interim conditions.

The following applications are considered significant enough to require RSC approval before work can commence. Interim approval by the RSO cannot be granted.

- Applications for acquisition of Hazard Class I nuclides in unsealed quantities greater than 10 microcuries or Hazard Class II nuclides other than ^{125}I or ^{131}I in unsealed quantities greater than 1 millicurie. (See Appendix A for classifications.) The RSO may grant interim approval for up to 10 mCi of ^{125}I or ^{131}I for PI's who have substantial experience using radioiodine.
- Applications for experiments or projects which involve substantial airborne hazards from gases, fine powders, or aerosols.
- Applications which the RSO feels should be brought to the attention of the RSC before approval.

APPROVAL BY RSC

After an application is reviewed by the RSO, the RSO forwards the application with recommendations to the RSC. The RSC will generally consider the application at the next regular RSC meeting. However, in rare cases, if urgent consideration by the RSC is required, a special meeting may be called, or a vote taken between meetings as described in Section 1. The RSC may approve, approve with special conditions, or disapprove the application.

If the RSC requires additional information before voting, such information will be requested from the PI and final action on the application will be postponed. If interim approval by the RSO has been granted, that approval will remain in force until final action is taken by the RSC unless the RSC rescinds the interim approval.

Once final action is taken by the RSC, the PI will be informed. If approval is granted, a permit will be issued to the PI which will be valid for five years from the date of RSC approval.

AMENDMENT

A PI may request changes to a permit by submitting a written request to the RSC via the RSO. The request must contain sufficient information for evaluation by the RSO and RSC. With the exception of adding additional radiation workers (see below), the approval process for amendments is the same as for initial applications.

RENEWAL

A permit expires five years from the date of approval by the RSC. In order to continue using radioactive materials without interruption, the renewal process must be started in [BioRAFT](#) in advance of the expiration date to allow for RSC review and approval.

TERMINATION

A permit may be terminated at the request of the PI, by revocation by the RSC, or at expiration if a renewal application is not submitted. When a permit is terminated, the RSO will take possession of any radioactive materials still in possession of the PI. See Decommissioning in Section 3.

NON-COMPLIANCE

The following items of non-compliance will be investigated by the RSO and will be reported to the RSC. In some instances, the Alabama Department of Public Health-Office of Radiation Control must also be notified.

- Willful violation of university policies or state regulations regarding the use of radioactive materials.
- Loss of or inability to account for radioactive material.
- Repeated instances of mid or high-level removable contamination (see Appendix C).
- Improper use of radioactive materials which results in a significant danger to personnel or the environment.
- Use of radioactive materials not authorized by the PI's permit.

The RSC will take appropriate action based on the significance of the incident. In severe cases, the RSC can suspend or revoke a PI's permit or ban an individual from working with radioactive materials at Auburn University.

EXCEPTIONS TO THE REQUIREMENTS OF THIS MANUAL

EXEMPT AND GENERALLY LICENSED DEVICES

An Auburn University permit is not required for the following categories of radioactive materials and the requirements of this manual do not apply. However, all such materials must be used in a safe and prudent manner. This exception does not limit the RSC's authority over the use of these materials. The RSC may impose any restrictions or conditions deemed appropriate.

- Commercially produced standards or sealed sources containing up to the activity listed in Schedule B of Rule 420-3-26-.02 of the Alabama Radiation Control Rules (ARCR). For example, most liquid scintillation counter standards are exempt but fall under a general license issued by the Alabama Department of Public Health-Office of Radiation Control. All conditions of the general license must be followed, and the Radiation Safety Officer must be informed of the acquisition, relocation, or transfer of any such devices.
- Commercially produced items containing radioactive materials which are exempt from Alabama Department of Public Health-Office of Radiation Control licensing requirements. For example, lantern mantles and welding rods containing thorium, watches containing tritium, and smoke detectors containing ^{241}Am are exempt from permitting.

Auburn University permit is required for certain generally licensed devices such as gas chromatographs. This permit process involves an *Application for Possession and Use of Radioactive Materials* form to the Radiation Safety Committee and evidence of training must accompany the application form for a new PI. This approval process allows for the Radiation Safety Office to maintain contact information, a list of users requiring training, leak testing if necessary and decommissioning of the instrument. The Radiation Safety Officer must be informed of the acquisition, relocation, or transfer of these devices.

If you are unsure if your device or sealed source requires permitting, contact the Radiation Safety Office for more information.

A PI may request an exemption from licensing or other requirements in this manual. The RSC will grant such a request only if it will maintain compliance with the Alabama Radiation Control Regulations and conditions of Auburn University's license, it will not result in a significantly higher radiation dose to any individual, and it will significantly enhance the ability of Auburn University to fulfill its mission.

EMAIL POLICY

A Principal Investigator must include a valid email address when submitting an application to use radioactive materials. It is the responsibility of the PI to inform the Radiation Safety Officer of any change of email address.

Except as noted below, communications via email from the RSO, Assistant RSO, or any member of the Radiation Safety Committee to a PI or vice versa carry the same authority and significance as written communications. Under certain circumstances, such as unreliable access to email at a remote location or the strong desire of a PI not to correspond by email, the RSO will strive to communicate with the PI by additional means.

An initial application for the use of radioactive materials requires an official signature of the PI. Applications may be signed and submitted electronically.

DUTIES OF THE PRINCIPAL INVESTIGATOR

The Principal Investigator is responsible for ensuring that all radioactive materials are used in accordance with applicable regulations, university policies, and conditions of the PI's permit. Specifically, the PI must ensure that:

- Appropriate safety precautions are taken to keep radiation doses to individuals as low as is reasonably achievable (See Section 4).
- Radioactive materials are used only as authorized by the PI's permit.
- Radioactive materials are used only by properly trained individuals qualified as radiation workers on the PI's permit (See below).
- Radioactive materials are securely stored, and updated inventories are kept (See Section 4).
- Contamination surveys are performed and documented as required (See Section 4).
- Radioactive materials are transferred only to authorized individuals (See Section 3).
- Dosimeters are properly worn by radiation workers and required bioassays are performed (See Section 6).
- Radioactive waste is properly collected (See Section 4).

RADIATION WORKERS

Radiation workers are individuals who use radioactive materials under the direction of a Principal Investigator. In order to be designated as a radiation worker, the PI must request that the worker be added to the PI's permit and the worker must receive orientation and training as described below.

ORIENTATION AND TRAINING

Each new radiation worker will attend initial Radiation Safety Training with the Radiation Safety Officer (RSO) or Assistant RSO. This is usually a one-on-one or small group meeting and the topics covered depend on the experience and knowledge of the new worker and the type of work to be performed. A passing score is required on the take home quiz for completion of the training. The RSO may waive the initial Radiation Safety Training requirement for students taking an academic course where appropriate topics are presented.

Hands-on radiation safety training for each radiation worker is also provided in the laboratory by the Principal Investigator (PI) or an experienced radiation worker designated by the PI. Topics covered during this training include, as appropriate:

- Safe use of laboratory equipment and materials, including protective clothing.
- Experiment procedures and protocols.
- Safe handling, storage, and disposal of radioactive materials.
- Methods to control and measure radiation levels and contamination.
- Proper maintenance of required records.
- Emergency procedures.

Hands-on Radiation Safety training will be documented on the [Certificate of Training for Use of Radioactive Materials](#) and returned to the Radiation Safety Office. It is suggested that individual keep a copy of certificate.

Annual Refresher Radiation Safety Training is required and available on BioRAFT for users of unsealed radioactive materials. Radiation workers working with only sealed sources must take the sealed source radiation safety training offered on BioRAFT; retraining is required every three years.

Other training requirements are addressed in corresponding sections.

RESPONSIBILITIES

Each radiation worker is responsible for using radioactive materials only as directed by the PI and in accordance with the PI's permit, applicable regulations, and university policies.

Section 3. PROCUREMENT AND TRANSFER OF RADIOACTIVE MATERIALS

GENERAL

Radioactive materials may be brought onto university property only with the prior approval of the Radiation Safety Officer (RSO).

All radioactive materials must be covered by a valid permit as described in Section 2. The procedure for obtaining radioactive materials is outlined below.

ORDERING

Approval must be obtained from the RSO prior to ordering any radioactive materials. For some users, the RSO may issue a standing approval for routine purchases up to a certain limit.

Notify the RSO indicating the vendor, the material (nuclide, activity, and form), the PI's name, the user's name, and the lab where the RSO should deliver the material.

NON-PURCHASED MATERIAL

The same requirements apply to non-purchased radioactive materials (e.g., material from researchers at other universities, free samples from vendors) as apply to purchased materials. It is especially important to make sure the sender addresses the package properly (see below).

RECEIPT

Except as noted below, all radioactive materials coming to Auburn University should be addressed to:

Radiation Safety Office
Attn: *user's name*
1161 W. Samford Avenue, RMS Building 9
Auburn, AL 36849

SPECIAL HANDLING

With prior approval, large, heavily shielded orders or materials requiring special handling may be delivered directly to the end user. However, such orders may only be opened under the supervision of Radiation Safety personnel.

VETERINARY MEDICINE

Radioactive materials used in the diagnosis and treatment of animals at the College of Veterinary Medicine complex may be shipped directly to the Nuclear Medicine Laboratory and opened by an authorized technician or veterinarian. Package opening and inventory procedures specific to the Nuclear Medicine Laboratory must be followed.

OTHER FACILITIES

With prior approval of the RSO, a facility outside of the main campus and College of Veterinary Medicine complex may have radioactive materials shipped directly to that facility. Packages received at that facility may be opened only by Radiation Safety personnel or by an individual at the facility specifically trained and authorized by the RSO.

INVENTORY

Radiation Safety will assign inventory tracking numbers to incoming shipments of radioactive materials. For unsealed radioactive materials, an inventory use log will be prepared and delivered to the user. This log must be updated as the material is used or placed in waste.

TRANSFER TO ANOTHER AUBURN PRINCIPAL INVESTIGATOR

With prior approval from the RSO, radioactive materials may be transferred from one PI to another PI at Auburn University. The RSO will make appropriate changes to each PI's inventory records.

TRANSFER AND SHIPPING OFF CAMPUS

Radioactive materials may be shipped from the university or otherwise taken off campus only by Radiation Safety (except for certain field instruments as described below).

FIELD INSTRUMENTS

Certain portable instruments containing radioactive sealed sources may be authorized by the Radiation Safety Committee for use at locations not owned or controlled by the university. Users of such instruments must follow specific procedures for transportation, storage, and use of the instruments.

SEALED SOURCES AND LEAK TESTS

A sealed source contains a quantity of radioactive material that is encased in a capsule, sealed between layer(s) of non-radioactive material, designed to prevent leakage of the radioactive material. The amount of activity can vary depending upon the purpose of the sealed source. Button or rod sources contain small amounts of radioactivity and are used for calibration and operational checks of radiation measuring/detection equipment or can be found in industrial gauges. Sealed sources are routinely tested by Radiation Safety for leakage of radioactive material. Leak tests are performed on sealed sources with greater than 100 microcuries of beta and/or gamma emitting material and greater than 10 microcuries of alpha emitting material (excluding gases, H-3, and radionuclides with half-lives less than 30 days), these leak tests are typically required every six months. If the test reveals any leakage greater than 0.005 microcuries, the source will be withdrawn from service and reported to ADPH-ORC.

Sealed sources will be inventoried every six months concurrent with the performance of the leak tests. Sealed sources not requiring leak tests will be included in the inventory.

NOTE: Certain equipment such as liquid scintillation counters and gas chromatographs contain radioactive sealed sources. Contact the Radiation Safety Office if purchasing this equipment or if it is to be decommissioned or transferred.

DECOMMISSIONING

Decommissioning or “closing out” a laboratory where sealed and unsealed radioactive materials are used and/or stored may result from a move away from Auburn University, the termination or inactivation of an internal radioactive materials license, or discontinuing the use of radioactive materials in one of the authorized laboratories. Proper steps must be taken for removal of all sealed and unsealed radioactive materials including generally licensed equipment such as liquid scintillation counters and gas chromatographs containing ^{63}Ni . The Principal Investigator (PI) should ensure that no radioactive material remain in the laboratories to be closed out. This can be achieved by radioactive material being disposed of as radioactive waste, or by authorized transfer to another authorized user. A checklist is available for use in Health Physics Procedure 10, Radioactive Materials Decommissioning and License Terminations.

Section 4. POLICIES AND PROCEDURES FOR RADIONUCLIDE USE IN THE LABORATORY

POSTING AND MARKING OF AREAS AND EQUIPMENT

ENTRANCE

Each laboratory or area where radioactive materials are used or stored must be posted at the entrance with a *CAUTION RADIOACTIVE MATERIAL* sign. (This can be incorporated in a laboratory's hazard communication sign.) The sign must include the name and after-hours phone number of the Principal Investigator or other knowledgeable individual designated by the PI. Entrance caution signs are to be removed only by the Radiation Safety Officer after a laboratory is decommissioned.

WORK AREAS

Areas in the lab used for work with unsealed radioactive materials must be clearly marked with *CAUTION RADIOACTIVE MATERIAL* tape or signs whenever radioactive materials are present.

STORAGE

Refrigerators, freezers, and other areas and containers in which radioactive materials are stored must have a visible *CAUTION RADIOACTIVE MATERIAL* label. Labels should be removed from containers that are empty and not contaminated.

EQUIPMENT

Laboratory equipment (flasks, beakers, centrifuges, etc.) containing or contaminated with radioactive materials should be marked with *CAUTION RADIOACTIVE MATERIAL* tape or labels.

CONTAMINATED AREAS

Radiation Safety may mark areas and equipment to indicate significant levels of contamination found during surveys. These markings are to be removed only after the article or area has been decontaminated.

RADIATION AREA

Areas where radiation levels could result in an individual receiving a dose equivalent in excess of 5 millirem in any one hour must be posted with a *CAUTION RADIATION AREA* sign.

OTHER

The Radiation Safety Officer may require additional postings to control access or ensure safe operations.

LABORATORY SAFETY PRACTICES

PERSONAL PROTECTIVE EQUIPMENT

A lab coat or apron, disposable gloves, and appropriate eye protection should always be worn whenever unsealed sources of radioactive material are handled.

EATING, DRINKING, SMOKING

Do not eat, drink, smoke, store food, or apply cosmetics in any laboratory where radioactive materials are used or stored.

PIPETTING

Pipetting by mouth is NOT permitted.

HAND WASHING

After handling radioactive materials, be sure to wash hands thoroughly before handling food, tobacco, etc.

SHIELDING

Appropriate shielding material should be used when working with radioactive materials that present a significant external radiation exposure hazard.

When not in use, radioactive sources and stock solutions should be stored or shielded in a manner such that radiation levels in occupied areas will be as low as is reasonably achievable.

CONTAMINATION CONTROL

To limit the spread of contamination when working with unsealed radioactive materials, work surfaces should be covered with absorbent paper. Any container holding radioactive liquids should be kept in a secondary container such as a tray or bucket.

AEROSOLS, DUSTS, AND VOLATILE MATERIAL

Procedures involving aerosols, dusts, or volatile materials must be conducted in fume hoods or suitable closed systems approved by the Radiation Safety Officer.

SPECIFIC PERMIT CONDITIONS

As part of the radioactive material use approval process described in Section 2, the Radiation Safety Committee may specify additional safety practices which must be followed.

GUIDELINES FOR LABORATORY SURVEYS

FREQUENCY OF SURVEYS

Users of radioactive materials should survey their work areas (hoods, benchtops, sinks, floors, refrigerator, etc.) and themselves after each experiment and at any time there is a reason to suspect a spill or contamination incident. These surveys do not have to be documented.

Documented surveys must be performed monthly for any laboratory in which unsealed radioactive materials are used or stored. The results of these surveys must be submitted to the Radiation Safety Officer (RSO). The Radiation Safety Committee or the RSO may require more frequent documented surveys for some laboratories.

Radiation Safety conducts documented audits of laboratories in which unsealed radioactive materials are used or stored at least twice each year. This audit includes a contamination survey.

CONTAMINATION LEVELS AND REQUIRED ACTIONS

Contamination levels requiring action are shown in Appendix C. Note that any contamination (greater than twice background) discovered in accessible areas or on items outside of a clearly marked radioactive use benchtop or fume hood must be decontaminated promptly even if below the "Low" level in Appendix C.

SURVEY INSTRUMENTS

Principal Investigators must provide radiation survey meters or appropriate counting instruments for use in laboratories where radioactive materials are used. Radiation Safety will calibrate portable survey meters at least annually and will replace weak or defective batteries and attempt minor repairs as needed.

It is the Principal Investigator's responsibility to make sure survey meters are available for calibration and to obtain any other servicing or repairs necessary to keep them operational.

Recommended survey instruments are shown in the table below.

| RECOMMENDED INSTRUMENTS | |
|--|---|
| RADIATION | INSTRUMENT |
| Low Energy Beta (H-3) | Liquid scintillation counter for wipe surveys |
| Intermediate Energy Beta (S-35, C-14, P-33) | G-M survey meter with a thin window (~2mg/cm ²) Liquid scintillation counter for wipe surveys |
| High Energy Beta (P-32, Sr-90) | G-M survey meter with a thin window detector |
| Low Energy Gamma (I-125) | Survey meter with a thin NaI crystal scintillation detector. Liquid scintillation counter or gamma counter for wipe surveys. |
| High Energy Gamma (Cr-51, Co-60) | G-M survey meter |

CONTROL OF RADIOACTIVE MATERIAL

Principal Investigators and radiation workers must ensure that radioactive materials are used only as described on the applicable permit. Materials must not be loaned or transferred to persons not named on the permit without the prior approval of the RSO. (See Section 3)

INVENTORY

As described in Section 3, all incoming radioactive materials are assigned inventory tracking numbers. For unsealed materials, use logs are prepared. PI's must ensure that these logs are kept updated.

On an annual basis, the Radiation Safety Office will reconcile the amount of unsealed radioactive material on campus. The PI's current inventory will be sent to the PI to review the inventory and make any corrections prior to sending the inventory back to the Radiation Safety Office.

SECURITY OF RADIOACTIVE MATERIALS

Radioactive material in its original delivery vial or in any other single container with an activity requiring labeling according to the Alabama Radiation Control Rules, 420-3-26-.03 Appendix C (*Quantities of Licensed Material Requiring Labeling*) must be kept under direct supervision, in locked storage (e.g., a locked cabinet or refrigerator), or in a locked laboratory. Material with a low specific activity (e.g., contaminated waste) is not included in this requirement. However, reasonable measures should be taken to secure those materials.

LOSS OR DAMAGE

The loss of any radioactive materials or damage to any sealed source must be reported to the Radiation Safety Officer immediately upon discovery. The RSO will determine what actions must be taken, including whether notification of the Alabama Department of Public Health-Office of Radiological Control is required.

RADIOACTIVE WASTE DISPOSAL

Radioactive waste may only be disposed of by Radiation Safety. Once the Radioactive Waste Disposal Sheet is properly filled out, contact Radiation Safety personnel for pick up. No radioactive waste is to be disposed of in ordinary trash receptacles. No liquid waste may be disposed of in drains or other sewer openings by laboratory personnel without prior approval of the RSO. (However, after the first rinse, glassware and other items may be washed in laboratory sinks.)

A [*Radioactive Waste Disposal Sheet*](#) must be properly completed for each container of waste to be picked up.

Do not wait for a container to completely fill up before calling for a pickup.

MIXED HAZARDOUS/RADIOACTIVE WASTE

Radioactive waste containing any other hazardous material requires special handling. Radiation Safety must be consulted before any such waste is generated.

Any items that may be considered hazardous waste (e.g., mercury thermometers, lead pigs) which become contaminated should not be placed in the solid waste containers. Radiation Safety will collect any such items separately.

SOLID WASTE

Radiation Safety provides containers (e.g., fiberboard drums) for the collection of solid radioactive waste. Depending on the radionuclides used in the laboratory, there may be separate solid waste containers based on their half-lives.

LIQUID WASTE

Radiation Safety provides containers (e.g., plastic carboys) for the collection of liquid radioactive waste. Depending on the radionuclides used in the laboratory, there will be separate liquid waste containers based on their half-lives as specified by Radiation Safety Office.

SCINTILLATION VIALS

Radiation Safety provides containers (e.g., fiberboard drums) for the collection of scintillation vials with scintillation fluid still in them. Do not mix full scintillation vials with solid waste.

SCINTILLATION FLUID

As an alternative to collecting full scintillation vials, fluid from the vials may be poured into a liquid waste container supplied by Radiation Safety. The empty vials may then be placed in the solid waste. This option may only be used if the scintillation fluid is non-hazardous.

SHARPS

Razor blades, needles, and other sharps which are contaminated should be placed in a separate sharps' container marked with a *CAUTION RADIOACTIVE MATERIAL* label. Do not place sharps in the solid waste drums.

SMALL CONTAINERS

For convenience, small, properly labeled containers may be used on the bench top to collect waste during an experiment.

ANIMAL WASTE

Disposal of animal carcasses, tissue, and excreta is handled on a case-by-case basis. Contact the Radiation Safety Officer to determine the proper method for handling any animal wastes generated.

USE OF RADIOACTIVE MATERIAL IN ANIMALS

APPROVAL BY IACUC

Use of radioactive materials in animals for research requires the approval of the Institutional Animal Care and Use Committee (IACUC) as well the approval of the Radiation Safety Committee (RSC) as described in Section 2.

Section 5. RADIATION-PRODUCING MACHINES

GENERAL

DEFINITIONS

A *radiation-producing machine* is any device capable of producing ionizing radiation when the associated control devices are operated, except devices which produce radiation only by the use of radioactive material. X-ray diffraction machines, diagnostic x-ray units, and particle accelerators are common examples of radiation-producing machines.

An *analytical x-ray machine* is a radiation-producing machine utilizing x-rays to determine the elemental composition or examine the microstructure of materials. The most common type of analytical x-ray machine on campus is the x-ray diffraction machine.

REGULATION

Use of radiation-producing machines is regulated by the state. A copy of the Alabama Radiation Control Rules (ARCR) is available for review at Risk Management and Safety, Radiation Safety Office, 1161 W. Samford Avenue. RMS Building 9. Auburn University's policies for the use of radiation-producing machines are designed to meet the applicable requirements of the ARCR and to ensure the safety of users and other personnel. Individuals using radiation-producing machines should be familiar with the applicable provisions of the ARCR.

REGISTRATION

All radiation-producing machines must be registered with the Alabama Department of Public Health-Office of Radiation Control (ADPH-ORC). Registration will be in the name of the university, with the Radiation Safety Officer (RSO) as the point of contact. The RSO must be notified of the acquisition, transfer, or disposal of any radiation-producing machine. Within thirty (30) days of change, the RSO shall report to the ADPH-ORC any change in the name or address or location of the installation, receipt, sale, or disposal of any reportable source of radiation.

DOSIMETRY

Dosimetry requirements, described in Section 6, will be established by the Radiation Safety Officer upon a review of each facility. An individual issued a dosimeter must wear it while involved in any operation of a radiation-producing machine.

AUBURN PERMIT

APPLICATION FOR USE

Faculty members who wish to operate a radiation-producing machine must submit an application to the Radiation Safety Committee (RSC) via the Radiation Safety Officer (RSO).

Each application must be completed in sufficient detail for RSC evaluation. Applications must include a description of the machine (including maximum operating parameters), description of proposed use, and for machines operating above 100 kV, a description of the facility.

Particle accelerators and certain other radiation-producing machines which may present special hazards require operating conditions beyond those listed in this chapter. The RSO will work closely with the PI to ensure appropriate facility designs and operating procedures are developed.

APPROVAL BY RSC

All applications for use of radiation producing machines are reviewed by the RSO and then forwarded to the RSC in the same manner as described in Section 2 for applications to use radioactive materials. Upon approval, a permit is issued, listing any special conditions specified by the RSC.

AMENDMENT TO PERMIT

A Principal Investigator (PI) may request changes to a permit by submitting a written request to the RSC via the RSO. The request must contain sufficient information for evaluation by the RSO and RSC. The procedure for adding a new radiation worker to a permit is similar to that described in Section 2.

RENEWAL

A permit expires five years from the date of approval by the RSC. In order to continue using a radiation-producing machine without interruption, a renewal application must be submitted far enough before the expiration date to allow for RSC review and approval.

TERMINATION

A permit may be terminated at the request of the PI, by revocation by the RSC, or at expiration if a renewal application is not submitted. When a permit is terminated, the RSO will take appropriate steps to ensure the machine is not operated.

NON-COMPLIANCE

The following items of non-compliance will be investigated by the RSO and will be reported to the RSC. In some instances, the Alabama Department of Public Health, Office of Radiation Control must also be notified.

- Willful violation of university policies or state regulations regarding the use of radiation-producing machines.
- Improper use of a radiation-producing machine which results in a significant danger to personnel.

The RSC will take appropriate action based on the significance of the incident. In severe cases, the RSC can suspend or revoke a PI's permit or ban an individual from working with radiation-producing machines at Auburn University.

POLICIES AND PROCEDURES FOR USE OF ANALYTICAL X-RAY MACHINES

AUTHORIZED OPERATORS

Principal Investigators are responsible for ensuring that only authorized individuals are allowed to operate their machines. Authorized individuals are those listed on the original application or added using the New Radiation Worker Form.

TRAINING

Analytical X-ray safety training is required for all personnel using X-ray equipment at Auburn University. This training is conducted in two parts and must be done consecutively.

All users will be required to take an initial Analytical X-ray Safety Course and successfully complete the quiz on BioRAFT. Hands-on equipment-specific training must be provided by the Principal Investigator (or an experienced qualified operator designated by the PI). New personnel must satisfactorily demonstrate knowledge of operating and safety procedures before independently operating a radiation-producing machine. This training must be documented for each x-ray user by completing the [Certificate of Training](#) and submitted to the RSO indicating that second component of training has been performed. It is suggested that individual keep a copy of certificate.

All personnel utilizing the analytical x-ray equipment must complete refresher training every other year.

POSTING

A sign bearing the radiation symbol and the words CAUTION X-RAY EQUIPMENT (or similar wording) must be posted at the entrance to each laboratory containing a radiation-producing machine.

A label bearing the words CAUTION THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED (or similar wording) must be affixed to the control device of each machine.

A label bearing the words CAUTION HIGH INTENSITY X-RAY BEAM (or similar wording) must be affixed on or near the tube of an x-ray unit.

An X-RAYS ON warning light, labeled as to its meaning, shall be located on or near an x-ray tube to indicate when x-rays are being produced.

ACCESS CONTROL

Key control or equivalent access control must be maintained for each machine. For older machines which do not have a keyed control device, this requirement may be fulfilled by controlling access to the laboratory.

STANDARD OPERATING PROCEDURES

Standard Operating Procedures (SOP) for each machine must be available near the machine and a copy of SOP must be submitted to Radiation Safety Office. SOP must be updated when changes are made to the procedure.

UNUSED PORTS

All unused x-ray ports on radiation source housing shall be secured in the closed position to prevent casual opening and interlocked so that x-ray production is stopped if the port is opened.

RADIATION SAFETY SURVEYS

Radiation Safety performs inspections of analytical x-ray machines when first installed, periodically, and whenever significant changes to the machine, facility, or operating procedures are made.

POLICIES AND PROCEDURES FOR USE OF VETERINARY X-RAY MACHINES

AUTHORIZED OPERATORS

Principal Investigators are responsible for ensuring that only authorized individuals are allowed to operate their x-ray machines. Authorized individuals are those listed on the original application or added using the New Radiation Worker Form.

TRAINING

Any person participating in the performance of x-ray procedures must receive radiation safety training prior to performing these duties. This

training is available on [BioRAFT](#). New personnel must satisfactorily demonstrate knowledge of operating and safety procedures before independently operating an x-ray machine.

All personnel participating in the performance of x-ray procedures must complete annual refresher radiation safety training. CVM Radiation Safety Training in BioRAFT will be taken annually as a refresher course.

RADIATION SAFETY PRACTICES

No x-ray exposure will be permitted of any animal unless ordered in writing or verbally by a veterinarian. Standing orders from a veterinarian are acceptable.

Mechanical aids will be used to hold an animal in position if practical. Any person holding an animal during an x-ray procedure must wear a lead apron, thyroid collar shield and leaded gloves of at least 0.5-millimeter lead equivalence. (The condition of aprons, thyroid collar and gloves should be checked at least annually).

No person shall be allowed to be in the primary x-ray beam at any time.

No person other than those involved in the procedure shall be in the x-ray room while an exposure is being made. If you are not required to be in the room, do not stay in the room in order to reduce unnecessary exposure.

POLICIES AND PROCEDURES FOR OTHER RADIATION PRODUCING MACHINES

The Radiation Safety Officer and Radiation Safety Committee will set specific policies and procedures for those types of radiation-producing machines not described above.

Section 6. RADIATION DOSE LIMITS AND PERSONNEL MONITORING

GENERAL

Permissible occupational radiation dose levels are set by the Alabama Radiation Control Rules (ARCR). The levels are based on recommendations by the International Commission on Radiation Protection (ICRP), the National Council on Radiation Protection and Measurements (NCRP), and by federal and state regulatory agencies.

Additional information may be found in Health Physics Procedure 6 Personnel Radiation Dose Monitoring.

ALARA

In practice, radiation doses should be kept *As Low As Reasonably Achievable*. ALARA is a guideline meant to strike a balance between the costs of radiation protection, the health benefits derived from that protection, and the benefits from the use of radioactive materials and radiation-producing machines.

Auburn University is committed to keeping radiation doses of all individuals as low as reasonably achievable, consistent with its mission to serve the citizens of Alabama through its instructional, research, and outreach programs.

It is the responsibility of everyone including radiation workers, principal investigators, The Radiation Safety Office, and the administration to operate within the ALARA guideline. This is achievable by developing and following radiationsafety procedures and by monitoring workplaces to control contamination and minimize doses.

DOSE LIMITS

The ARCR dose limits for adult radiation workers are listed in the table below.

| Dose Category | Adult Occupational Dose Limit |
|--|--|
| Total Effective Dose Equivalent (TEDE) | 5 rem per year |
| Total Organ Dose Equivalent (TODE) | 50 rem per year to any individual organ or tissue except the lens of the eye |
| Lens Dose Equivalent | 15 rem per year to the lens of the eye |
| Shallow Dose Equivalent | 50 rem per year to the skin or to any extremity |

It should be noted that the above dose limits are permissible *occupational* dose limits. These dose limits are in addition to the background radiation dose or medical radiation dose received by the worker. The average annual background radiation in the U.S. due to natural sources is approximately 620 millirem per year.

OCCUPATIONAL DOSE LIMIT EXCEPTION

College of Veterinary Medicine (CVM) Senior Veterinary Students have been allowed an exemption from ADPH-ORC Rule 420-3-26-.03(10)(c), Determination of Prior Occupational Dose for obtaining previous radiation dose history due to the volume of students and the limited time they are at the CVM. To comply with the exemption granted by ADPH-ORC, Senior Veterinary Students have an administrative dose limit of 1.25 rem for the calendar year and will not be eligible to participate in a planned special exposure. The lowered administrative exposure limit will not affect the students' ability to work with radiation. If a student loses their dosimeter or fails to return it to the Radiation Safety Office at the end of the wearing period, then the administrative limit will be reduced to 625 mrem for the calendar year.

MINORS

Radiation dose limits for radiation workers under eighteen years old are ten percent of the adult limits shown above. Except under exceptional circumstances, minors will not be authorized to use radioactive materials or radiation-producing machines.

PREGNANCY

The dose limit to the embryo/fetus of a declared pregnant woman is 0.5 rem. Efforts must also be made to avoid substantial variation above a uniform monthly exposure rate. A declared pregnant woman means a woman who has voluntarily informed the Radiation Safety Officer, in writing, of her pregnancy and the estimated date of conception.

The dose to an embryo/fetus is the sum of the deep-dose equivalent to the declared pregnant woman and the dose from internally deposited radionuclides in the embryo/fetus and in the woman.

EXTERNAL DOSE MONITORING

The ARCR specify individuals who must be monitored for exposure to radiation. They include individuals:

- Entering a high or very high radiation area.
- Operating a panoramic irradiator or entering the irradiation room.
- Operating fluoroscopic equipment in the healing arts.
- Operating mobile x-ray equipment in the healing arts.
- Servicing an operable x-ray producing machine.
- Likely to receive an external dose greater than ten percent of the occupational dose limits shown above.
- Likely to receive more than 25 mrem per week from operating x-ray equipment in the healing arts.

Experience has shown that very few radiation workers at Auburn University will require monitoring based on the ARCR. However, Auburn University policy is that in addition to those requiring monitoring by the ARCR, whole-body dosimeters will be worn by individuals frequently handling one millicurie or more of a radionuclide with a beta energy of greater than 600 keV or with a gamma of any energy. Individuals handling higher activities of such radionuclides may also be required to wear ring dosimeters.

The Radiation Safety Officer (RSO) may also designate other individuals to be monitored.

DOSIMETERS

If you are required to be monitored as a radiation worker you must fill out the [New Radiation Worker Form](#) and submit it to the Radiation Safety Office.

Generally, an optically stimulated luminescence (OSL) dosimeter is used for whole-body dose monitoring and a thermoluminescent dosimeter (TLD) ring is used for monitoring dose to the hands. In most cases, dosimeters are exchanged quarterly or semiannually.

The RSO may authorize or require additional or other types of dosimeters to be used, increase the exchange frequency, or post environmental dosimeters in areas near radiation sources.

Dosimeters are processed commercially, and dose reports are generated. These reports are reviewed by the RSO. Any unusual or excessive doses are

investigated by the RSO and, when appropriate, additional measures are implemented to prevent a recurrence.

DOSIMETRY RECORDKEEPING

Recordkeeping requirements are also set forth in Alabama Department of Health-Office of Radiation Control (ADPH-ORC) Chapter 420-3-26-.03(10). For each individual who is likely to receive, in a year, an occupational dose requiring monitoring, Auburn University shall determine the occupational radiation dose received during the current year and attempt to obtain the records of lifetime cumulative occupational radiation dose.

If Auburn University is unable to obtain the current year occupational dose for the individual, then the allowable dose limit for the individual is administratively reduced by 1.25 rem for each missing quarter, i.e., if one quarter is missing for the current year then the individual's maximum dose for the year at Auburn University would be 3.75 rem. In addition, the individual is not available for planned special exposures for that calendar year.

INVESTIGATIONAL LEVELS

Auburn University has established conservative investigational levels for radiation doses which, when exceeded, will initiate review or investigation by the RSC and/or the RSO. The investigational levels that Auburn University has adopted are 100 mrem for Level 1 and 300 mrem for Level 2 and are based on fractions of the legal exposure limits. These levels apply to both internal and external exposure of individuals.

Investigational levels are set to trigger an ALARA review by the RSO (or designee) and the following actions will be taken at the investigational levels.

For a Level 1 investigation, individuals are notified of their exposure and asked to evaluate work practices with the purpose of reducing future exposure.

For a Level 2 Investigation, the individual is asked to submit a letter of acknowledgement describing the type of work that was performed during the monitoring period and, if possible, to identify how the increased exposure occurred. The RSO will review the documentation of the increased exposure and discuss ways the individual can decrease their exposure. Documentation of exceeding the Level 2 limits is to be signed by the individual. The returned signed documentation will be maintained by the Radiation Safety Office.

DOSE HISTORY

Radiation workers' annual dose report will be sent to the Principal Investigator for dissemination to the users; for the AU College of Veterinary

Medicine (CVM), the reports are sent to the Manager of Radiology. A written authorization signed by the radiation worker is required to release dose history records to a third party (except for certain government agencies).

PRECAUTIONS

If an individual is issued a whole-body dosimeter, it is to be worn when in an area in which radioactive materials are used or radiation-producing machines are being operated. The ring dosimeter is to be worn when handling radioactive materials. Both dosimeters register radiation from gamma rays, x-rays, and high-energy beta particles. Neither dosimeter detects radiation from low energy beta emitters such as H-3, C-14, and S-35. In the case of neutron radiation, special dosimeters are issued.

The whole-body dosimeter should be worn at the collar or chest level to measure the radiation dose received by the trunk of the body. The ring dosimeter is worn under the glove on a finger of the hand expected to receive the larger radiation dose.

The radiation dose recorded by the dosimeters is entered into the occupational dose record of the individual. To ensure that this record is valid and accurate, the following precautions must be observed:

- A dosimeter must only be worn by the individual to whom it has been issued.
- When not in use, a dosimeter should be left in a place free from radiation, moisture, and high temperatures.
- A dosimeter must not be deliberately exposed to radiation.
- The dosimeter packet must not be tampered with.
- The Radiation Safety Officer must be notified as soon as possible if there is reason to believe that a dosimeter has been damaged, lost, or accidentally exposed or contaminated.

LOST DOSIMETER OR FAILURE TO RETURN DOSIMETER FOR PROCESSING

If a dosimeter is lost or not returned for processing, there is a \$20.00 replacement fee that will be charged to badge user. In addition, the annual dose allowed will be reduced by 1.25 rem for each quarter the dosimeter is unavailable for processing. If it is a semi-annual dosimeter then the annual dose allowed is reduced by 2.5 rem.

BIOASSAY GUIDELINES

When using radioactive materials, accidental ingestion, inhalation, or absorption may occur. This can happen as the result of loose surface contamination or as the result of volatile chemical forms of radionuclides. The latter is of special concern when individuals are working with ^{125}I or ^{131}I .

For example, some radioiodine compounds undergo decomposition that could result in the volatilization of the radioiodine. If this happens, accidental uptake of radioiodine may occur. In the body, iodine concentrates in the thyroid and irradiates that organ.

The bioassay program is designed to enable Radiation Safety to determine the amount of radioactivity in the body and to calculate the radiation dose. Any unusual or excessive doses are investigated by the Radiation Safety Officer and, when appropriate, additional measures are implemented to prevent recurrence.

PROGRAM PARTICIPATION

Any individual working with unsealed sources in amounts exceeding the levels described below will be included in the bioassay program.

| Nuclide | Activity | Form |
|-----------------------------------|--|---|
| I-125 or I-131 | 10 mCi | Volatile (e.g., NaI) |
| | 100 mCi | Non-volatile (e.g., protein bound) |
| H-3, C-14, P-32, P-33, or S-35 | 100 mCi | Any (except H-3 accelerator targets) |
| Other | As determined by the Radiation Safety Officer | |

Note that:

- All volatile forms of radioiodine must be used inside an approved fume hood or glove box (except for the administration of veterinary treatments).
- All non-volatile forms of radioiodine over 1 mCi must be used inside an approved fume hood or glove box.
- For ^{131}I solutions used in veterinary treatments given by subcutaneous injection (typical method), a thyroid assay will be required for any single procedure involving greater than 10 mCi or cumulative use greater than 15 mCi in any one week.

USE OF I-125 OR I-131

| Required Thyroid Assays | | |
|-------------------------|---|--|
| Type of Assay | Necessary when... | Done... |
| Baseline | Beginning work with I-125 or I-131 in quantities stated above. | Before beginning work with radioiodine. |
| Routine | Working with quantities stated above (at any one time or cumulatively over a one month period). | Within 7 days for I-125 or 3 days for I-131. |
| Special | Determining internal uptake after an incident involving radioiodine. | As determined by the Radiation Safety Officer. |
| Follow-up | Monitoring existing internal contamination. | As determined by the Radiation Safety Officer. |

USE OF OTHER RADIONUCLIDES

| Required Urinalyses | | |
|---------------------|---|---|
| Type of Assay | Necessary When... | Done... |
| Routine | Working with quantities stated above (at any one time or cumulatively over a one month period). | Within 7 days or as determined by the Radiation Safety Officer. |
| Special | Determining internal uptake after an incident involving radioactive material. | As determined by the Radiation Safety Officer. |
| Follow-up | Monitoring existing internal contamination. | As determined by the Radiation Safety Officer. |

Section 7. EMERGENCY PROCEDURES

INTRODUCTION

During the course of routine operations, radioactive material may be spilled resulting in contamination of personnel or lab equipment and areas. Correct action taken during such an incident can prevent unnecessary doses to personnel and further spread of contamination.

GENERAL PROCEDURES

Medical attention takes precedence over radiological or other concerns in the case of a serious injury. Inform emergency personnel if there is the possibility of contamination.

Do not risk an external or internal radiation dose in order to save equipment or an experiment. An exception to this should only be made at the direction of a person qualified to evaluate the hazards involved.

Take all reasonable precautions to limit the spread of the radioactive contamination.

- Limit access to the area.
- Turn off ventilation system, if possible.
- Prevent spread of liquid or powdered contaminants.

SERIOUS INJURY INVOLVING RADIOACTIVE MATERIAL

1. Dial 911 and request emergency medical services. Tell the 911 operator that it is also a radiation emergency and request notification of the Radiation Safety Officer.
2. When emergency personnel arrive, inform them of the possibility of radioactive contamination.
3. Follow the steps for a major or minor spill as appropriate.
4. Try to determine the radionuclide, activity, and chemical form of the material involved.

MAJOR SPILL

A radioactive material spill is considered major if it results in any of the following:

- Internal radiation dose to personnel (inhalation/ingestion of radioactive material).
 - Excessive external radiation dose to or contamination of personnel.
 - Contamination of large areas.
 - Considerable delay in work.
1. Notify personnel not involved in the spill to vacate the laboratory. Prevent other personnel from entering the contaminated area.
 2. Monitor personnel for contamination.
 3. Remove contaminated clothing. If skin is contaminated, flush thoroughly with water and wash gently with mild soap. Do not abrade the skin, to prevent internal contamination.
 4. Confine movement of all potentially contaminated personnel to prevent further spread of contamination.
 5. Cover a liquid spill with absorbent paper or pads. Dampen dry powders, being careful not to spread contamination. Use oil if material is water reactive. Do not attempt to clean up the spill.
 6. Notify the Radiation Safety Officer (334-844-4870). If after working hours, dial 911 and instruct operator to contact the Radiation Safety Officer. Also notify the laboratory supervisor or Principal Investigator.
 7. If possible, turn off fans or ventilation that might spread vapors or dust.
 8. Try to determine the radionuclide, activity, and chemical form of the material involved.
 9. Assist Radiation Safety in evaluation and decontamination.

MINOR SPILL

A radioactive material spill can generally be considered minor if it contaminates small areas or equipment and results in:

- No external or internal contamination of personnel.
 - No excessive external radiation dose to personnel.
 - No serious delay in work.
1. Notify personnel in the area that a spill has occurred.
 2. Monitor personnel leaving the area and remove any contaminated clothing.
 3. Cover a liquid spill with absorbent paper or pads. Dampen dry powders, being careful not to spread contamination. Use oil if material is water reactive.
 4. Call the Radiation Safety Officer (334-844-4870) if assistance is needed.
 5. Plan the decontamination procedure before proceeding. Keep in mind these points:
 - Limit personnel to a minimum.
 - Wear appropriate protective clothing.
 - Dispose of all contaminated material as radioactive waste.
 - Use appropriate survey instruments. Perform wipe tests if necessary.
 - After decontamination, check all areas around the spill and all personnel for contamination. Be sure to check hands and shoes.

RADIATION-PRODUCING MACHINE

In the event of an accident or unusual incident involving a radiation producing machine:

1. If there is a serious injury or fire, call 911 and request emergency medical services or the fire department.
2. **TURN OFF THE MACHINE.** If possible, turn off the circuit breaker for the machine.
3. Notify the Radiation Safety Officer (334-844-4870). If after working hours, call 911 and have the 911 operator contact the Radiation Safety Officer.

4. Notify the laboratory supervisor or Principal Investigator.
5. Record information about the incident (e.g., operating voltage and current, exposure time, distance from radiation source).

Appendix A CLASSIFICATION OF RADIONUCLIDES ACCORDING TO RELATIVE HAZARD POTENTIAL

| <u>HAZARD POTENTIAL</u> | <u>RADIONUCLIDES</u> |
|--|--|
| <p>VERY HIGH (HAZARD CLASS I)</p> | <p>Sr-90, Pb-210, Po-210, At-211, Ra-226, Ac-227, Th-228, Th-229, Th-230, Th-231, U-233, Pu-238, Pu-239, Am-241, Cm-242, Cf-252, other transuranic nuclides</p> |
| <p>HIGH (HAZARD CLASS II)</p> | <p>Ca-47, Fe-59, Co-60, Sr-85, Sr-89, Y-91, Ru-106, Cd-109, Cd-115, I-125, I-131, Ba-140, Ce-144, Sm-151, Eu-152, Eu-154, Tm-170, Hg-203, Bi-207, Th-232, natural thorium, natural uranium.</p> |
| <p>MODERATE (HAZARD CLASS III)</p> | <p>Na-22, Na-24, P-32, P-33, S-35, Cl-36, K-42, Ca-45, Sc-46, Sc-47, Sc-48, V-48, Mn-56, Fe-55, Co-57, Co-58, Ni-59, Ni-63, Cu-64, Cu-67, Zn-65, Ga-67, Ga-68, Ga-72, As-74, As-76, Br-82, Kr-85, Rb-84, Rb-86, Y-90, Zr-95, Nb-95, Mo-99, Tc-99, Rh-105, Pd-103, Ag-105, Ag-111, Sn-113, Te-127, Te-129, I-132, Xe-133, Cs-137, La-140, Pr-143, Pm-147, Ho-166, Lu-177, Ta-182, W-181, Re-183, Ir-190, Ir-192, Pt-191, Pt-193, Au-196, Au-198, Au-199, Tl-200, Tl-202, Tl-204, Pb-203, Hg-197</p> |
| <p>LOW (HAZARD CLASS IV)</p> | <p>H-3, Be-7, C-14, F-18, Cr-51, Ge-68, Ge-71, Sr-87m, Tc-99m, In-111, Tl-201</p> |

The hazard potential of a radionuclide is considered during the evaluation of an application to use radioactive material. It is used when determining the workplace type and other approval conditions.

These classifications are based on various published data, Auburn University experience, and the judgment of the Radiation Safety Officer.

Appendix B WORKPLACE STANDARDS FOR OPERATIONS WITH UNSEALED RADIOACTIVE MATERIAL

The Radiation Safety Committee (RSC) will specify the minimum required workplace type as one of the approval conditions for each permit for unsealed radioactive material. The RSC takes into account the nature of the operation, the radionuclide involved, the physical and chemical form of the radionuclide, the activity to be used, and other possible hazards.

Below are the minimum requirements for each workplace type.

TYPE A - Laboratory

1. Must have a ventilation system that provides at least four air changes per hour.
2. Must have smooth and impermeable work surfaces for experiments involving radioactive material.

TYPE B - Laboratory with Fume Hood

1. Must satisfy Type A requirements.
2. Must be equipped with a fume hood. The hood must have an average face velocity of at least 100 feet per minute with the sash at a workable height.

TYPE C - Restricted Use Laboratory

1. Must satisfy Type B requirements.
2. Must be used primarily for radioactive material work. No area of the laboratory may be used as a study area.

TYPE D - High Hazard Laboratory*

1. Must satisfy Type C requirements.
2. Additional requirements will be determined by the RSC on a case-by-case basis. These requirements may include some or all the following:
 - Glove boxes
 - High efficiency filtration of exhaust air
 - Contamination control at exit points
 - Remote handling facilities
 - High level waste collection facilities
 - Alarm systems to signal high levels of airborne radioactivity or high radiation fields.

Appendix C CONTAMINATION LEVELS AND REQUIRED ACTIONS

Any contamination (greater than twice background level) discovered in accessible areas or on items outside of a clearly marked benchtop or fume hood radioactive use work area must be decontaminated promptly even if below the "Low" level in this table.

| Type of Contamination | Removable Contamination Levels (pCi/100cm ²) * | | |
|--|---|--|---|
| | Low | Mid | High |
| Alpha Emitter (e.g., Am-241) | 5 - 10 | 10 - 100 | > 100 |
| Example instrument readings** | Any 10-20 cpm with LSC, 2-4 cpm with alpha detector | Any 20-200 cpm with LSC, 4-40 cpm with alpha detector | Any >200 cpm with LSC, >40 cpm with alpha detector |
| Gamma or High Energy Beta Emitter (e.g., I-125, P-32) | 100 - 250 | 250 - 1000 | > 1000 |
| Example instrument readings** | P-32 200-500 cpm with LSC, 75-200 cpm with G-M I-125 100-250 cpm with LSC, 150-400 cpm with LEGS | P-32 500-2000 cpm with LSC, 200-800 cpm with G-M I-125 250-1000 cpm with LSC, 400-1500 cpm with LEGS | P-32 >2000 cpm with LSC, >800 cpm with G-M I-125 >1000 cpm with LSC, >1500 cpm with LEGS |
| Low or Intermediate Energy Beta Emitter (e.g., H-3, C-14, P-33) | 1000 - 2500 | 2500 - 10000 | > 10000 |
| Example instrument readings** | H-3 detectable with LSC only, 1000-2500 cpm C-14 1500-4000 cpm with LSC, 75-200 cpm with G-M | H-3 detectable with LSC only, 2500-10000 cpm C-14 4000-15000 cpm with LSC, 200-800 cpm with G-M | H-3 detectable with LSC only, >10000 cpm C-14 >15000 cpm with LSC, >800 cpm with G-M |
| Required Actions | Should be decontaminated promptly but may be tolerated in a particular work situation. (Must be in a clearly marked radioactive work area.) | Must be decontaminated promptly. If repeated instances occur or large areas are discovered, the PI may be required to report to the RSC stating the reason for the incident(s) and actions taken to minimize the risk of a repeat. | Requires immediate action. The PI and RSO must be informed. Depending on the extent of the contamination, further use may be suspended until decontamination is completed. The PI may be required to report to the RSC stating the reason for the incident and actions taken to minimize the risk of a repeat. |

* "Removable contamination" means the amount of radioactive material which would be removed by wiping a surface with an absorbent material (e.g., filter paper) using moderate pressure. The RSO may designate higher limits for a Type D laboratory or lower limits for certain nuclides.

** Example instrument readings are given in counts per minute (cpm) above background for counting wipes in a liquid scintillation counter (LSC); direct measurements using a thin-window Geiger-Mueller (G-M) detector or low energy gamma scintillator (LEGS) detector at 1 inch from the surface; or direct measurements using an alpha detector on contact with the surface. The examples are based on typical values for the efficiencies of different types of detectors and the percentage of material which would be removed by a wipe of the area. Refer to [the Radiation Safety Reference Handbook](#) for more information on the selection and use of detection instruments.

The degree of hazard involved with radioactive contamination is dependent on a number of factors such as total area, radionuclide, chemical/physical form, accessibility to the area, and permeability of surface. Radiation Safety Office professionals are available to assess hazards and to provide guidance and assistance in decontamination.