



MANUAL FOR THE SAFE USE OF RADIOACTIVE MATERIALS

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RADIATION SAFETY MANUAL FOR RADIOACTIVE MATERIAL

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1.0 THE RADIATION SAFETY COMMITTEE

1.1 PURPOSE OF THE RADIATION SAFETY COMMITTEE

The purpose of the Radiation Safety Committee of the University of Delaware is the promotion of the best practice in safe handling and use of radioactive materials and radiation producing devices. Occupational radiation exposures to individuals and the environment are maintained as low as is reasonably achievable. The purview of the committee is the University campus, regional facilities, affiliated institutions, and University properties throughout the State of Delaware and University research vessels in national and international waters.

The establishment of a Radiation Safety Committee is required by federal regulations before an institution will be licensed for "broad scope" use of radionuclides in research and development.

Federal and state government regulations for radionuclides shall be implemented by the Committee in association with individual radionuclide users, department heads, and the administration of the University.

Radiation, as used herein, includes x-rays, gamma rays, alpha and beta particles, high-speed electrons, neutrons, protons, and other nuclear particles; but not sound, microwaves or radio waves, or visible, infrared, or ultraviolet light.

1.2 ORGANIZATION OF THE RADIATION SAFETY COMMITTEE

The Radiation Safety Committee (RSC) shall be appointed by the Provost of the University.

Membership shall consist of faculty and professional staff experienced in handling radionuclides, the use of radiation producing devices, the practice of radiation protection, or those who have a desire to institute practices of safety with regard to radiation. The Director of Occupational Health and Safety shall be a member and act as a representative of management.

The activities of the committee are directed by the chairperson who is appointed by the Provost of the University upon recommendation of the committee.

The business of the Committee is administered through the Department of Occupational Health and Safety (DOHS). The Radiation Safety Officer is a full-time professional staff member of the DOHS and is appointed to this position based on experience, education and qualifications in the area of Radiation Safety and with the recommendation of the Radiation Safety Committee. The Radiation Safety Officer serves as Executive Secretary of the Radiation Safety Committee.

Meetings of the Committee shall be called by the chairperson at his/her discretion, not less than once per calendar quarter or on petition by any member of the Committee.

A quorum of the Committee to conduct business shall consist of the RSC Chair (or his/her alternate), the RSO, one representative of management (or his/her alternate), and two technical members.

The RSC delegates to the Radiation Safety Officer the authority to review, grant, or deny temporary permits for use of radioactive materials during the interim between Radiation Safety

Committee meetings. Such decisions are subject to final approval or denial after review at the next scheduled Committee meeting.

1.3 RESPONSIBILITIES OF THE RADIATION SAFETY COMMITTEE

- 1.3.1 Assume the responsibility for radiation safety aspects for all University programs involving radioactive materials or radiation producing devices.
- 1.3.2 Review and grant permission for, or deny the use of radioactive materials or radiation producing devices within the University. Approval is necessary before a project involving these materials or devices can be initiated. A majority vote of the committee is required for approval.
- 1.3.3 Review and prescribe special conditions, requirements, and restrictions that may be necessary for safe handling of radioactive materials and radiation producing devices. These may include oral or written examination, additional training of personnel, physical examination (e.g. blood test, urine test, etc.), upgrading of facility (hoods, ventilation, shielding, etc.), evaluation of airborne radioactivity, designation of areas of use within the laboratory, proper caution signs, proper disposal methods, proper handling procedures and procedures to be followed after spills or other radiation accidents.
- 1.3.4 Serve as a liaison with the Delaware State Office of Radiation Control and the United States Nuclear Regulatory Commission in matters of registration, licensing and radiation safety.
- 1.3.5 Receive and review periodic and/or urgent reports from the Radiation Safety Officer regarding:
 - A. Results of area monitoring.
 - B. Personnel exposures as measured by suitable dosimeters.
 - C. Accidents in handling, storage or use of radionuclides.
 - D. Loss or theft of any amount of radionuclides.
 - E. Records of radionuclides procurement and disposal.
- 1.3.6 Recommend and/or initiate remedial action up to and including termination of permits, authorizations of personnel and confiscation of radioactive materials or radiation producing devices where safe procedures are not followed under an authorized project or where procedures are not in compliance with government regulations. Authorize resumption of operations, stopped by the Radiation Safety Officer when the operations are in compliance with the regulations.
- 1.3.7 Recommend modifications to operating and maintenance procedures, review and recommend in advance of construction of new buildings or alterations or remodeling of existing buildings, proper ventilation, flow rates and filtration as necessary on properly

designed fume hoods, shielding, construction material, furniture and finishes for laboratories and rooms in which the use and storage of radioactive materials or radiation producing devices is contemplated. The Department of Occupational Health and Safety shall carry out the Committee's responsibility in this area in order that the concept and philosophy of "as low as is reasonably achievable" (radiation exposure to personnel and environment) is carried out.

- 1.3.8 Keep department chairpersons, Permit Supervisors, Authorized Users and other academic and administrative officers advised of changes in rules and recommendations of various government agencies concerned with radiation safety and the safe use of radioactive materials and radiation producing devices.
- 1.3.9 Keep a written record of action taken in approving or disapproving the use of radioactive materials and radiation producing devices and other transactions, communications, and reports involved in the work of the Committee.
- 1.3.10 Delegate to the Radiation Safety Officer the authority to review, grant or deny temporary permits for use of radioactive materials and radiation producing devices during the interim between quarterly meetings. Such permits shall be subject to final approval or denial after review at a regularly scheduled committee meeting.
- 1.3.11 Arrange for and/or conduct an annual management audit of the Radiation Safety Program.

1.4 APPEAL OF COMMITTEE ACTIONS

Appeals to the actions taken by the Radiation Safety Committee should be directed to the Chairman of the Radiation Safety Committee.

2.0 THE RADIATION SAFETY OFFICER

2.1 AUTHORITY OF THE RADIATION SAFETY OFFICER

The Radiation Safety Officer derives his/her authority from the Office of the Provost. The Radiation Safety Officer is a member and the authorized representative of the Radiation Safety Committee regarding radiation protection and control within the University.

The Radiation Safety Officer or his/her authorized representative has the authority to stop all operations with radioactive materials or radiation producing devices where a potential hazard or violation of federal, state or University rules and regulations exist. Resumption of operations may take place only upon authorization from the Radiation Safety Committee.

The Radiation Safety Officer shall determine the applicable limits possible for maintaining occupational radiation exposures as low as is reasonably achievable.

2.2 RESPONSIBILITIES OF THE RADIATION SAFETY OFFICER

The Radiation Safety Officer has the responsibility for ensuring adherence to all the current applicable regulations of the United States Nuclear Regulatory Commission (U.S.N.R.C.), state

and local agencies, and all similar codes and regulations and will advise and assist the Radiation Safety Committee with regard to all regulations issued by or subscribed to by the Radiation Safety Committee.

- 2.2.1 Implement the organization, administration and management of the Radiation Safety Program of the University of Delaware.
- 2.2.2 Interpret regulations which govern the use of sources of ionizing radiation and disseminate information on radiation safety.
- 2.2.3 Develop and keep up-to-date a manual of Radiation Safety regulations and procedures for the University of Delaware.
- 2.2.4 Supervise all radiation protection programs and develop and maintain these programs.
- 2.2.5 Review research protocols and applications for the use of sources of ionizing radiation. Make recommendations to the Radiation Safety Committee.
- 2.2.6 Coordinate the dosimetry service, maintain personnel exposure records, and give timely notification of exposures to supervisors as well as individuals exposed.
- 2.2.7 Review all requests for procurement of radionuclides to assure compliance with limitations for possession and use.
- 2.2.8 Procure, receive and arrange delivery and shipment of radioactive materials coming to or leaving the University.
- 2.2.9 Maintain records of procurement and receipt of all radioactive materials and radiation producing devices and machines.
- 2.2.10 Supervise the radioactive waste disposal program.
- 2.2.11 Instruct groups of employees and students on proper procedures for handling radioactive materials, radiation in restricted areas, health protection problems associated with exposure to such radioactive materials or radiations, exposure precautions, protective devices and applicable portions of the Commission's regulations.
- 2.2.12 Maintain radionuclide disposal records and records of disposal, transfer, or shutdown of any radiation producing equipment.
- 2.2.13 Conduct periodic radiation surveys and wipe tests in laboratories and storage areas.
- 2.2.14 Conduct alpha scintillation meter surveys when applicable (e.g. radium storage areas) and provide instrumentation for overseeing the decontamination of alpha-contaminated areas or equipment.
- 2.2.15 Conduct surveys on and register all radiation producing equipment.
- 2.2.16 Perform leak tests on sealed sources of radionuclides.

- 2.2.17 Maintain running inventory of radionuclides and sealed sources.
- 2.2.18 Assume the responsibility for storage of sources and materials not in current use.
- 2.2.19 Assume the responsibility for calibration of monitoring and surveying equipment.
- 2.2.20 Verify and report to appropriate authorities any radiation incident identified by regulations as a "reportable" incident.
- 2.2.21 Note and take steps in order to correct radiation safety problems.
- 2.2.22 Conduct periodic laboratory audits.
- 2.2.23 Perform other duties related or similar to the type described above.

3.0 UNIVERSITY REGULATIONS GOVERNING THE USE OF RADIOACTIVE MATERIALS

The University has committed to certain controls on the use of radioactive materials in its Nuclear Regulatory Commission License. Failure of the University to observe these rules and regulations can result in citation, infractions, and/or removal of the University's License. Failure to observe these rules and regulations by Permit Supervisors, Authorized Users, or Trainees will result in warnings and/or other actions by the Radiation Safety Committee as stated in Section 1.3.6 or by the Radiation Safety Officer as stated in Section 2.1.

3.1 PROCUREMENT OF RADIOACTIVE MATERIAL

All radioactive materials intended for use at the University of Delaware (including regional campuses and other properties) shall be procured through the Department of Occupational Health and Safety. This includes "license-exempt" quantities of radioactive materials.

A Radioactive Materials Requisition form can be obtained from the Department of Occupational Health and Safety and is also available on the department's web site (www.udel.edu/OHS/).

Only persons authorized by the Radiation Safety Committee may procure radioactive materials.

3.2 TRANSFER OF RADIOACTIVE MATERIALS

3.2.1 OFF-CAMPUS TRANSFERS

Radioactive material shall not be shipped, carried or transferred to or from the University without approval of the Radiation Safety Officer. Approved shipments must be packaged and labeled in accordance with D.O.T., N.R.C., E.P.A., D.N.R.E.C., and/or F.A.A regulations, whichever are applicable.

3.2.1.1 Only persons authorized by the Radiation Safety Committee may transfer radioactive materials to or from the University with the approval of the Radiation Safety Officer. Unless otherwise approved, all transferred radioactive material coming to the University shall be shipped to or brought to the Department of

Occupational Health and Safety for contamination check and inventory control before being stored or used at the University.

3.2.2 ON-CAMPUS TRANSFERS

Radioactive materials shall not be transferred from one building, department or laboratory to another without prior approval of the Radiation Safety Officer, since approval for the use of the materials is given only for the original working areas, amounts used, and the project specified.

3.2.2.1 All transfers approved between Permit Supervisors, laboratories, or from storage areas to working areas shall be done in such a manner as to minimize the probability of spillage or breakage. Double containers should be used, including suitable shielding, for such transfers.

3.2.2.2 Responsibility for obtaining approval lies with the original owner of the radioactive material. Approval may be obtained by contacting the Department of Occupational Health and Safety.

3.3 AUTHORIZATION TO USE RADIOACTIVE MATERIALS

Approval or denial of an application to use radionuclides in research and development by the Radiation Safety Committee is based on:

- A. Training in and experience with radionuclides of the applicant.
- B. Proposed use of radionuclides in the project and precautions for the safe use of the radionuclides.
- C. Type of radionuclide and amount to be used.
- D. Adequacy of the facility and equipment for the projected use and compatibility of the project to other uses of the laboratory.
- E. Training and experience of others working on the project.

Application forms can be obtained from the Department of Occupational Health and Safety and must be submitted to the Radiation Safety Officer who will evaluate and present the application to the Radiation Safety Committee.

3.3.1 PERSONNEL DEFINITIONS

- A. Permit Supervisor: the faculty or professional staff member who directs the research/teaching project and supervises the laboratory in which the radionuclides are used.
 - 1. A Permit Supervisor must meet the following requirements: a college degree in science or engineering and training by formal course work or on-the-job training covering:

- a. Principles and practices of radiation protection.
 - b. Radioactivity measurements, standardization and monitoring techniques and measurements.
 - c. Mathematics and calculations basic to the use and measurement of radioactivity.
 - d. Biological effects of radiation.
2. Experience: generally, the minimum experience expected of a Permit Supervisor will be one year's research use of the radionuclides requested or experience with equivalent radionuclides.
 3. Knowledge of his/her responsibilities as outlined in Section 3.4.
- B. Authorized User: the professional or technical staff person, graduate student or undergraduate student who assists the Permit Supervisor or works under the authority of the Permit Supervisor but does not require direct supervision.
1. An Authorized User will be expected to meet the following minimum requirements: formal course work or on-the-job training covering the subjects listed under Item 3.3.1. A. 1.
 2. Experience: generally, the minimum experience expected of an Authorized User will be three months research experience with the radionuclides requested or experience with the equivalent radionuclides or demonstrated competency to conduct specific radionuclide techniques.
 3. Knowledge of his/her responsibilities as outlined in Section 3.5.
- C. Trainee: a person working with radionuclides who does not meet the qualifications of an Authorized User and who must work in the continuous presence of the Permit Supervisor (or an appropriate Authorized User) while handling radionuclides.
1. Knowledge of his/her responsibilities as outlined in Section 3.5.
- D. Non-Radionuclide Lab Staff: laboratory staff that work in a location where licensed material is used but do not handle the licensed material .
- E. Frequenter: employees who may be required to enter a restricted area during the course of normal duties (e.g. physical plant personnel, University Police and Security personnel, etc.)

3.3.2 PERSONNEL TRAINING REQUIREMENTS

3.3.2.1 USERS OF RADIOACTIVE MATERIAL

- A. Attendance at seminars on Radiation Safety and other subjects as outlined under 3.3.1. A. 1. presented by the Department of Occupational Health and Safety in conjunction with on-the-job training specified in 3.3.1.B.2. and working experience under the direct supervision of a Permit Supervisor or appropriate Authorized User or
- B. On-the-job training specified in 3.3.1. B. 2. and experience in using radionuclides under the direct supervision and instruction of the Permit Supervisor or appropriate Authorized User, instruction to cover:
 - 1. Subjects as outlined under 3.3.1. A. 1.
 - 2. Rules and regulations of the University of Delaware including precautions and procedures to minimize exposure to radionuclides used.
 - 3. Federal regulations of 10-CFR-19 & 20.
 - 4. Type(s) of radiation and energy(s) of radiation from the radionuclides used.
 - 5. Interaction of radiation(s) with matter.
 - 6. External and internal biological hazards of radionuclide(s) used.
 - 7. Security requirements, storage areas, and designated work areas in the laboratory where radionuclide(s) can be used.
 - 8. Special handling problems of radionuclide(s) used and operation of instruments used to detect the radionuclides.
 - 9. Responsibilities of Permit Supervisor, Authorized User, and Trainee at the University of Delaware.
- C. An oral or written examination to evaluate the training of the employee or student may be administered by the Radiation Safety Officer.

3.3.2.2 NON-RADIONUCLIDE LAB STAFF AND FREQUENTERS

- A. Frequenters shall be instructed in the recognition of radiation hazards and those aspects of radiation safety that are necessary for the safe completion of their specific tasks. Subjects specified in 10 CFR 19 & 20 shall be included as appropriate.
- B. Frequenters required to enter a radionuclide laboratory in order to repair items/areas marked as “radioactive” (e.g. a RAM storage refrigerator) shall notify the Permit Supervisor or the Department of Occupational Health and Safety prior to performing any work. A radiation evaluation

will be conducted to assure work can be completed without unnecessary exposure to radiation.

3.3.2.3 OTHER TRAINING REQUIREMENTS

- A. Permit Supervisors shall ensure that all individuals handling radioactive materials under their supervision attend radiation safety training on an annual basis. Newly assigned students and employees shall be provided training before working with or in a work area containing radioactive material.
- B. Permit Supervisors shall ensure that all individuals working in or frequenting any portion of a restricted area are kept informed of the storage, transfer, or use of radioactive materials or of radiation in such portions of the restricted area; are instructed in the health protection problems associated with exposure to such radioactive materials or radiation, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed; are instructed in, and instructed to observe, to the extent within the worker's control, the applicable provisions of USNRC regulations and licenses for the protection of personnel from exposures to radiation or radioactive materials occurring in such areas; are instructed of their responsibility to report promptly to the Department of Occupational Health and Safety any condition which may lead to or cause a violation of USNRC regulations and licenses or unnecessary exposure to radiation or to radioactive material; are instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material; and are advised as to the radiation exposure reports which workers may request pursuant to 10 CFR 19.13. The extent of these instructions shall be commensurate with potential radiological health protection problems in the restricted area and the worker's duties in the area.

3.3.3 PROJECT APPROVAL

The project for which radionuclides are requested shall be reviewed by the Radiation Safety Officer and the Radiation Safety Committee for feasibility based on the applicant's experience with the radionuclides requested for the project and other information given in the project section of the application for authorization.

3.3.4 FACILITY APPROVAL

Radioactive materials are to be used only in those facilities which have been approved by the Radiation Safety Officer and the Radiation Safety Committee.

3.3.4.1 LABORATORY CLASSIFICATION AND REQUIREMENTS

Laboratories are classified as Type A (high level), Type B (intermediate level), Type C (low level), and Type D (very low level) according to type and level of

material to be used and type of usage. Requirements for laboratories are listed in Appendix A.

3.3.4.2 MONITORING INSTRUMENTS

Unless specifically exempted by the Radiation Safety Committee or the Radiation Safety Officer, each Permit Supervisor using radioactive materials shall have available and in operating condition, a properly calibrated survey or monitoring instrument appropriate to the type and level of ionizing radiation used.

3.3.4.3 OTHER RADIATION SAFETY EQUIPMENT

The Radiation Safety Committee may require the use of other special equipment or devices that it may determine necessary to ensure the safe use of radionuclides in a given situation. This includes special shielding, handling tools or tongs, alarms and warning devices, sampling equipment and other such apparatus.

3.3.4.4 WASTE CONTAINERS

Radioactive waste containers for facilities shall be provided or authorized by the Department of Occupational Health and Safety (See Section 3.8).

3.3.5 ISSUANCE OF AUTHORIZED PERMITS

Upon receipt of the application for authorization in the Department of Occupational Health and Safety, the Radiation Safety Officer or his/her representative shall: review the training and experience of the applicant(s) for the radionuclides requested, review the protocols proposed, and carry out a preauthorization investigation and inspection of the personnel and facility.

The Radiation Safety Officer may issue a temporary permit as per Section 1.3.10.

A "Conditional Approval" may be given on a temporary permit when a Permit Supervisor has experience and training with radionuclides in general but not with the particular radionuclide(s) requested for use. "Conditional Approval" may require oral or written examination or other conditions prescribed as per Section 1.3.3 at the discretion of the Radiation Safety Committee.

Permanent permits are issued after review and final approval by the Radiation Safety Committee at a quarterly or special meeting.

Permits are granted for one year or two years depending on the Permit Supervisor's longevity at the University and his/her safety and compliance history.

3.3.6 AMENDMENT(S) TO AUTHORIZED PERMITS

Amendments will be granted on the same basis as the original application for authorization.

3.3.7 RENEWAL OF AUTHORIZATION

Prior to the expiration date of the permit, the Radiation Safety Officer will contact the Permit Supervisor concerning renewal. At a scheduled meeting, changes in personnel, facility, project, and/or additional radionuclides required will be made. Revised applications will be prepared by the RSO and submitted to the Radiation Safety Committee for authorization.

3.4 RESPONSIBILITIES OF PERMIT SUPERVISOR

Those persons who have been authorized by the Radiation Safety Committee as Permit Supervisors are responsible for the safe use of radionuclides and radiation sources by Authorized Users and Trainees under their supervision. They shall also:

- A. Ensure compliance with Federal (10-CFR-19 & 20), State, and University rules and regulations, and U.S.N.R.C. license conditions regarding radioactive materials.
- B. Instruct personnel (students and employees) as outlined in Section 3.3.2 of this manual. Documentation of training shall be submitted to the Department of Occupational Health and Safety.
- C. Ensure radioactive material utilized in undergraduate and graduate teaching laboratories shall be under the supervision and in the physical presence of an instructor approved by the Radiation Safety Committee.
- D. Ensure that Authorized Users and Trainees wear personnel dosimeters as required by Section 3.10, submit urine samples as required, have thyroid monitoring if using radioactive iodine as required, and follow the protective rules for preventing personal contamination listed in Section 3.7.1.1.
- E. Ensure that NO Eating, Drinking, Food Preparation, Food Storage, Food Container Storage, Application of Cosmetics, or Smoking occurs in the restricted area.
- F. Ensure radiation surveys are conducted and documented each day that radionuclides have been used.
- G. Ensure proper planning of an experiment or procedure to ensure that adequate safety precautions are observed.
- H. Limit the use of radionuclides under their permit to the Authorized Users or Trainees under supervision.
- I. Limit the use of radionuclides to use areas within the restricted area approved by the Radiation Safety Officer.
- J. Maintain required records of receipt(s), use, storage, and disposal of radionuclides and periodic surveys conducted by themselves and Authorized Users under their permits.
- K. Limit the use of radionuclides to protocols approved by the Radiation Safety Committee.

- L. Update radioisotope inventory monthly.
- M. Allow Department of Occupational Health and Safety to conduct a physical inventory of radioisotopes at intervals specified by the Radiation Safety Officer.
- N. Secure radionuclides utilized under their permits from unauthorized access.
- O. Attend seminars on Radiation Safety as required by the Radiation Safety Committee.
- P. Report immediately to the Radiation Safety Officer any theft or loss of radionuclides and accidents involving radionuclides.
- Q. Decontaminate spills to a level specified by the Radiation Safety Officer.
- R. Communicate to the Radiation Safety Officer all pertinent information regarding changes in their permits (e.g. change in facility, deletion or addition of personnel, changes in project, etc.).
- S. Cooperate with the Radiation Safety Committee and Radiation Safety Officer on all matters related to radiation safety and sources of ionizing radiation.
- T. Answer communications from the Radiation Safety Committee or Radiation Safety Officer in a timely manner regarding deficiencies or violations of regulations indicating corrective actions taken.
- U. Clearly label radionuclide use areas in their laboratory.

3.5 RESPONSIBILITIES OF AUTHORIZED USER(S) AND TRAINEE(S)

Each person who is authorized to use radionuclides has the responsibility to comply with the University rules and regulations contained in this manual and also to:

- A. Not smoke, eat, drink, prepare food, apply cosmetics, store food or food containers in any laboratory where radionuclides are used or stored.
- B. Survey hands, shoes, body and clothing for radioactivity and remove any contamination before leaving the laboratory.
- C. Check work areas, periodically, for contamination and keep a written record of results. Periodically means daily when radionuclides are used.
- D. Conduct decontamination procedures when necessary.
- E. Report immediately to the Permit Supervisor and the Radiation Safety Officer the details of spills or other accidents, loss or theft of radioactive materials.
- F. Wear personnel dosimeters, as required, and comply with the rules concerning these dosimeters.

- G. Use all recommended or required protective measures, such as, protective clothing, respiratory protection, automatic pipetting devices, ventilated and shielded glove boxes and hoods.
- H. Limit the use of radionuclides to procedures approved by the Radiation Safety Committee.
- I. Keep accurate records of all radioactive material received, in use, storage, transferred to another permit, or transferred for disposal.
- J. Keep his/her personal exposure to radiation as low as is reasonably achievable.
- K. Follow the protective rules for preventing personal contamination.
- L. Submit urine or blood samples, as required; be monitored for thyroid uptake of iodine, as required.
- M. Dispose of radioactive wastes in proper containers and document amounts.
- N. Maintain security of radionuclides in use and in storage.
- O. Receive additional education as required.
- P. Maintain good housekeeping practices, label equipment contaminated with radionuclides to avoid cross contamination in the laboratory.

3.6 CLASSIFICATION OF AREAS

3.6.1 DEFINITIONS

- A. Radionuclide use area: any working surface where unsealed sources of radionuclides are used.
- B. Radionuclide Laboratory: any laboratory having one or more radionuclide use areas.
- C. Restricted Area: any Laboratory access which is controlled for purposes of protection of individuals from exposure to radiation and radioactive materials. See Section 3.6.2.G.
- D. Unrestricted Area: any area or laboratory which is not controlled for purposes of protection of individuals from exposure to radioactive materials.

3.6.2 POSTING OF AREAS AND LABELING REQUIREMENTS

Signs and labels are required by 10-CFR-20 to denote areas or containers containing radiation or radionuclides. The following signs and labels shall be used:

- A. CAUTION, RADIOACTIVE MATERIAL(S)

Each area or room in which there is used or stored an amount of radioactive material exceeding ten times the quantity of such material specified in 10-CFR-20 Appendix C shall be posted with a sign bearing the radiation caution symbol and the words "Caution, Radioactive Material."

Each container which holds an amount of radioactive material exceeding the quantity of such material specified in 10-CFR-20 Appendix C shall bear a label with the radiation caution symbol and the words "Caution, Radioactive Material."

B. CAUTION, RADIATION AREA

Any area accessible to individuals in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 mrem in one hour at 30 cm from the radiation source, shall be posted with a "Caution, Radiation Area" sign.

C. CAUTION HIGH RADIATION AREA

Any area accessible to individuals in which radiation levels could result in an individual receiving a dose equivalent in excess of 100 mrem in one hour at 30 cm from the radiation source, shall be posted with a "Caution, High Radiation Area" sign.

Each area so posted shall be equipped with a control device which shall: i) cause the level of radiation to be reduced below that level at which an individual might receive a dose of 100 mrem in one hour at 30 cm from the source, and/or ii) shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering and the supervisor of the activity are made aware of the entry.

D. CAUTION AIRBORNE RADIOACTIVITY AREA

Any room, enclosure or area in which airborne radioactive materials exist in concentrations in excess of the derived air concentration (DAC) limits specified in 10-CFR-20, Appendix B, shall be posted with a "Caution, Airborne Radioactivity Area" sign.

E. Only signs of the design specified in 10-CFR-20 shall be used.

F. The Department of Occupational Health and Safety will supply all signs required for posting in areas or rooms. The Permit Supervisor shall insure that proper labels are available in the laboratory for labeling containers.

G. All areas, rooms or laboratories requiring posting shall be considered **Restricted Areas.**

3.6.3 EXCEPTIONS FROM POSTING REQUIREMENTS

- A. A room or area is not required to be posted with a caution sign because of the presence of a sealed source provided the radiation level at 30 centimeters from the surface of the source container or housing does not exceed 5 mRem/hr.
- B. Caution signs are not required to be posted at areas or rooms containing radioactive materials for periods less than 8 hours provided such materials are constantly attended during such periods by an individual who shall take the precautions necessary to prevent the exposure of any individual to radiation or radioactive materials in excess of the limits established in this section and such area or room is under the control of the Permit Supervisor or Authorized User.

3.7 PROCEDURES FOR USING RADIOACTIVE MATERIALS

3.7.1 UNSEALED SOURCES

3.7.1.1 PROTECTIVE RULES FOR PREVENTING PERSONAL CONTAMINATION

Extreme personal cleanliness and careful techniques are the primary means of preventing contamination and protecting against inhalation, absorption, or ingestion of radionuclides. In order to minimize contamination and prevent entrance of radionuclides into the body, the following rules shall be observed in laboratories where unsealed sources are used.

- A. EATING, DRINKING, SMOKING, FOOD STORAGE OR PREPARATION, AND APPLICATION OF COSMETICS SHALL NOT BE PERMITTED IN ANY ROOM WHICH IS POSTED WITH A SIGN DESCRIBED IN 3.6.2.
- B. Storage of empty food containers is also not permitted in any room which is posted with a radiation warning sign. Examples are coffee mug/cup, soda cans, lunch boxes, thermoses, etc.
- C. Protective gloves, a long sleeved lab coat, and safety eyewear shall be worn when handling radionuclides.
- D. Pipetting of radioactive solutions by mouth shall not be permitted no matter what activity is involved. Automatic devices are available and shall be used for such applications.
- E. Contaminated equipment and other apparatus used in the processing of radioactive material shall bear a "Caution-Radioactive Material" label.
- F. Containers for radioactive samples shall have only one distinctive label which indicates that the contents are radioactive material (e.g. a coffee can used for storage of samples shall have original label completely obliterated). The container must also be marked with the name of the nuclide within, the amount of activity and storage date.
- G. No experiment with radionuclides should be undertaken until trial runs, complete in every detail, are made with non-radioactive materials. Such

runs should be made until the procedure is reproducible, and improvements incorporated as needed.

- H. Any work with radionuclides susceptible to atmospheric distribution (e.g. vaporizing, aerosol producing, spillage, lusting, effervescence of solution or other releases of radioactive gas) shall be confined to suitable hood or glove box. See Appendix A for specifications.
- I. Personnel shall not be permitted to work with radionuclides if there are open cuts or abrasions on the body (e.g. fingers, hands, arms, etc.). Extreme precaution must be taken to avoid cuts or puncture wounds, especially when working with materials of high activity or of a high hazard.
- J. Care must be exercised when using organic solvents to avoid skin contact with radioactive materials (solvents may make the skin more permeable and many are biohazards). Radioactive iodine (non-bound forms) can quickly permeate through latex and rubber gloves. Therefore, when handling radioiodine, 2 pairs of gloves (preferably polyethylene or nitrile) shall be worn with the outer pair changed after each handling. Hands should be frequently surveyed with the survey meter during radioiodine work.
- K. Monitoring of hands, feet, and clothing is required when using radionuclides. Protective garments shall be left in the laboratory when work is completed or until monitored and found free of contamination.

3.7.1.2 PROTECTIVE RULES FOR CONTROLLING CONTAMINATION OF LABORATORY FACILITIES AND EQUIPMENT

- A. Contaminated equipment or equipment that has been used and is suspected of being contaminated, shall be isolated in designated areas in the laboratory or in suitable storage spaces until it can be smear tested to determine the contamination level. Such equipment shall be decontaminated as soon as possible. Contaminated equipment must bear the "Caution Radioactive Material" label.
- B. One sink in each laboratory may be designated for washing contaminated glassware equipment, etc.
- C. Tools, equipment, and apparatus when used in handling radioactive material, should be placed in non-porous metal trays or pans which are lined with plastic backed absorbent (disposable) paper. This paper should be surveyed and changed frequently.
- D. Any working surface where radioactive materials are used shall be covered with plastic backed absorbent paper (disposable) and be appropriately labeled. This paper shall be surveyed as specified in Section 3.5.C and changed when contaminated or after each experiment.

Trays with a raised edge may be used as an alternative to absorbent paper.

- E. Auxiliary containers, blotters, and covers shall always be used where danger of spills and contamination of personnel exist.
- F. Refrain from bringing equipment into the working area if it is not immediately necessary to the operations being performed.
- G. Equipment and tools shall be routinely surveyed following their use. No equipment shall be returned to stock unless it is known to be completely free of contamination inside and outside.
- H. Contamination shall not be allowed to remain on working surfaces unless appropriately shielded.

3.7.1.3 ALLOWABLE CONTAMINATION LEVELS

For the purposes of this manual contamination means amounts for beta-gamma activity greater than 100 dpm or alpha activity greater than 20 dpm as determined by survey of a filter paper smear on a surface of 100 cm².

3.7.2 SEALED SOURCES

3.7.2.1 DEFINITION

A sealed source is one in which radioactive material is permanently encapsulated (in stainless steel, plastic, glass, lacquer, or other material) to prevent leakage, and in which the intent is to utilize the radiation emitted rather than the material itself. Sealed source purchase is subject to Section 3.1 of this manual.

3.7.2.2 PROTECTIVE RULES FOR PREVENTING PERSONAL EXPOSURE

- A. Sealed sources shall not be handled directly by hand (exception: reference sources of very low activity; e.g. 0.1 μ Ci). The use of remote handling tools for sources of high activity is essential to minimize both whole body and hand exposure.
- B. Permit Supervisors, Authorized Users, or Trainees should monitor themselves periodically during periods of work with the sealed source(s) to assure that source rupture or leakage has not occurred.
- C. Users shall not attempt to repair a ruptured or leaking source.
- D. In case of devices containing sealed sources (e.g. gas chromatography), the device and source shall be used only as recommended by the manufacturer. Sources may not be removed from such devices except in those cases where the devices are specifically designed for usage of the source outside the devices. The Department of Occupational Health and

Safety shall be notified if a source is to be removed from a device such as a gas chromatograph.

- E. Repair of devices containing radioactive sources is normally not permitted when such repair involves those parts of the device containing the source. The Radiation Safety Officer shall be consulted to determine the conditions under which minor repairs or corrections may be authorized.

3.7.2.3 LEAK TESTING

Unless otherwise exempted by the U.S.N.R.C. regulations because of low activity, periodic leak tests are required on all sealed sources. (Exceptions: beta-gamma sources 100 μ Ci or less, alpha sources 10 μ Ci or less.)

- A. Leak tests will be carried out on each sealed source containing radioactive material (other than H-3) with a half-life greater than 30 days and in any form (other than gas) every six months.
- B. Alpha emitting sources shall be leak tested every three months.
- C. If a leak test certification does not accompany the acquired sealed source, it must be leak tested upon receipt in the Department of Occupational Health and Safety before it can be put in use.
- D. Except for alpha sources, sealed sources which are in storage and have not been used, need not be leak tested. However, they shall be leak tested prior to being placed in use or transferred to another person unless they have been leak tested within six months prior to the date of use or transfer. A leak test certification must accompany any sealed source transferred.
- E. Any sealed source which is fabricated by a Permit Supervisor, Authorized User or Trainee shall be inspected and leak tested by the Department of Occupational Health and Safety for construction defects, leakage, and contamination prior to use or transfer as a sealed source.
- F. If inspection or leak test reveals any construction defect or the presence of 0.005 microcuries or more of removable contamination on the sealed source, the source will be immediately removed and shall not be used or transferred as a sealed source until it has been repaired, decontaminated and retested.
- G. Leaking sources must be disposed of as radioactive waste if they cannot be returned to the manufacturer for repairs.
- H. The Radiation Safety Officer or his/her authorized representative shall perform inspection of sources and leak testing as necessary. A permanent record of such actions is kept in the Department of

Occupational Health and Safety with results kept in units of microcuries. A report of actions is also sent to the Permit Supervisor in charge of the sealed source. The Radiation Safety Officer shall also inform the N.R.C. of tests revealing contamination in excess of 0.005 microcuries in the required five day time limit.

3.7.2.4 CAUTION SIGNS, LABELS, AND TAGS FOR SEALED SOURCES

- A. Any sealed sources containing by-product material or special nuclear material (as defined by the U.S.N.R.C.) which is used outside of its shielded container shall be clearly labeled.
- B. Sealed sources mounted in devices or shields shall have on the shield or device a sign "Caution Radioactive Material." Also the radionuclide, amount, and date assayed shall be included.
- C. Sealed sources mounted in devices or shields should not have a radiation exposure of greater than 2.5 mR/hr. at one foot when in a shielded storage condition.
- D. Sealed sources in devices or shields having an exposure rate greater than 2.5 mR/hr. at one foot must be provided with additional shielding or a "Caution Radiation Area" sign must be posted at the point where the exposure exceeds 2.5 mR/hr.

3.7.3 GIFTS

No gifts of radioactive material or other radiation emitting devices shall be accepted by any person at the University unless authorized by the Radiation Safety Officer.

3.8 DISPOSAL OF RADIOACTIVE WASTE

3.8.1 GENERAL CONSIDERATIONS

- A. Unless specifically authorized by the Radiation Safety Committee, no radioactive materials shall be disposed of directly into any sanitary sewer system.
- B. Radioactive wastes shall not be placed into the cold trash (non-radioactive waste).
- C. Radioactive wastes shall not be stored for decay by Permit Supervisors.
- D. Shipping containers (cardboard boxes) may be placed in the cold trash if all shipping labels have been removed and a survey of the container indicates no removable or embedded contamination.
- E. All radioactive wastes shall be collected in suitable containers provided or authorized by the Department of Occupational Health and Safety. Containers

shall not be removed from the restricted area. All containers must be labeled with a "Caution Radioactive Material" sign.

- F. The Department of Occupational Health and Safety will collect radioactive wastes from user facilities.
- G. The Department of Occupational Health and Safety may not pick up any radioactive waste which is not properly labeled in accordance with the regulations of this section.
- H. Any accidental releases of radioactive wastes, into the environment must be reported immediately to the Department of Occupational Health and Safety.
- I. If wastes are not segregated as specified by the Radiation Safety Officer, the Department of Occupational Health and Safety may levy a separation charge against the responsible party or require the responsible party to segregate the waste.
- J. When unusual problems of disposal arise, the Department of Occupational Health and Safety shall be consulted to establish a satisfactory procedure.

3.8.2 SOLID DRY WASTE

Definition: paper, pipettes, glassware, gloves, polyethylene or absorbent paper work coverings, bottles, dry scintillation vials containing no fluids.

3.8.2.1 CONTAINERS

Dry waste is collected in five gallon waste cans provided by the Department of Occupational Health and Safety. Other waste containers may be authorized by the Department of Occupational Health and Safety if proper signs are placed on the containers. Solid waste must be segregated by isotope.

3.8.3 LIQUID SCINTILLATION VIALS (LSV)

Definition: plastic or glass vials which contain liquid scintillation cocktail.

3.8.3.1 CONTAINERS

The containers for LSVs are the same type used for solid waste. Disposal regulations and processing requirements require LSVs be segregated as follows:

- A. Vials containing H-3 and/or C-14 and less than 0.05 microcuries per gram of media.
- B. All others.

3.8.4 LIQUID WASTES

Definition: aqueous and/or organic fluids containing radioactive material.

3.8.4.1 CONTAINERS

The Department of Occupational Health and Safety provides polyethylene jugs for liquid waste. All liquid containers shall be placed inside plastic trays or other secondary containment to contain spillage. Aqueous and organic solutions shall not be mixed in the same container.

3.8.4.2 STRONG ACIDS, BASES, OR SOLVENTS

Unless special arrangements are made with the Department of Occupational Health and Safety, the Permit Supervisor or Authorized User is required to neutralize strongly acidic or basic waste solutions to a pH between 4 and 10.

3.8.5 GASEOUS AND AIRBORNE WASTES

In cases where the release of volatile radioactive products or radioactive aerosols are anticipated, means shall be provided to trap such materials (either by chemical or physical methods, e.g. a phenylethylamine trap for $^{14}\text{CO}_2$ or activated charcoal trap for radioiodine). The resulting product may then be handled as liquid or solid dry waste, whichever is appropriate.

3.8.6 BIOLOGICAL WASTES

All animal carcasses and other biological wastes shall be disposed of according to procedures issued by the Department of Occupational Health and Safety.

3.8.7 PROCEDURE FOR COLLECTION

To arrange for a waste collection, the Permit Supervisor or Authorized User must contact the Department of Occupational Health and Safety, extension 8475. An on-line form, available on the department's web site (www.udel.edu/OHS), may also be used to arrange a collection. The following information must be provided: Permit Supervisor's name, room and building, container size, type of waste, isotope and activity.

Additional questions regarding radioactive waste disposal should be directed to the Department of Occupational Health and Safety.

3.9 USE OF ANIMALS IN RESEARCH WITH RADIOACTIVE MATERIALS

- A. Normally radioactive materials shall be administered only to animals owned by the University. Any administrations to animals not owned by the University shall be approved by the Radiation Safety Officer and Director of Laboratory Animal Care.
- B. All cages containing animals into which radioactive materials have been injected shall be marked with warning tape stating "Caution Radioactive Material." The use of disposable cages is highly recommended.

- C. All dead animals which had been injected with radioactive materials must be considered as radioactive waste. Feces and urine from animals injected with radioactive materials must be collected and considered as radioactive waste. Dead animals or feces shall be double contained. Plastic bags may be used for this purpose. All wastes so collected shall be marked with warning tape stating "Caution Radioactive Material" and the radionuclide, amount and date.
- D. The Permit Supervisor, Authorized User or Trainee shall be responsible for feeding, watering, cage cleaning, and removal of urine and feces from cages which contain animals injected with radionuclides. They are also responsible for decontamination of the cages to less than or equal to the limits allowable as per Section 3.7.1.3 at the end of the experiment.
- E. If an animal is sacrificed following the injection of radionuclides or shortly thereafter, the carcass should be double bagged, frozen, and marked with warning tape stating "Caution Radioactive Materials", the radionuclide, amount, and date, and held for radioactive waste pick-up. If the animal is to remain alive or is to be used in other succeeding experiments, the Permit Supervisor, in conjunction with the Director of Laboratory Animal Care and the Radiation Safety Officer, is responsible for tagging the animal in such a way as to insure that when the animal is sacrificed or dies it will be considered as radioactive waste and will be properly disposed of through the required channels. Animals may be tagged by ear notches or by other appropriate means. Tagging must be properly recorded so that when the animal dies the radionuclide used and amounts will be known. (See Section 3.9.B.).
- F. Possible hazards resulting from air concentrations of radionuclides arising from metabolism of the animal or from cage waste must be controlled with particular attention to airborne levels in Non-Restricted Areas. The Department of Occupational Health and Safety will carry out air sampling necessary to determine concentrations of radionuclides in air. Filter traps or metabolism cages may be required to meet safety standards for airborne concentrations of radionuclides.
- G. In cases where an animal caretaker may be necessary for care and feeding of animals injected with radionuclides, the Permit Supervisor shall submit written instructions for animal care and hazards involved to the Director of Laboratory Animal Care and the Radiation Safety Officer for review. If the use of an animal caretaker is approved, the Permit Supervisor is responsible for advising the animal caretaker of the hazards (if any) which are involved.
- H. The animal rooms have not been designed for research with radioactive materials. Unless approved by the Radiation Safety Officer and the Director of Laboratory Animal Care, animals can not be returned to the normal population. They must be sacrificed.
- I. Normally, all animals used in radionuclide research must be held in the researcher's laboratory until sacrificed.
- J. The Permit Supervisor is responsible for notifying the Director of Laboratory Animal Care and the Radiation Safety Officer of any location where animals injected with radioactive materials are to be placed prior to placement of the animals.

3.10 PERSONNEL MONITORING

3.10.1 EXTERNAL MONITORING

3.10.1.1 USNRC REQUIREMENTS

Any person occupationally exposed to radiation must be issued, and shall use, an individual monitoring device (e.g. film dosimeter) if he/she is likely to receive a dose in excess of 10% of any limit specified in 10-CFR 20.1201, 20.1207, and 20.1208.

Maximum permissible dose per year (in rems) per 10-CFR 20.1201, 20.1207, and 20.1208:

Whole body (head, trunk, and legs/arms out knee/elbow): 5 rems

Any individual organ: 50 rems

Extremities (hands, forearms, feet, and ankles): 50 rems to the part of the body receiving the highest exposure

Skin: 50 rems to the part of the body receiving the highest exposure

Lens of the Eye: 15 rems

Minors (under age 18): must not exceed 10% of the above limits

Embryo/Fetus of a Declared* Pregnant Woman: 0.5 rems

* has voluntarily informed the Department of Occupational Health and Safety, in writing, of her pregnancy and estimated date of conception

3.10.1.2 UNIVERSITY REQUIREMENTS

Although not necessarily required according to the USNRC requirements, the wearing of personnel dosimeters are required by University policy for University personnel and students using radiation producing devices, USNRC or non-USNRC regulated radioactive materials, for all the following situations except as specified in 3.10.1.3.

- A. When working with beta emitters with a maximum beta energy exceeding 0.250 MeV.
- B. When working with x-ray or gamma emitters of any energy (exception: I-125 in amounts less than 100uCi).
- C. When working with neutron sources of any type.
- D. When working with x-ray producing devices.

- E. When working with accelerators or devices accelerating charged particles.
- F. When working in a high or very high radiation area.

In addition to whole body dosimeters, wrist, ankle or ring dosimeters will be provided as necessary depending on the expected radiation exposure from use of the radioactive material or the device.

3.10.1.3 EXEMPTIONS FROM PERSONNEL MONITORING

The use of personnel dosimeters may not be required in cases where it has been definitely established by the Department of Occupational Health and Safety that exposure to external source of radiation will not exceed 10% of the occupational dose limits listed in 3.10.1.1. Exceptions will depend on an evaluation of the intensity and energy of the radiation and working conditions involved.

3.10.1.4 DOSIMETER INFORMATION

- A. The Department of Occupational Health and Safety issues personnel dosimeters to individuals who work with radiation as described in 3.10.1.2. Individuals must fill out a Statement of Training and Experience Form available from the Department of Occupational Health and Safety.
- B. If an individual is issued a personnel dosimeter, it must be worn at all times when the individual is occupationally exposed. Whole body dosimeters shall be worn on the part of the body which receives the highest exposure (e.g. on breast pocket, collar, belt). Extremity dosimeters (e.g. ring badges, wrist badges) shall be worn on the part of the extremity which receives the highest exposure.
- C. Dosimeters are cycled on a quarterly basis; new ones are issued and old ones are collected and processed.
- D. The badge shall not be worn when the individual is undergoing diagnostic or therapeutic radiation exposure.
- E. When not in use, the badge shall be stored in a location away from sources of radiation (above background), excessive heat, or moisture.
- F. If a badge is lost, the department will be charged a lost fee of \$20.00.

3.10.1.5 RECORDS AND REPORTS

- A. Permanent records of the radiation dose to workers are maintained by the Department of Occupational Health and Safety.
- B. In cases where an individual monitored for external exposure receives a quarterly exposure equal to or exceeding 2.5% of the applicable regulatory dose limit, the Department of Occupational Health and Safety will contact the individual as part of the University's ALARA policy. Together with a radiation safety staff member, the individual will evaluate exposure to determine whether future similar exposures can be avoided or reduced.
- C. The Department of Occupational Health and Safety will provide an individual on an annual basis or upon written request, a copy of his/her external occupational exposure at the University. Records of external exposure will be forwarded to new employees upon written request of the individual.
- D. Individuals who indicate on the University of Delaware Request for Personnel Dosimeter Form that they have had previous occupational exposure which was recorded by personnel dosimeter at other institutions shall authorize release of such exposure from each of these institutions to the University of Delaware Department of Occupational Health and Safety.

3.10.2 INTERNAL MONITORING

Any individual authorized to use unsealed sources of radioactive materials is subject to internal monitoring at the discretion of the Radiation Safety Committee.

3.10.2.1 ROUTINE URINE BIOASSAY

Individuals are subject to routine urine bioassays in accordance with the following parameters:

- A. Each individual so designated shall submit a urine specimen to the Department of Occupational Health and Safety on a semi-annual basis for bioassay.
- B. Any individual handling and using in an experiment, 25 millicuries or more of any isotope as an unsealed source (liquid, solid, or gas) excluding plated sources shall notify the Department of Occupational Health and Safety at least 24 hours in advance of such usage and submit a urine specimen for bioassay. Within 24 to 72 hours after handling such amounts, the individual shall again submit a urine specimen for bioassay.

- C. If area monitoring for removable contamination in a radionuclide laboratory indicates the presence of removable contamination in excess of 100 times the allowable contamination levels of Section 3.7.1.3, authorized individuals in the laboratory shall be subject to an immediate urine bioassay.
- D. Individuals subject to routine urine bioassay who are terminating their use of unsealed sources of radionuclide should submit a urine sample to the Department of Occupational Health and Safety within one week after last possible use of radionuclides and prior to total termination.

3.10.2.2 SPECIAL URINE BIOASSAY

- A. Individuals who are known or suspected to have accidentally swallowed, inhaled, absorbed, or otherwise ingested radioactive materials shall be required to submit urine specimens to the Department of Occupational Health and Safety within 24 hours of known or suspected intake. Additional samples and actions up to and including hospitalization will be based on the activity of the urine specimen.
- B. Other special urine bioassays may be required at the discretion of the Radiation Safety Officer.

3.10.2.3 OTHER SPECIMENS FOR BIOASSAY

- A. Depending on the particular radionuclide, the physical and chemical form and mode of intake, individuals who are known or suspected to have accidentally absorbed, inhaled, or ingested radioactive material shall submit other samples (e.g. fecal, nose wipes, breath or blood) for bioassay in addition to or in lieu of urine specimens.
- B. Other specimens for bioassay may be required at the discretion of the Radiation Safety Officer.

3.10.2.4 THYROID MONITORING

- A. All individuals authorized to handle and use in an experiment I-125 or I-131 shall be monitored for possible thyroid uptake of radioiodine by the Department of Occupational Health and Safety depending on the chemical or physical form and amount of radioiodine used per experiment (e.g. >100 μ Ci non-bound form; 1 mCi bound form). Initial measurements shall be taken prior to initial use of the radionuclide and within 72 hours after use.

- B. Each authorized individual subject to thyroid monitoring shall have an initial measurement prior to initial use of the radionuclide. Thereafter, routine measurements shall be taken once per calendar quarter.
- C. Individuals subject to routine thyroid monitoring should have an uptake measurement within one week after last possible use of radioiodine and prior to total termination of usage.
- D. Should results of thyroid monitoring exceed 0.052 μCi of I-125 or 0.093 μCi of I-131, the Department of Occupational Health and Safety shall take appropriate measures to investigate operations, determine possible causes for uptake, and take other corrective actions to eliminate or lower the potential for future exposures.

3.10.2.5 WHOLE BODY COUNTING

In case of real or suspected intake of gamma emitting nuclides, whole body counting may be required in addition to or in lieu of bioassays. The Department of Occupational Health and Safety will arrange for such counting.

3.10.2.6 RECORDS AND REPORTS

- A. Permanent records of internal monitoring results on individuals subject to regulations of this Section are on file in the Department of Occupational Health and Safety.
- B. The Department of Occupational Health and Safety will provide an individual, upon written request, a copy of his/her internal monitoring results. Records of internal monitoring will be forwarded to new employees upon written request of the individual.

APPENDIX A

Contents

TABLE I	Radionuclide Classification
TABLE II	Laboratory Class
TABLE III	Modifying Factors
TABLE IV	General Design Criteria For Laboratories

Facility Requirements:	Hoods
	Glove Boxes
	Working Surfaces
	Walls And Floors
	Shielding
	Air Sampling
	Area Monitoring
	Calibration

EXPLANATIONS OF TABLES I, II, III AND IV

Laboratories are classified based on three factors: (1) radiotoxicity hazard of nuclides in use; (2) maximum amounts of activity stored or used in the area; and (3) type of use in terms of relative hazard of the handling procedures.

In Table I, radionuclides are classified as to their relative radiotoxic hazard in relation to internal dose. The hazard of the radioisotope depends on the effective half-life of the nuclide in the body or organ, the type and energy of the emitted radiation, the physical and chemical form of the material, and the organ of maximum concentration.

For normal usage, laboratories are classified according to the total activity of the various classes of nuclides present in the laboratory. Table II gives the four laboratory classifications (high, intermediate, low, and very low) based on the hazard group and activity present. In cases of more than one nuclide in use in the laboratory, the classification will be determined by summing of the constituent nuclides.

The amount of nuclide permitted in a given class laboratory may be increased or decreased according to type of usage. With high accident risk operations, the amount permitted within the classification is decreased. For simple, relatively safe operations, the amount in a given classification may be increased. As a guide, the modifying factors in Table III are used to determine the amount by which the permitted activity should be increased or decreased.

For general design criteria, Table IV may be used. In designing new areas, the researcher should consult the Radiation Safety Officer to discuss requirements for a particular facility.

FACILITY REQUIREMENTS

HOODS:

A fume hood (radiochemical) shall be used for all operations where there is any chance of airborne radioactivity.

All hoods purchased for installation in new facilities must meet the following requirements and be approved prior to purchase by the Radiation Safety Officer and the Director of Engineering and Construction.

1. Hood Surfaces: The inside surfaces of the hood shall be nonporous, constructed of stainless steel (or similar construction) or in case of currently installed hoods, the inside surfaces must be sealed with an approved epoxy paint in a manner to be approved by the Department of Occupational Health and Safety and Engineering and Construction.
2. Ducting: Unless otherwise approved by the Radiation Safety Officer, each radiochemical hood shall be ducted directly from the hood to the roof of the building with an exhaust stack of at least 10 feet or greater above the roof. A net negative pressure shall be maintained in the ducting. Duct material shall be determined on the basis of the chemical reactivity of the material predominately used in the hood. All duct work must be sealed.
3. Filter Housing: Hoods shall be equipped with a filter housing for the insertion of appropriate exhaust filters (prefilter, HEPA and/or charcoal) as necessary. The filter housing shall be labeled "Radiation Hazard - Contact Department of Occupational Health and Safety." Filters will be changed by qualified personnel. Exhaust fan impeller will be positioned in the duct system in such a way that it is on the discharge side of all filters and contaminated air stream. Filter housing selected should be current "state of the art" providing for least exposure to contaminants and ease of maintenance.
4. Airflow Rate: The airflow rate into the working opening or window shall have a linear velocity (flow rate) of 80 to 125 linear feet per minute and be capable of maintaining a continuous negative pressure (not less than 0.5 inches of water) in the hoods.

In addition, hoods being upgraded for radionuclide use through remodeling or alteration in a facility shall meet the above requirements.

All factors being considered, the hazard involved with a particular operation for which the hood is being used shall be a higher priority than energy conservation in order that health and safety be maintained.

Note: Hoods specified above shall be used predominantly for laboratories using radioactive materials, the use of other materials in radiochemical hoods should be discouraged. The general design specifications for hoods of Table IV of this appendix shall be used to evaluate the need of each of the above stated requirements.

GLOVE BOXES:

The glove box (or dry box) is a portable totally enclosed chamber in which alpha-emitters and low energy beta sources can be handled safely. Glove boxes are designed to protect personnel

and prevent the spread of radioactive and toxic contamination by localizing the hazardous material. They allow operations with low-activity materials to be performed manually, instead of by less convenient remote handling methods.

Glove boxes are constructed of plexiglass or of metal or wood equipped with plate glass or plexiglass windows. Glove ports, fitted with rubber or neoprene gauntlets, permit the worker to handle active substances safely. The walls and gauntlets absorb low-energy radiation so that external exposure is kept below the maximum permissible level. By isolating contamination from the laboratory, glove boxes also afford protection against internal exposure. Negative pressure is maintained within the glove box to prevent the escape of radioactive dusts or mists.

A small exhaust blower is employed to keep the chamber slightly below atmospheric pressure. An exhaust rate of 10 cubic feet per minute is sufficient for most operations. Air passing through the exhaust system must be filtered to remove airborne contamination in addition, incoming air may be dried by a desiccant and filtered. The glove box and its exhaust system must contain no leaks.

Materials and equipment are placed in the glove box and removed through an airlock located at one end of the chamber. In this way, items are introduced into the glove box without having to open it to the outside. Old or worn gauntlets also may be replaced without uncovering the glove ports. A glove box is normally provided with electricity, vacuum, etc., by means of service connections at the rear of the chamber. A fluorescent light located on the outside of the box, near the top, supplies illumination. The bottom panel may have an opening under which a plastic bag is fastened to hold solid waste products. For most operations, however, waste can be withdrawn through the airlock after the experiment is completed.

WORKING SURFACES, WALLS AND FLOORS:

All working surfaces will be constructed of materials that are non-porous and resistant to attack by solutions containing radioactivity. These shall be capable of being decontaminated with acid or base solutions and have flush seams or be seamless to simplify decontamination. In general, stainless steel, tempered glass, or plastics of a strippable nature are usually satisfactory. Should surfaces not meet requirements, they must be covered with plastic backed absorbent paper.

Bare concrete will not be used as flooring. Floors will be constructed with a non-porous covering, such as, stainless steel, vinyl plastic tile, asphalt tile or heavy duty linoleum with a thick wax coating. Laboratories or other areas with wooden floors or working surfaces will not be used for radiological operation.

The walls and ceilings of laboratories using radionuclides should be constructed of non-porous materials or covered with a heavy coating of strippable paint or heavy-duty waterproof paper for easy decontamination.

SHIELDING:

The Department of Occupational Health and Safety will check periodically to ensure that adequate shielding is used in operations with radionuclides. The total amount of shielding material that will be necessary will depend on the amount of activity and the type of radiation involved.

The Department of Occupational Health and Safety shall be consulted on all shielding problems encountered.

The following are efficient shielding materials for various types of radiation emitted.

<u>Radiation Type</u>	<u>Shielding Material</u>
Gamma Ray or X-ray	Lead or Concrete
Beta Particles	Aluminum, Lucite or other Plastics of low Atomic Number
Neutron	Water, Paraffin or Barytes Concrete

AIR SAMPLING:

In cases where operations with radionuclides may produce airborne radioactivity, air monitoring shall be carried out by the Department of Occupational Health and Safety during the use of the material. Review of the air monitoring results will determine the need for further air monitoring or actions to be taken by the Radiation Safety Officer.

All operations with radionuclides which may produce airborne radioactivity shall be confined to a hood or glove box.

AREA MONITORING:

Area monitoring of a laboratory facility by the Department of Occupational Health and Safety for removable contamination shall be carried out monthly. This survey is not a substitute for area surveys for contamination to be carried out by the Permit Supervisor, Authorized User or Trainee.

Area monitoring for external radiation shall be carried out by the Department of Occupational Health and Safety on an as needed basis depending on the nuclide, amount, or whether sealed or unsealed sources are involved.

CALIBRATIONS:

Survey Instruments shall be sent to the Department of Occupational Health and Safety every year for calibration. The Department of Occupational Health and Safety will notify the Permit Supervisor of the date the instrument is to be calibrated.

APPENDIX B

Radiation Safety Program Compliance Policy [Amended by the Radiation Safety Committee on March 18, 2004]

It is the aim of the Radiation Safety Program to work cooperatively with radiation permit supervisors and laboratory workers to achieve compliance with University radiation safety policies and governmental regulations. From time to time, however, it may be necessary to impose sanctions to achieve compliance. This policy is designed to ensure compliance through a system of phases that applies increasing pressure on a supervisor to make the appropriate corrective actions. The Radiation Safety Committee has the authority to modify this policy at any time.

Phase 1

When a deficiency is identified in a laboratory, the following steps are taken.

1. The Permit Supervisor is informed of the deficiency in person, by phone and/or by email.
2. The deficiency is noted on the Audit Report which is sent to the Supervisor by campus mail.
3. The Supervisor is informed on the Audit Report that a follow-up audit will be conducted and that a repeat of the deficiency will result in a Notice of Violation.
4. Within four weeks, a follow-up audit is conducted to determine if the Supervisor's corrective actions were successful at eliminating the deficiency.

Phase 2

When a follow up audit identifies the same, or a similar, deficiency the following steps are taken.

1. The Permit Supervisor is informed of the repeat deficiency in person, by phone and/or by email.
2. A Notice of Violation, signed by the Radiation Safety Officer and/or Radiation Safety Chair, is sent to the Supervisor requiring that the Supervisor send a written response to the Radiation Safety Committee explaining the corrective measures that will be employed to prevent future deficiencies. The Supervisor must respond within 30 days.
3. The Radiation Safety Committee reviews the Supervisor's response. If unsatisfactory, the Committee will exercise its judgment to either require more information from the Supervisor or move directly to Phase 3. If satisfactory, the Committee responds to the Supervisor in writing. The Supervisor is informed that another violation of the same requirement anytime in the next 12 months will initiate Phase 3 actions.
4. The laboratory of the Supervisor is audited at an increased frequency for the next 12 month period.

Phase 3

The following actions are taken if any of the following occur-- 1) the Supervisor does not respond to a Notice of Violation (NOV) within 30 days, 2) the Supervisor's response to the NOV is deemed unsatisfactory by the Radiation Safety Committee, 3) the same (or similar) deficiency is noted within 12 months of the Radiation Safety Committee's acceptance of the Supervisor's NOV response.

1. The Permit Supervisor may not order radioactive material. All use of radioactive material conducted under the Supervisor's Radiation Use Permit must cease for at least 30 days.
2. Authorization to order and use radioactive material shall be reinstated only after the Permit Supervisor has appeared in person before the Radiation Safety Committee, at a meeting called specifically for that purpose, and satisfactorily explained the measures taken to avoid future deficiencies.
3. The Supervisor is informed of these restrictions in person, by phone and/or by email. A letter, signed by the Radiation Safety Officer and/or Radiation Safety Chair, is also sent to the Supervisor explaining the restrictions. A copy of the letter is also sent to the Chairperson of the Permit Supervisor's department.
4. Once the Supervisor is re-authorized, radiation safety staff audits the laboratory of the Supervisor at an increased frequency until otherwise instructed by the Radiation Safety Committee.

Phase 4

If deficiencies continue past the Phase 3 stage, the Radiation Safety Committee will determine the next course of action on a case-by-case basis. This may include temporary or permanent withdrawal of radioactive material use authorization.