

RADIATION SAFETY MANUAL



THE UNIVERSITY OF
TOLEDO
1872

RADIATION SAFETY OFFICE

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RADIATION SAFETY MANUAL

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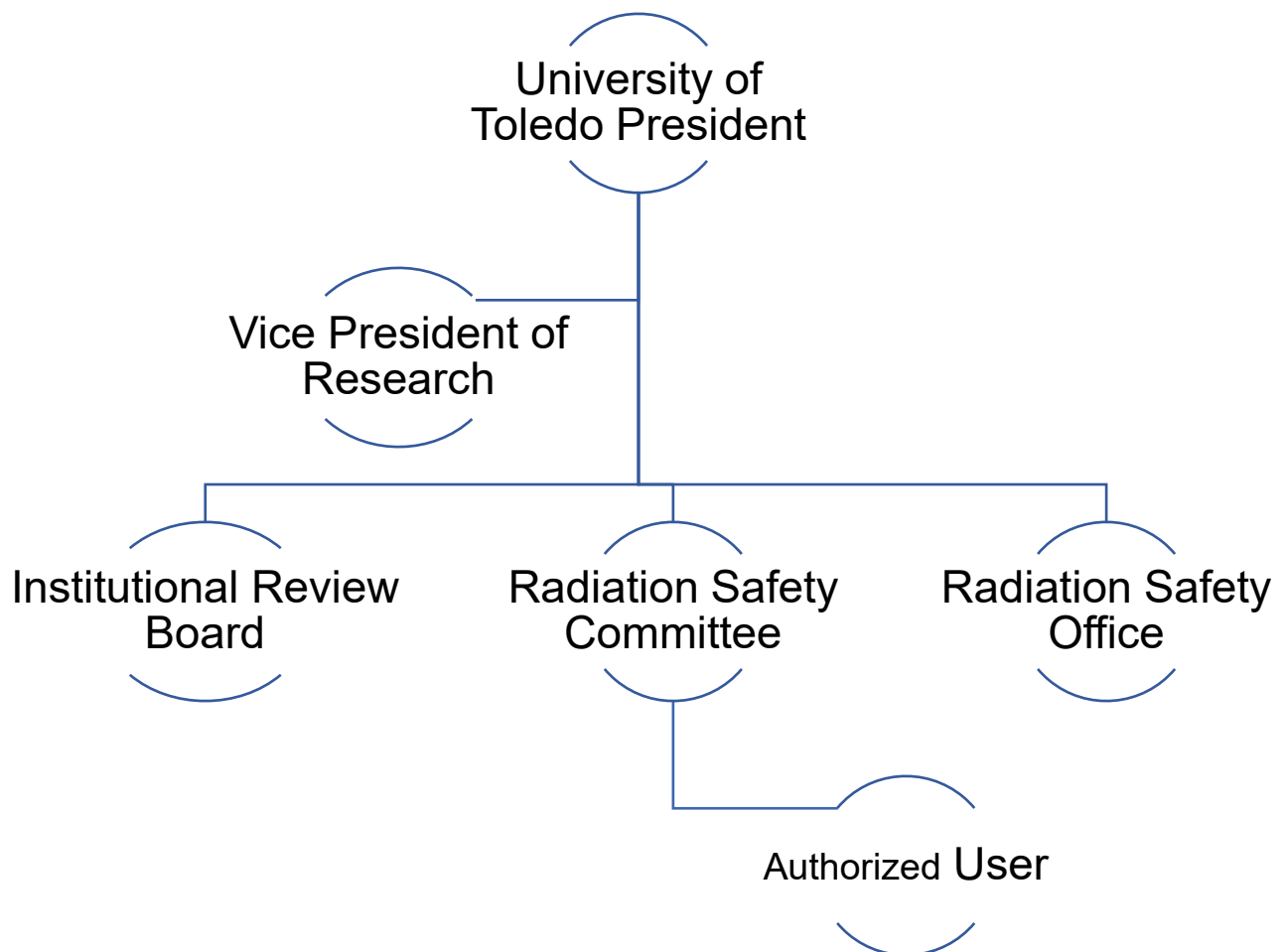
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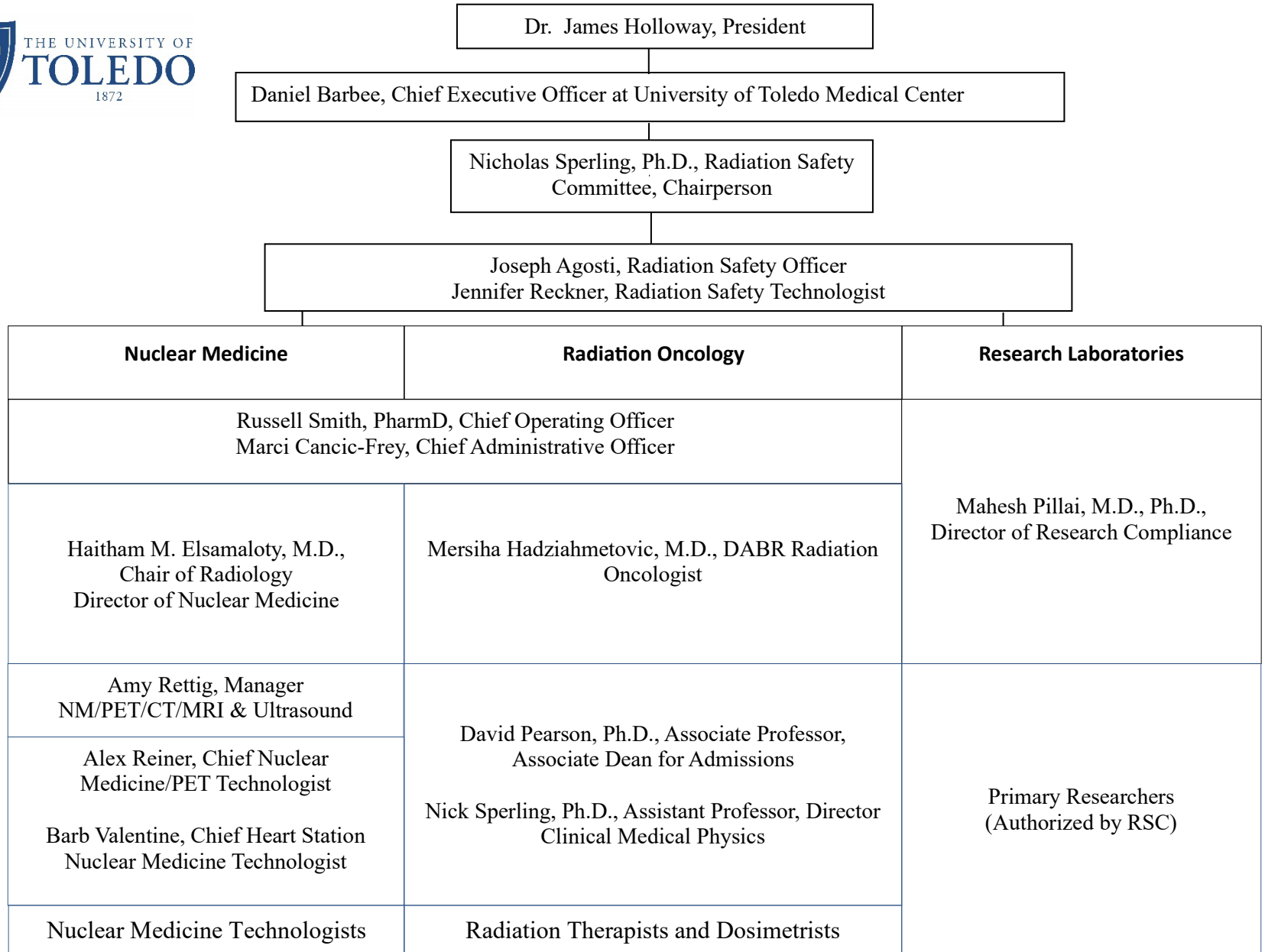
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Administrative Controls

A. Organization

The administrative control of the University of Toledo Radiation Safety Program is schematically represented by the chart below. There are two channels of administrative authority. The administration is for appointments and executive responsibility; the Radiation Safety Committee is for review and approval of applications.





B. Radiation Safety Committee

1. Function

The Radiation Safety Committee (RSC) is mandated by the Ohio Department of Health (ODH) and is comprised of faculty and staff from the University of Toledo. The RSC is responsible for the establishment, control, direction, and enforcement of the University of Toledo's Radiation Safety Program to ensure the safety and welfare of Main Campus and Health Science Campus personnel and property as well as protecting the surrounding community from the potential hazards of all sources of ionizing radiation.

2. Membership

The Chairman of the Committee is appointed by the Executive Vice President for Academic Affairs; members of the Committee are appointed upon the recommendation of the Radiation Safety Officer (RSO). The committee must include an authorized user of each type of use permitted by the license, the radiation safety officer, a representative of the nursing service, and a representative of management who is neither an authorized user nor a radiation safety officer. The committee may include other members the licensee considers appropriate.

3. Meetings

The Committee shall meet regularly, and no less than once every quarter. Meetings other than regular meetings may be called by the Chairman or any three members of the Committee. Minutes of the proceedings shall be recorded and circulated by the Radiation Safety Office to membership and to personnel of the institution having specific interest in the proceedings.

4. Procedures

The meeting shall generally be conducted according to the principles of Robert's Rules of Order and the Chairman shall use them as a guide at the request of any individual member.

a. The Order of Business shall proceed as follows:

- i. Review of minutes from the previous meeting
- ii. Old Business
- iii. New Business

b. Quorum

- i. To establish a quorum and to conduct business, at least one-half of the Committee's membership must be present during the quarterly meeting and must include the Radiation Safety Officer and the administrative representative.
- ii. For all matters considered by the Committee, a simple majority vote of the quorum shall be required for approval.

5. Duties

- a. Reviewing, approving, disapproving, or tabling applications for the procurement and use of radioactive materials at the University of Toledo.
- b. Reviewing and recommending actions on applications for medical use of radioactive material in research with human subjects. Final approval by the RSC of these applications requires the final approval of the Institutional Review Board.
- c. Reviewing and recommending approval of application for medical use of radioactive material in standard clinical procedures.
- d. Prescribing specific conditions that may be necessary for the safe handling of any source of ionizing radiation in connection with granting approval of an application.
- e. Maintaining awareness of the regulations and license conditions pertaining to the Radiation Safety Program.

- f. Prescribing specific conditions that may be necessary for the safe handling of any source of ionizing radiation in connection with granting approval of an application.
- g. Developing and implementing policies and regulations specific to the University of Toledo for maintaining safety and compliance.
- h. Reviewing any violation of the University of Toledo's Radiation Safety Program and taking appropriate action to address the violation. Violations will be reported to administration by the RSO and the administrative representative for the RSC.

6. Enforcement

In the event of a failure to comply with ODH rules and regulation and University of Toledo specific policies governing the safe use of radioactive material, the RSO shall notify the offending individual(s). The notification will state the nature of any violation as well as the information that an unfavorable report will be made to the RSC unless the violation is remedied. If full compliance has not been achieved within a reasonable period of time, the RSO shall bring the violation to the attention of the RSC at its next quarterly meeting. The RSO may call a special meeting to consider the violation depending on the nature of the violation. After consideration of such a report, the RSC may make recommendations for mandatory remedial actions with a failure to comply being just cause for withdrawal of the RSC's approval of the individual's authorized user status. In enforcement cases, the authorized user may be present at the RSC hearing if he or she desires.

C. Radiation Safety Office

1. Function

The Radiation Safety Office shall be responsible for the surveillance and maintenance of the Radiation Safety Program of the University of Toledo on a daily basis and shall be responsible for notifying the RSC and executive administration as to the status of said program.

2. Organization

The Radiation Safety Office shall be composed of the RSO and a sufficient number of technical and support personnel to carry out the functions and duties of the Radiation Safety Office.

3. Duties

The RSO and the Radiation Safety Office personnel shall:

- a. Conduct routine monitoring and regulatory compliance surveys in all areas and facilities where sources of ionizing radiation are employed as well as those surrounding areas where the effects of radiation may be a possibility.
- b. Distribute personnel monitoring devices to individuals who are exposed to ionizing radiation from radioactive materials or devices possessed by the University of Toledo, and who are likely to exceed 10% of the annual occupational dose limits.
- c. Manage the processing, evaluation, and record keeping for the monitoring program to include advising personnel of their exposure.
- d. Supervise and coordinate the University of Toledo's radioactive waste storage, decay, and disposal program.
- e. Perform leak tests of sealed sources in accordance with OAC 3701:1-58-27. Leak test records must be retained for three years.
- f. Perform or arrange for the calibration of GM survey meters.
- g. Approve all orders for radioactive materials to determine compliance with the authorized user's possession limits.
- h. Review all shipments of radioactive materials and confirm their authorized use and delivery to an authorized area of use.
- i. Maintain an inventory of all sealed sources and unsealed radioactive material at the University of Toledo, as well as review authorized user's record of receipt, disposition, and disposal.
- j. Provide guidance, advice, and training on regulatory requirements in addition to University of Toledo radiation safety procedures.

- k. Supervise decontamination activities in the event of a significant contamination event.
4. Audit of Radioactive Material Use
- a. Items included in the Annual Audit of the Radiation Safety Program are:
 - i. Review of the types and quantities of RAM used clinically and in research to ensure compliance with license limits.
 - ii. Review of surveys done in clinical and research areas
 - iii. Evaluation of training for authorized users and technologists.
 - iv. Review results of all surveys performed by the Radiation Safety Office.
 - v. Evaluation of compliance with regulations, conditions of our RAM license, authorized user certificates of use, and the University of Toledo Radiation Safety Manual.
 - vi. Review of performance-based instruction by the Radiation Safety Office for authorized users and/or technical staff.
 - b. The frequency of audits for areas of use varies depending on the type of radioactive material used.
 - i. Clinical General Nuclear Medicine, PET/CT, and the Heart Station Nuclear Cardiology are audited by the Radiation Safety Office on a quarterly basis.
 - ii. All research areas are audited by the Radiation Safety Office quarterly for adherence to University of Toledo procedures and regulatory compliance.
 - iii. The Radiation Safety personnel informally observe areas of use during waste pick-ups, delivery of dosimetry, and informal walk-throughs. This method has proven to be effective to keep clean lab spaces that are free of contamination and to foster guidance-based communication between the Radiation Safety Office and authorized users.

D. Authorized User

1. Definition

An Authorized User (AU) is any individual who has been granted permission to use radioactive material for specific uses approved by the Radiation Safety Committee.

2. Qualifications

To qualify as an authorized user, the applicant shall:

- a. Be a member of the faculty of the University of Toledo holding the position of Instructor or higher.
- b. Be actively engaged in work, instruction, and/or research at the University of Toledo which requires the use of radioactive materials.
- c. Possess, at the least, the minimum training and experience outlined in Appendix A for Non-Human Use, or meet the requirements outlined in O.A.C. 3701:1-58 for Human Use.

3. Function

The authorized user shall have the primary safety responsibility for those sources of radioactive materials which are listed on his/her Certificate of Use and Quarterly Inventory submissions. The AU shall assure that procurement, storage, and usage all comply with the rules and regulations in this manual.

4. Duties

The authorized user shall:

- a. Confine possession and use of sources of radioactive material to those limits, locations, and purposed detailed in the application for use that he/she submitted to the Radiation Safety Committee as part of the approval process.
- b. Not transfer, abandon, or dispose of such sources except as authorized by the Radiation Safety Office.
- c. Maintain records as specified in this manual.
- d. Conduct or cause to have conducted the required surveys, wipe tests, and leak tests.

- e. Limit the use of sources of radioactive material under his/her control to those people adequately trained in procedures and protocols, and subject to his/her direct supervision.
- f. Instruct the personnel, under his/her supervision in the use of lab specific protocols, radiation safety procedures, and equipment.
- g. Assure that personnel under his/her supervision have become familiar with the University of Toledo's Radiation Safety Program and that they comply with all regulations therein.
- h. Plan his/her research use and use of sources of radioactive material to assure that adequate safety precautions are taken.
- i. Communicate, to the Radiation Safety Officer, pertinent information with respect to changes in operational procedures, new techniques, and any alterations in the physical facilities.
- j. At all times, comply with the University of Toledo's Radiation Safety Program, as detailed in this manual.

II. GENERAL INSTRUCTIONS

A. Application for Use of Radioactive Material

1. General Requirements

To procure the use of any source of radioactive material at the University of Toledo, approval must be obtained from the Radiation Safety Committee.

- a. Considerations: Approval of any applicant shall be based upon its radiation safety aspects and conditions of the radioactive materials license held by the University of Toledo.
- b. Applicant Position: The applicant must meet the requirements of the Radiation Safety Committee for non-human use authorized users.
- c. Training and Experience: The applicant's training and experience must meet the requirements of the Radiation Safety Committee listed in Appendix A.

2. Human Use Requirements

Authorized users for human use must meet the requirements outlined in O.A.C. 3701:1-58. Institutional Review Board (IRB) approval is required for research on humans.

3. Procedures

All applications for possession and use of sources of radioactive material shall be made on appropriate forms obtainable from the Radiation Safety Office or on the University of Toledo Environmental Health & Radiation Safety webpage.

4. Approval of Application

After the Radiation Safety Committee has received and acted upon the application, the applicant will be notified of its decision by the Committee Chairperson. Any revisions to the original application must be submitted to be approved by the Radiation Safety Committee.

B. Procurement Procedures

1. All sources of radioactive material shall be procured and approved under the direction of the Radiation Safety Office. (See Appendix B) for procurement instructions.
2. Any questions concerning the procurement of sources or radioactive material shall be directed to the Radiation Safety Officer.
3. Any procurement of radioactive material without the prior approval of the Radiation Safety Office will lead to the seizure of said radioactive material and the possible suspension or loss of authorized user status.

C. Transfer of Sources of Radioactive Material

The transfer of any source of radioactive material from the University of Toledo or between authorized users must be approved by the Radiation Safety Office.

D. Records

Records relating to personnel exposure, radiation surveys, leak tests, inventories, waste disposals, and calibrations must be maintained and available for inspection as directed by the ODH rules and regulations.

E. Facilities and Laboratory Equipment

1. Designs and Plans

All designs and plans for new facilities, or alterations to existing facilities in which sources of ionizing radiation will be stored and/or uses, shall be reviewed and approved by the Radiation Safety Officer prior to the start of any construction or alteration operations.

2. Release of Facilities for Other Use

Facilities in which radioactive material was either used or stored shall not be released for other purposes until the facility has been decommissioned under the direction of the Radiation Safety Office.

3. Transfer of Facility Responsibility

The responsibility for the operation of a facility is placed in the hands of the authorized user by the Radiation Safety Committee. Therefore, this responsibility shall not be transferred to another individual until an application for such has been approved by the Committee.

4. Laboratory Equipment

Laboratory equipment which has been used for radioactive materials purposes or located within a radioactive material facility shall not be transferred out of the lab until it has been surveyed and determined to be free of radioactive contamination. The survey and/or decontamination shall be completed by the authorized user under the direction of the Radiation Safety Office.

III. Radiation Safety

A. General

1. Objectives

The following sections contain recommendations which are intended to accomplish the objectives of the University of Toledo's Radiation Safety Program, which are:

- a. To maintain radiation exposure to levels that are As Low As Reasonably Achievable (ALARA).
- b. To reduce the possibility of the entry of radioactive material into the human body by ingestion, inhalation, absorption, or through open wounds.
- c. To reduce to the lowest reasonable achievable limits, the amounts of radioactive material released to the general environment.

These recommendations are made to cover most general situations and cannot possibly cover all circumstances; there may be instances in which these recommendations do not apply. In such situations, the Radiation Safety Office shall be contacted for assistance or clarification. If the problem cannot be rectified, it shall be presented to the Radiation Safety Committee for a resolution.

2. Permissible Dose Limits

Permissible dose limits and concentrations of radionuclides in air and water have been established by the Department of Health (ODH) of the State of Ohio. It must be emphasized that although these limits have been established under the concept that no probable radiation damage will occur at these levels, all exposure should be kept as low as reasonably achievable (ALARA).

3. Safe Use of Radioactive Material

To ensure the safe use of radioactive material, it is the policy of the University of Toledo to:

- a. Always wear a laboratory coat or other protective clothing when handling radioactive material.
- b. Wear disposal gloves at all times while handling any radioactive materials which could cause contamination to the skin.
- c. After each procedure or before leaving the area, monitor hands, shoes, and clothing for any possible contamination. Attempt to perform this monitoring while in a low background area.
- d. Do not eat, chew gum, drink, or apply cosmetics in an area where radioactive material is stored or used. Pipetting by mouth is strictly prohibited.
- e. Do not store any personal effects in areas where radioactive material is used or stored.
- f. Always wear issued personnel monitoring devices, when in an area where radioactive materials are used or stored.
- g. When not in use, store personnel monitoring devices in a designated area of low background radiation.
- h. Personnel monitoring devices are not to leave campus at any time unless otherwise approved by the Radiation Safety Office.
- i. Only dispose of radioactive waste in a designated, clearly labeled, and properly shielded receptacle.
- j. Store radioactive solutions in clearly labeled containers.
- k. When not under constant surveillance, secure radioactive material by locking the lab door or storage unit which houses the radioactive material. (e.g.: locking the refrigerator, freezer, or using lock boxes to secure primary containers of radioactive material).

B. Exposure

Exposure to ionizing radiation can essentially be classified under two categories: External and Internal

1. External

For protection against external exposure, the basic protection factors of time, distance, and shielding shall be employed to reduce the exposure

potential to a value below maximum permissible levels. In every situation these three factors must be considered jointly. While shielding is desirable in reducing the exposure, it must be remembered that doing the job at twice the distance is just as effective as adding two half-value thicknesses of shielding material or completing the job in one-fourth the time. Continuous use of monitoring equipment is the best method of evaluating the hazard and reducing the exposure.

2. Internal

The prevention of internal exposure is more exacting and less easily performed than that of external exposure. The maximum permissible levels of radioactive contamination in the air or on laboratory surfaces are of such a low level that they cannot be detected with ordinary survey instruments. If a low-level contamination is suspected, the authorized user in charge of the area should be notified so that a survey can be made. The general policy in the use of radionuclides is to use equipment and procedures which will reduce the probability of ingestion and inhalation of radionuclides into the body, such as use being performed in a fume hood.

3. Additional Rules

Outlined below are additional rules and procedures to be followed for protection against exposure to sources of ionizing radiation.

- a. The exposure potential shall be estimated before placing a procedure into operation in which personnel may become exposed to ionizing radiation.
- b. The use of sources of ionizing radiation shall be subjected to programs of continuous monitoring or regularly scheduled surveys as a means of evaluating radiation hazards.
- c. Special clothing (e.g., lab coats, gloves, etc.) which can be easily laundered or disposed of must be worn and properly fastened when there is a possibility of contamination with radioactive material. When necessary, safety glasses and shoe coverings must be worn. These items must not be worn outside of the laboratory or designated

area. Protective clothing must be monitored for contamination before sending it to be laundered. Any protective clothing that has become contaminated must be handled as any other piece of contaminated material.

- d. Before any work is undertaken which uses radioactive material, attention must be given to precautionary measures including the use of laboratory fume hoods, remote handling equipment, and glove boxes. The Radiation Safety Office must be consulted for specific recommendations on operations. Plan the procedure to be used and if possible, perform a dry run.
- e. Wearing impervious gloves is necessary with any manipulation of unsealed radioactive material.
- f. Plastic-backed absorbent paper such as chucks must be used on benchtops when working with radioactive material.
- g. Pipetting by mouth is strictly prohibited. Use pipette bulbs, syringes, or pipettors.
- h. When transporting or transferring liquid radioactive material, double containers or absorbent material must be used.
- i. Containers affording adequate protection and shielding must be used to store radioactive material.
- j. Keep the laboratory neat and clean. Keep the work area free of equipment and materials not required for the procedure.
- k. Eating, drinking, storing, or preparation of food is strictly prohibited in laboratory areas where work with radioactive material is used, stored, or where contamination may exist.
- l. Refrigerators and freezers where radioactive material is stored must not be used for the storage of any food or beverages.
- m. An area must be set aside for the decontamination or cleaning of a laboratory apparatus used for working with radioactive material. A sink in this area must be designated for use with radioactive material.

- n. Isolate all laboratory apparatuses and equipment which are used in procedures involving the use of radioactive material.
- o. Use of flammable liquids is not permitted in laboratories unless such flammable are:
 - i. Contained in U.L. approved safety containers with anti-flashback screens.
 - ii. Used in properly vented enclosure.
- p. Pressure bottles or tanks containing counting or laboratory gas must not be used or stored in a laboratory unless they are securely mounted to the wall, bench, or floor.
- q. Good personal hygiene practices such as washing hands and arms thoroughly using soap and water before handling any object which goes to the mouth, nose, or eyes will greatly reduce the possibility of internal exposure.
- r. Wash and monitor hands whenever leaving the laboratory after handling radioactive material.
- s. Do not apply cosmetics in a laboratory where unsealed sources of radioactive material are used.
- t. Monitor shoes or other clothing for contamination and remove all contamination before leaving the work area.

C. Area Controls

Areas in which sources of radioactive material are used or stored must be controlled to prevent any unnecessary exposure to personnel. In order to ensure proper area controls, the methods listed below shall be employed:

1. Postings

Areas shall be classified for posting as follows:

- a. High Radiation Area
- b. Radiation Area
- c. Airborne Radioactivity Area
- d. Caution – Radioactive Material

Note: The Ohio Department of Health (ODH) has regulations governing posting, control, and safety devices required for these areas in: O.A.C. 3701:1-38. ODH also has regulation governing the posting of “Notice to Employees” and other instructions to employees in: O.A.C. 3701:1-38-10.

2. Restrictions

- a. Those areas authorized by the Radiation Safety Committee for use with sources of radioactive material are restricted to use by the authorized user and those personnel under his/her immediate supervision. Caution must be taken to prevent unauthorized removal of radioactive material when authorized personnel are not present in the areas.
- b. Sealed and unsealed sources of radioactive material must always be kept in their labeled storage containers when not in use.

3. Methods of Security of Radioactive Material in Labs

- a. Lock the door. When no one is present in the laboratory, the lab door should be locked.
- b. If the door is not locked when no one is present, the storage unit for the radioactive material, such as a refrigerator or freezer, should be secured by a locking mechanism.
- c. If the storage unit is not locked when no one is present in the lab, a Radiation Safety Office approved lock box may be used. This box must be secured and locked when no one is present in the lab.

D. Monitoring and Surveys

To ensure satisfactory radiation safety throughout the University of Toledo, routine and periodic monitoring and surveying of personnel, equipment, and facilities are required. The frequency of surveys will depend upon the classification of the facilities employing sources of radioactive material. (See Appendix D).

1. Responsibilities

- a. It is the responsibility of the radiation worker to see that his/her working environment is safe and well organized, safety devices are

installed and working properly, appropriate records are maintained, and that contamination is not permitted to build-up.

- b. The Radiation Safety Office will periodically monitor and survey all controlled areas.
- c. The Radiation Safety Office will provide the authorized user with all reports detailing any adverse audit findings, and recommendations for the correction of any items of non-compliance to ODH regulations or University of Toledo procedures. This report will include a specific time period for making the necessary corrections.
- d. Experimental work using radioactive materials must be monitored throughout to determine the possible occurrence of new increased radiation hazards.

2. Leak Tests and Special Surveys

- a. For sealed sources that require leak testing we will implement the model leak test program published in Appendix M of NUREG-1556, Volume 11, Revision 1. To lessen exposure to personnel performing leak tests of brachytherapy sources, each drawer housing the sources will be leak tested. This will be done by wiping the area surrounding the sources. If the leak test shows activities in excess of 0.005 uCi then each source in the drawer will be tested individually.
- b. The University of Toledo's Ohio Department of Health RAM license has conditions regarding the testing of sealed sources for leakage and/or contamination. It is the responsibility of the authorized users to see that each of their sealed sources, except sources exempt by OAC 3701:1-58-27, are tested in the manner and at the interval required. Results of these tests shall be kept on file in the Radiation Safety Office. These tests will be performed by the Radiation Safety Office.

3. Personnel Monitoring

All personnel working with or around sources of radioactive materials who may receive greater than 10% TEDE radiation exposure in one year must wear monitoring devices approved by the Radiation Safety Office.

a. Radiation Monitoring Badges

- i. Dosimeter badges shall be the general personnel monitoring device used throughout the University of Toledo. To initiate dosimeter badge service for any individual, contact the Radiation Safety Office. A supply of dosimeter badges will be available for temporary use upon request. Each individual assigned a dosimeter badge must wear only the specific badge assigned to him or her.
- ii. In the event of a lost dosimeter badge, notify the Radiation Safety Office. Personnel assigned badges must wear them whenever they are working with or near radioactive materials. Dosimeter badges may be worn comfortably between the waist and chest. All dosimeter badges must be kept in a controlled area when not in use and put back at the end of the work period. Dosimeter badges must not be removed from the University. Assigned dosimeter badges must not be used for any purpose other than occupational monitoring.
- iii. New dosimeter badges will be distributed by the Radiation Safety Office or designated department within three working days of the beginning of the wear period and previous badges will be collected within the first ten working days of the start of the wear period.
- iv. It is the responsibility of the individual to ensure the change of badge. If certain operations require special badges for the wrist, fingers, etc., or special dosimeter devices, contact the Radiation Safety Office. If a badge is suspected of being

contaminated, contact the Radiation Safety Office for replacement.

- v. Unreturned or lost dosimeter badges will be billed to the wearer's department on a monthly basis at the cost of \$10 per badge. The fee is imposed to discourage repeated offenses by the wearer and to cover the cost of the dosimeter badge and dose estimates that are performed for the lost badge.

b. Dosimeter Exposure Level 1

A Level 1 Exposure is when an individual exceeds 10% of their allowable quarterly dose. Badges worn at the collar are assigned dose based on EDE2 calculation.

c. Dosimeter Exposure Level 2

A Level 2 Exposure is when an individual exceeds 30% of their allowable quarterly dose. Individuals who reach a Level 2 exposure will undergo an investigation by the Radiation Safety Officer to determine the reason for the exposure, corrective actions will be applied if needed, and a re-training will be completed by the individual.

Quarterly ALARA Investigation Levels		
Dose	ALARA Level 1	ALARA Level 2
Category	(mrem)	(mrem)
Deep	125	375
Lens	375	1125
Shallow	1250	3750
Extremity	1250	3750

- d. Bioassays are required if an individual is expected to exceed 2% of an Annual Limit on Intake (ALI). An ALI is defined in OAC 3701:1-38-01(A)(17) as the derived limit for the activity of the radioactive materials taken into the body of an adult worker by inhalation or

ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rems, or a committed dose equivalent of 50 rems to any individual organ or tissue. All people working with such radioactive material shall make themselves available for such a test when requested by the Radiation Safety Office (See Appendix I).

e. Thyroid Bioassay

- i. No bioassay is required when I-131 capsules are used during patient treatment, unless the capsule becomes compromised and is no longer intact. In which case all personnel present would be required to have a bioassay performed to include any individual in the immediate area or present during the decontamination process.
- ii. All radioiodine radiation workers are required to have a thyroid bioassay performed if the location uses an unsealed or loose form on a yearly basis a quantity of radioiodine > 2000 ALI. Bioassays must be performed 24-72 hours post iodination.
- iii. Thyroid bioassays will also be performed in accordance with requirements from the Radiation Safety Committee.

f. Medical Examination

When deemed necessary by the Radiation Safety Office, a medical examination may be required for individuals working with radioactive materials. The Radiation Safety Office shall notify those workers who are to receive an examination.

g. Survey Meters

Facilities utilizing certain sources of radioactive material shall have appropriate survey instruments available. These instruments shall be used by laboratory or clinical personnel to measure possible radiation fields, check for contamination on hands, shoes, clothing,

and work areas. A survey meter shall only be shared by a maximum of two adjacent labs.

E. Calibration of Equipment

1. Radiation Monitors

All instruments utilized as radiation monitors must be calibrated at appropriate intervals to assure the validity and integrity of results. It is the responsibility of each authorized user to see that his instruments are properly functioning and within calibration. All survey meters used to quantitate radiation exposure or contamination must be calibrated at least annually or whenever such instruments have been repaired. The calibrations can be performed by the Radiation Safety Office (We will follow the procedure in Appendix H of NUREG-1556, Volume 11, Revision 1 "Model Instrument Calibration Program: for survey meters used for exposure rate readings) or the meters will be sent out for calibration by an external company. Instruments used in the research labs will be calibrated using disc sealed sources appropriate for the type of radioactive materials used. Documentation will be retained for the appropriate time interval by the owner of the equipment and also in the Radiation Safety Office.

2. Dose Calibrator Testing

Nuclear Medicine, PET/CT, and the Nuclear Cardiology Heart Station dose calibrators used to measure doses will be calibrated in accordance with nationally recognized standards, manufacturer's recommendations, and ODH regulations.

F. Contamination

No amount of radioactivity shall be released into unrestricted areas in any manner which will cause the limits specified in O.A.C. 3701:1-38-19 to be exceeded.

IV. EMERGENCY PROCEDURES

Any circumstance or event which has caused or threatens to cause abnormal exposure of persons to ionizing radiation, or a loss of radioactive materials, shall be termed a radiological emergency. Emergencies may arise from a variety of situations; therefore,

procedures cannot be established to cover all possibilities. Lifesaving procedures are the primary concern in any emergency. Following this is the protection of all personnel from exposure to ionizing radiation, and then the confinement of contamination to the local area of the accident whenever possible. All emergencies shall be reported to the Radiation Safety Office and the authorized user responsible for the source of the ionizing radiation.

A. Contaminated Personnel

1. Contaminated personnel must be reported to the Radiation Safety Office immediately. Call the Radiation Safety Office at 419-383-4301 for assistance. If the occurrence is after hours, call the Emergency Telephone Contacts listed on your department posting or have hospital operators or Campus Police page the Radiation Safety Officer.

B. Injured Personnel Complicated by Radioactive Contamination

1. All life-saving procedures should be carried out immediately; contact a physician at once if needed.
2. Report all radiation accidents involving personnel (contaminated wounds, ingestion, and inhalation) to the Radiation Safety Office as soon as possible.
3. Wash minor wounds under running water immediately, while spreading the edge of the wound.
4. Permit no person who has sustained a radiation injury to return to work without the approval of the Radiation Safety Office and the attending physician.
5. A report shall be prepared by the injured individual and the authorized user in charge.
6. In the event of a radioactively contaminated injured individual report to the UPMC Emergency Department, the "Code Orange – Radioactive" procedure is to be instituted.

C. Overexposure and/or Suspected Overexposure

1. Contact the Radiation Safety Office at once.
2. A report shall be prepared by the authorized user in charge and the Certified Radiation Expert.

3. It is the responsibility of the Radiation Safety Office to report exposures greater than limits set forth in the Ohio Administrative Code.

D. Emergencies Involving Fires in Restricted Areas and Their Adjacent Locations

1. Notify, in order: all persons in the area, Contact Emergency Services by Dialing 911, and then the Radiation Safety Office at 419-383-4301 immediately. The caller must relate his name, location, and degree of any radiation hazard involved.

E. Emergency Involving Motor Vehicles Acting as Carriers of Radioactive Material

Because of the nature of this kind of emergency, the following set of instructions shall be carried in every vehicle used while transporting radioactive substances. These instructions are to be read and followed by all personnel in the event of an emergency.

1. Immediate notification is to be given by calling in the following order: local Police and/or Highway Patrol, and the Radiation Safety Office at the University of Toledo. The caller must state his or her name, location, what happened, when, where, who was involved, and what has been done to control or contain the radioactive materials.
2. Someone must maintain the security of the vehicle and radioactive material and keep bystanders away while calls are being made.
3. All traffic should be detoured around the scene of the accident. If this is not possible, vehicles should be moved the shortest distance necessary to clear the right-of-way. If radioactive material is spilled, passage through the area should be prevented unless absolutely necessary. If the right-of-way must be cleared before radiological assistance has arrived, the spillage should be washed to the shoulders of the road with minimum dispersal of wash water or cover with at least four inches of earth or sand.
4. The Radiation Safety Office will notify the Ohio Department of Health Bureau of Environmental Health & Radiation Protection as soon as possible.

5. The area of the accident should be restricted. The public should be kept as far from the scene as practical. Local authorities should make only necessary entries and investigations in the accident area. No attempt should be made to clean up any debris or material involved in the accident prior to the arrival of an emergency monitoring team.

F. Sealed Source Rupture or Accidents Involving Radioactive Dust, Mists, Fumes, Organic Vapor, or Gasses

1. Notify all individuals to vacate the room immediately.
2. If time permits all windows should be closed, fans or air conditioners should be shut off, the door and all other openings should be sealed with wide masking or adhesive tape.
3. Notify the Radiation Safety Office
4. Restrict the movement of potentially contaminated individuals to a local zone just outside the spill areas until the extent of the contamination is ascertained.
5. If no means are available for monitoring, it should be assumed that all personnel involved are contaminated.
6. Decontamination of the area shall be done only under the direction of the Radiation Safety Office.
7. Occupancy of, or work in, the area shall not be resumed until approved by the Radiation Safety Office.
8. The Radiation Safety Office will notify the Ohio Department of Health Bureau of Environmental Health & Radiation Protection as soon as possible when required.

G. Lost Sources

1. If a source is lost, notify all personnel in the area, monitor each individual, and evacuate the area.
2. Restrict movement of personnel involved to a known and controlled area.

3. Do not remove any articles such as waste containers, linen bags, or any soiled linens from the area involved.
4. Notify the Radiation Safety Office.

H. Accidents Involving the Release of Radioactive Material

Successful decontamination calls for planned action. Decontamination shall be accomplished by the AU and his/her trained clinical or laboratory personnel. Decontamination procedures depend upon source type, strength, chemical and physical properties, and total area contaminated. The trigger level for initiating decontamination is 200 dpm/100cm². The University of Toledo has developed and will implement and maintain written procedures for the safe response to all spills of licensed material in accordance with O.A.C. 3701:1-38.

1. General Decontamination Procedures

- a. Decontamination of any area shall be accomplished by surveying to determine the extent of the contamination and then working to decontaminate from the outer edges of the contamination towards the center to prevent further contamination.
- b. Make full use of protective clothing (double gloved and lab coat buttoned up at a minimum), shoe covers, masks, etc. to reduce the possibilities of personnel contamination for those involved in the decontamination process.
- c. Do NOT wear protective clothing outside of a designated change area.
- d. Handle all equipment used in the decontamination process and all run-off solutions as ones which are potentially contaminated.
- e. Make provisions for the disposal of all used cleaning materials and equipment as well as other contaminated articles in the area. Always bring the necessary collection of receptacles to the area in question, not vice versa.
- f. The Radiation Safety Office can suggest agents for the removal of contamination from various surfaces.

- g. Make full use of instrumentation available for monitoring, choosing the most effective for your purpose.
- h. Make a complete record of decontamination operations utilizing a survey diagram.
- i. After decontamination has been completed, do not permit any work or occupancy within the area until a survey has been done to verify the removal of the contamination, utilizing wipe tests and survey meters. If all contamination is not removable, the area can be shielded or closed until readings are below trigger levels.
- j. All decontamination events must be recorded and kept on file for a minimum of three years. Submit a copy of all decontamination records to the Radiation Safety Office.

2. Minor Spills (<100 microcuries)

- a. Notify all personnel in the affected area that a spill has occurred.
- b. Restrict all potentially contaminated personnel from leaving the area until they have been evaluated for possible contamination.
- c. Cover the spill with absorbent pads or chucks to prevent the spread of contamination.
- d. Follow "General Decontamination Procedures" outlined in the Radiation Safety Manual.
- e. Report the contamination event and submit a copy of all decontamination records to the Radiation Safety Office within 24 hours.

3. Major Spills (>100 microcuries)

- a. Clear the Area: Notify all personnel not involved to vacate the affected area.
- b. Immediately call the Radiation Safety Office at 419-383-4301 for assistance. If after hours, call the Emergency Telephone Contacts listed on your department posting or have hospital operators call Campus Police and page the Radiation Safety Officer.

- c. Shield the Source: Cover the spill with absorbent pads. If possible, the spill should be shielded, but only if it can be done without further contamination or without significantly increasing radiation exposure.
- d. Restrict all potentially contaminated personnel from leaving the area until they have been evaluated for possible contamination.
- e. Close the Room. Leave the room and lock the door to prevent entry. Post all appropriate signage on the door to prevent any unwanted entry.
- f. Decontaminate the area under the guidance of the Radiation Safety personnel and submit a copy of all decontamination records to the Radiation Safety Office within 24 hours.

V. Radioactive Waste

All radioactive waste shall be disposed of via procedures approved by the Radiation Safety Office. Accumulation and storage of radioactive waste shall be in containers labeled Radioactive Materials. The containers must be lined with yellow bags marked Radioactive Materials. These bags are obtained from the Radiation Safety Office. The containers are to be kept either in a secured central storage area or within the authorized user's laboratory. Proper disposal or transfer of radioactive waste is the responsibility of the authorized user.

A. Method of Disposal

The following methods of disposal will be utilized at all University of Toledo facilities.

1. Storage for Decay

This process will be performed by the Radiation Safety Office. Waste contaminated with radionuclides having a half-life of less than 120 days will be stored for decay. The material may be discharged into the sewer or through normal waste disposal routes when the material has been surveyed

with a suitable survey instrument and all readings are at background levels. Proper documentation of this process must be kept.

2. Sanitary Sewer Disposal

Radioactive waste which is water soluble and readily dispersible may be disposed of through the municipal sewer system. This shall be done in accordance with State regulations. Contact the Radiation Safety Office for limits. Records of sink disposal shall be forwarded to the RSO at the end of each month.

3. Shipment to Commercial Disposal Facilities

Radioactive waste materials which cannot be disposed of by other designated means shall be disposed of through a licensed commercial facility, via the Radiation Safety Office

B. Responsibilities

1. Authorized User Responsibilities

The proper storage and disposal of radioactive waste within the laboratory is the responsibility of the authorized user. The authorized user shall ensure compliance with applicable regulations and maintain positive control over all such waste in their area until it is removed. The authorized user shall ensure that the following procedures are adhered with regards to storage of radioactive waste:

- a. Radioactive waste material shall be segregated according to the instruction of the Radiation Safety Office to include:
 - i. Radioactive Dry waste with half-life < 120 days
 - ii. Radioactive Dry waste with half-life \geq 120 days
 - iii. Radioactive Liquid waste with half-life < 120 days
 - iv. Radioactive Liquid waste with half-life \geq 120 days
- b. Radioactive waste shall be stored in a separate designated area within the individual laboratories. The waste shall be removed from the individual laboratories by scheduling a pick-up with the Radiation Safety Office. Information for waste pick-up must include which

radionuclide, the activity of the radionuclide, the authorized user's name, and any other pertinent information. This information must be available on the waste log when picked up. The containers provided for the accumulation and storage of radioactive waste material must not be used for any other purposes.

- c. The authorized user shall use care in the selection of containers for the transfer and storage of liquid waste. In case of organic solvents, containers of a capacity not exceeding five gallons shall be used for accumulation and storage purposes.
- d. Acids and bases shall be neutralized to approximately pH7 before depositing them in waste containers.
- e. Liquid waste shall be stored in a manner that assures there will be no possibility of a chemical reaction which might cause an explosion or cause the release of radioactive or toxic gas or vapors.
- f. The authorized user shall not dispose of radioactive waste into the sewer system in excess of amounts listed in the sink disposal log.
- g. The material must be water soluble and readily dispersible in water. The release of gaseous waste to the air effluent shall be accomplished only through hoods designated for this purpose and with approval from the Radiation Safety Office.

2. Radiation Safety Office Responsibilities

The Radiation Safety Office has the ultimate responsibility for the disposal of radioactive materials. The Radiation Safety Office shall maintain the central storage areas. Radioactive waste shall be removed periodically from the individual laboratories by the Radiation Safety Office and be placed in appropriate containers within the central storage area.

C. Animal Carcasses / Excreta Containing Radioactive Material

- 1. Instructions to be followed when working with animal carcasses containing radioactive materials include:

- a. All objects which can inflict a wound shall be removed from animal carcasses.
- b. Animal carcasses shall be double packaged in plastic bags in a manner that assures protection against the leakage of body fluids.
- c. Each package shall be labeled using a radioactive material string secured tag listing:
 - i. Radionuclide
 - ii. Activity of radionuclide
 - iii. Date of injection or treatment
 - iv. Weight in kilograms
 - v. Authorized user's name
- d. Animal carcasses shall be stored only in approved freezers designated by the Radiation Safety Office.
- e. All excreta shall be collected and placed in appropriate containers. Solids, including liquids mixed with absorbent material, etc., shall be placed in plastic bags and then stored in appropriate containers. Liquids shall be placed in one-gallon plastic containers.
- f. The containers shall be labeled, listing:
 - i. Radionuclide
 - ii. Estimated activity of radionuclide
 - iii. Date of collection
 - iv. Authorized user's name

VI. CLASSIFICATION OF FACILITIES AND SOURCES OF IONIZING RADIATION

A. Laboratory Areas

1. Type 3:

Laboratories which are specifically designed for handling high levels or highly toxic radioactive materials. They incorporate special apparatus, equipment, materials of construction, and construction designed to limit the exposure to ionizing radiation and to assist in maintaining high standards of laboratory hygiene.

2. Type 2:

Laboratories which handle intermediate levels of activity or radioactive material of intermediate toxicity. This type of laboratory incorporates many features of the Type 3 laboratory but with some of the more specialized features being omitted.

3. Type 1:

Laboratories intended for use with only low levels of toxicity or activity. This type of laboratory is usually one which has a few special features to accommodate work with radioactive materials.

4. Type 0:

Laboratories in which the use of radioactive material is limited to small tracer amounts. Here the activity shall not exceed the limits specified for Type 0 laboratories.

B. Radioactive Materials

1. Type 3: Activities \geq 500 millicuries
2. Type 2: Activities \geq 100 millicuries but $<$ 500 millicuries
3. Type 1: Activities $<$ 100 millicuries but \geq 100 microcuries
4. Type 0: Activities $<$ 100 microcuries

VII. TRANSPORTING OF RADIOACTIVE MATERIAL

Transporting of radioactive material by personnel of the University of Toledo must be done in full compliance with State and Federal Regulations and specifications. All questions pertaining to the transporting of radioactive material must be directed to the Radiation Safety Office.

A. On-Campus Transport

1. Transport shall be in unbreakable, spill-proof, double containers which are free from loose, external contamination.
2. Gamma radiation, or equivalent, shall not exceed 10 mR/hr at one-meter distance.
3. Containers shall be labeled in accordance with Federal and State regulations.

B. Transport Via-Vehicle – Campus to Campus & Other Facilities

The transport of radioactive material to/from University of Toledo main campus and/or University of Toledo health science campus or other facilities via motor vehicle shall be performed under the following conditions:

1. All radioactive material shall be packaged in Department of Transportation specification containers. All containers shall be free of loose contamination on the outside.
2. The gamma radiation or equivalent shall not exceed 200 mR/hr at one meter with appropriate DOT diamond label.
3. There must not be any loose radioactive material in the motor vehicle and all containers shall be placed securely in the vehicle to prevent leakage or shifting of load under conditions normally incident to transportation. There shall not be more than 40 units per vehicle (one unit equals 1 milliroentgen per hour at one meter for hard gamma radiation).
4. All shipments must meet regulations and general packaging requirements of 49 CFR Parts 170-180.
5. The motor vehicle code shall be placarded conformity with D.O.T. regulations, 49 CFR part 172 Subpart F.
6. Shipping orders, bills of lading and other forms of shipping papers shall be prepared in conformity with D.O.T. regulations.
7. The motor vehicle shall be attended at all times. For transportation of high levels of unsealed radioactive materials, two people shall accompany the shipments.
8. Emergency instructions and an appropriate survey instrument shall accompany the driver of the motor vehicle.

VIII. ADDITIONAL PROCEDURES AND INSTRUCTIONS

A. Testing of Sealed Sources

Before any sealed source greater than 100 microcuries beta/gamma or 10 microcuries alpha is put into useful service for the first time, and at intervals not to

exceed six months beta/gamma or three months alpha, the authorized user shall conduct or have conducted a leak test to determine its integrity.

1. A sealed source shall be considered to be leaking if the presence of one hundred eighty-five Becquerels (0.005 microcuries) or more of removal contamination on any test sample is identified.
2. The Radiation Safety Office shall immediately withdraw a leaking sealed source from use and shall take action to prevent the spread of contamination. The leaking sealed source shall be repaired or disposed of in accordance with this O.A.C. 3701:1-38.
3. Reports of test results for leaking or contaminated sealed sources shall be made pursuant to paragraph (F) of rule 3701:1-38-21 of the Administrative Code.

B. Instructions Regarding Use of Animals Exposed to Radioactive Material

1. Authorized User's Responsibilities

The authorized user of radioactive materials, in charge of a research project involving animals, must obtain prior approval from the Institutional Animal Care and Use Committee. The authorized user is responsible for the radionuclides and radiation safety involved while the animals are confined in the animal facilities.

- a. Division of laboratory animal medicine technicians shall be notified of animals containing radioactive material and given specific information regarding the care and management of these animals, their biological waste, required equipment, and necessary radiation safety instructions.
- b. All cages containing radioactive animals shall be tagged with the following information with a "Caution Radioactive Material" string tag.
 - i. Name of radionuclide
 - ii. Activity of radionuclide injected per animal.
 - iii. Date of injection
 - iv. Authorized user's name and phone number

- c. Animals containing radioactive materials shall be kept in cages apart from the other animals.
- d. All procedures, including injection of radionuclides and preservation of carcasses performed outside of cages, shall be done on steel trays with absorbent paper. The investigator shall make any necessary surveys of the area to verify that there is no contamination of the facilities.
- e. Animals which have been injected with radioactive material that may be volatilized and dispersed into the room shall be kept in an area with adequate ventilation and air cleaning facilities.
- f. Exercise of animals containing radioactive material normally will be restricted to their cages or primary enclosure. If some type of activity outside the cage or primary enclosure is required, it will be carried out by the authorized user or a person directly responsible to him/her. The authorized user shall be responsible for any emergency or contamination which may arise.
- g. Appropriate surveys by the authorized user, during and at the conclusion of a project, shall be recorded and the results of these surveys shall be recorded and kept on file. The Radiation Safety Office must be notified immediately of any pertinent information arising from these surveys which may imply a contamination event or a health hazard.
- h. No animals from outside of the University of Toledo which contain radioactive material shall be obtained or placed in animal quarters without prior written approval of the Radiation Safety Officer, and the Director of Division of Laboratory Animal Medicine.
- i. The cages will be monitored by the authorized user with equipment and methods appropriate to the radionuclide involved to determine the level of contamination. If contamination is found, it shall be reported to the Radiation Safety Office and decontamination of the cages will be performed under the direction of the authorized user.

C. Support Personnel

Support personnel shall constitute the members of Maintenance, Environmental Services, and Campus Police.

1. Emergencies

If a question exists regarding a possible radiation hazard, the Radiation Safety Office, as well as the staff member in charge of the facility shall be called. No attempt should be made to enter an area where a known or suspected radiation hazard exists.

2. Requested Maintenance and Environmental Services

Maintenance and custodial personnel shall request the authorized user to conduct a radiation survey of the area where the services are required. This survey shall be conducted prior to, or simultaneously with, the service being rendered.

3. Training Program for Support Personnel and Ancillary Personnel

Training programs for support personnel shall be conducted periodically and completed on The University of Toledo test bank for purposes of familiarizing personnel with those aspects of radiation safety relevant to the performance of their duties. Participation of support personnel in these programs shall be mandatory and monitored by the supporting department or upon notification from the Radiation Safety Officer. In general, the topics covered in these programs shall consist of:

- a. Types of ionizing radiation.
- b. Description of postings, placards, signs, and labels.
- c. Instructions regarding services in posted areas.
- d. Special instructions regarding emergencies or suspected incidents.
- e. Special instructions regarding portal monitor and radioactive waste.

IX. MEDICAL USE OF RADIOACTIVE MATERIAL

A. Approval of Authorized Users (AU) for Medical Use

Primary approval for authorized medical use of radioactive material at the University of Toledo Medical Center is contingent on-board certification by an appropriate board and/or being listed on an NRC/agreement state license for the same type of use. If the applicant does not meet the above requirements the steps listed in Appendix D of NMS-LIC-09 will be followed. Applicants for routine medical use of byproducts should provide some or all the following documents for review as determined by the Radiation Safety Committee:

1. Application form for authorized users found on the University of Toledo Radiation Safety website.
2. Verification of training and experience as outlined in O.A.C. 3701:1-58.
3. Curriculum Vitae (CV) & Ohio medical license verification.
4. Medical specialty board certification whose certification process has recognized by the director, United States Nuclear Regulatory Commission, or an Agreement State and who meets the requirements in O.A.C. 3701:1-58. The names of the specialty board certifications recognized will be posted on the Nuclear Regulatory Commission's web page at www.nrg.gov
5. Name listed on NRC or Agreement State Radioactive Materials License.
6. ODH or NRC preceptor certification form.

B. Experimental or Non-Routine Medical Uses

Applicants for experimental or non-routine medical uses of radioactive material must furnish additional information to the Radiation Safety Committee to supplement the above forms. The Committee's review of the application may be delayed if the appropriate information is not furnished. This supportive information may be completed in one or two methods.

1. Research protocol, to include any supportive information requested by the Radiation Safety Committee pertaining to Non-Routine Medical Uses of Byproduct Material, and IRB approval.

2. Investigational New Drug Application (Form 1571)

X. TRAINING & EXPERIENCE FOR MEDICAL USE OF RADIOACTIVE MATERIAL

A. Types of Medical Use of Radioactive Material

1. Use of unsealed radioactive material for uptake, dilution, and excretion studies for which a written directive is not required (O.A.C. 3701:1-58-32).
 - a. For authorization, an individual must meet training criteria as outlines in O.A.C. 3701:1-58-33. "Training for uptake, dilution, and excretion studies".
2. Use of unsealed radioactive material for imaging and localization studies for which a written directive is not required (O.A.C. 3701:1-58-34).
 - a. For authorization, an individual must meet training criteria as outlined in O.A.C. 3701:1-58-36. "Training for imaging and localization studies".
3. Use of unsealed radioactive material for which a written directive is required, (O.A.C. 3701:1-58-37).
 - a. The training for this modality can be broken down into four sections based on a variety of factors including but not limited to the radionuclide, activity, and route of administration. For authorization of individual or all sections, an individual must meet the training criteria as outlined in OAC:
 - i. 3701:1-58-40 - "Training for use of unsealed radioactive material for which a written directive is required".
 - ii. 3701:1-58-41 - "Training for the oral administration of sodium iodide iodine-131 requiring a written directive in quantities less than or equal to 1.22 gigabecquerels (thirty-three millicuries)".
 - iii. 3701:1-58-42 – "Training for the oral administration of sodium iodide iodine-131 requiring a written directive in quantities greater than 1.22 gigabecquerels (thirty-three millicuries)".
 - iv. 3701:1-58-104 – "Training for the parenteral administration of unsealed radioactive material requiring a written directive".

4. Use of sources for manual brachytherapy, (O.A.C. 3701:1-58-43).
 - a. For authorization, an individual must meet the training criteria as outlined in O.A.C. 3701:1-58-51 – “Training for the use of manual brachytherapy sources”.
5. Use of sealed sources for diagnosis (O.A.C. 3701:1-58-53).
 - a. For authorization, an individual must meet the training criteria as outline in O.A.C 3701:1-58-54 – “Training for use of sealed sources for diagnosis”.
6. Use of a sealed source in a remote afterloader unit, teletherapy unit, or gamma stereotactic radiosurgery unit, (O.A.C. 3701:1-58-55).
 - a. For authorization, an individual must meet the training criteria as outlined in O.A.C. 3701:1-58-71.

B. Authorized Medical Physicist

1. Training for an Authorized Medical Physicist.
 - a. For authorization, except as provided in O.A.C. 3701:1-58-21, an individual must meet the training criteria as outlined in O.A.C. 3701:1-58-19.

XI. USE OF BRACHYTHERAPY SOURCES

A. Responsibilities of the Radiation Oncologist

1. The attending radiation oncologist shall be solely responsible for all aspects of prescription, use, and return of sources of brachytherapy storage area at UTM. The UTM Quality Management Program must be followed.
2. Prior to insertion and following removal, brachytherapy sources shall be in possession of the radiation oncologist or locked in appropriately shielded designated areas for which he/she is responsible.
3. Sources shall be brought to the patient in the operating room or patient's bedside by the radiation oncologist or their designee. A physicist, dosimetrist or radiological technologist qualified in brachytherapy source

handling may assist the radiation oncologist and, in so doing, shall remain with the sources until the radiation oncologist takes charge of the sources.

4. When brachytherapy sources are removed from a patient, the radiation oncologist or their designee shall see that a source count and a radiation survey are performed before discharge. The radiation oncologist shall also see that the sources are returned to a designated safe storage area. The designee may assist the radiation oncologist by receiving the brachytherapy sources and returning them immediately to the safe storage area.
5. The radiation oncologist shall maintain a current copy of standing orders for patients undergoing brachytherapy with the Radiation Safety Office for review by the Radiation Safety Committee.

B. General Brachytherapy Procedures

1. Patients receiving permanent implants shall be assigned a room on a nursing floor. These patients do not require a private room.
2. Patients receiving temporary brachytherapy shall be assigned to private rooms on nursing floor 4AB UTMC hospital. If because of medical complications, it is required that the patient be placed in another unit, the Radiation Safety Office must be notified prior to the placement.
3. A radiation survey of the patient's room shall be performed as soon as possible after the insertion of the sources.
4. During the period of temporary brachytherapy treatment, the patient's room shall be posted with appropriate signs indicating:
 - a. Source type, strength, and side application
 - b. Radiation exposure levels at bedside, at 1 meter, and at 6 feet from the source of radiation.
 - c. Instructions to nursing personnel and visitors indicating any restrictions.
5. The patient's chart will also be marked with a Radioactive Materials label and will contain the physician's orders regarding radiation protection.
6. All nursing personnel and other staff at UTMC Hospital who attends to a patient while radioactive sources are in place shall be issued personal

dosimeters supplied by the Radiation Safety Office. Nurses should observe the time limits (maximum time for 100 millirem exposure) and enforce the prescribed limits for pregnant women, minors, and visitors. Any nurse who is pregnant, or suspects she may be pregnant, shall not attend to the patient. Nurses and other assistants should employ the principles of minimum time, maximum distance, and shielding as protection measures.

C. Guidelines for Temporary Brachytherapy Implants

These procedures are in addition to the General Brachytherapy Procedures listed in the previous section of this manual.

1. Immediately preceding the insertion of radioactive sources in a patient, the radiation oncologist will visually check the radioactive source loading to ensure that the sources loaded are exactly as prescribed. After inserting the brachytherapy sources in the patient, the radiation oncologist will sign the Radiation Oncology Brachytherapy Source Record under "Certificate of Receipt". This entry will include the number and type of sources and the time and date of insertion.
2. A Radiation survey will be performed at location within the patient's room sufficient to provide time limits for staff and visitors.
3. The radiation survey after insertion will include the rooms above, below and adjacent to the patient's room. These exposure readings will be entered on the Brachytherapy Source Record. No room will remain occupied if an exposure rate greater than 2.0 mR/hr is measured.

D. Guidelines for Permanent Brachytherapy Implants

These procedures are in addition to the General Brachytherapy Procedures listed in section XI. B (1-6) of this manual.

1. Following implantation, a radiation survey shall be performed in the operating room before the room is cleaned. The survey will specifically include all suction fluids, sponges, trays and linens which might contain a source.
2. In cases where there is a possibility of brachytherapy sources being discharged through surgical wounds or body orifices, linens and appropriate

waste materials will be kept in the room (e.g., urine, drainage, and stool). The patient's room will be surveyed daily to check for the presence of dislodged sources. A Radiation Survey Log will be posted on the door to the patient's room and a notation will be made daily indicating that waste materials and linens have been checked, are not contaminated with radioactive material and may be discarded in the normal manner.

3. If after 3 days no dislodged sources have been found and in the opinion of the radiation oncologist, there is negligible chance of a source becoming dislodged, the Radiation Safety Officer may authorize the discontinuance of daily radiation contamination surveys.
4. A final radiation survey shall be performed after the patient is discharged, but before linens and waste have been removed and the room cleaned.
5. Upon discharge from the hospital, patients at risk of discharging a radioactive source (e.g., prostate seeds) will be given instructions for handling any sources that may be recovered.

XII. GUIDELINES FOR THERAPEUTIC ADMINISTRATION OF SODIUM IODIDE IODINE-131 REQUIRING A WRITTEN DIRECTIVE IN QUANTITIES GREATER THAN 1.22 GIGABECQUERELS (THIRTY-THREE MILLICUIRES). (INPATIENT)

A. Room Selection

1. The hospital patient room shall be a corner room in a low traffic section of the hallway or cove.
2. Private toilet facilities must be available because urine, body oils, and perspiration will be contaminated with iodine-131.
3. Adequate ventilation is necessary because iodine-131 is volatile, and levels of iodine-131 can build up.

B. Room Preparation

1. Determine if urine is to be stored in the room, if so, select an area and provide shielding if necessary.
2. Remove unnecessary furniture from the room. Arrange coverings for floor, tabletops, telephone, and television as necessary to aid in decontamination.
3. Arrange for meals to be brought on disposable trays if possible.

4. Provide two labeled waste containers. All disposable items go in one; gowns and linens go in the other.
5. Central Service must be contacted to provide an isolation cart to hold the following items:
 - a. Exam Gloves
 - b. Isolation Gowns
 - c. Foot Coverings

This cart is to be kept in the hall immediately outside of the patient's room.

C. Iodine-131 Dose Preparation and Administration

1. The dose shall be corrected for decay from the manufacturer's assay.
2. The dose must be assayed in the dose calibrator and compared to the manufacturer's assay. Values must assay within 10% in order to proceed with the administration of iodine-131 or must be approved by the authorized user before administration occurs.
3. The dose should be placed on a tray having absorbent coverings and appropriate shielding to reduce external radiation levels below 10mR/hr at 12 inches from the container.
4. For inpatients the dose must be administered to the patient in the patient's room (for iodine-131 cancer therapy).
5. The administration of the dose and the time immediately thereafter represent the period of greatest radiation safety concern. If liquid iodine-131 is used, then volatile iodine can represent an exposure to personnel therefore only experienced personnel should handle the dose. The patient may regurgitate the iodine dose immediately after administration and caused elevated air concentration as well as gamma levels. The Radiation Safety Office is to be notified immediately if the patient regurgitates. Decontamination supplies should be readily available during the time following the administration of the iodine-131.
6. The standard safety procedures such as wearing a buttoned-up lab coat, ring dosimeter, whole body monitors, and gloves are required.

XIII. GUIDELINES FOR THERAPEUTIC ADMINISTRATION OF SODIUM IODIDE Iodine-131 REQUIRING A WRITTEN DIRECTIVE IN QUANTITIES GREATER THAN 1.22 GIGABECQUERELS (THIRTY-THREE MILLICUIRES). (OUTPATIENT)

A. Room Selection

1. The Nuclear Medicine Department hospital room 1232, or one of the PET/CT patient treatment rooms (DCC 1070A or DCC 1070B shall be used for administration

B. Room Preparation

1. Arrange coverings for floor, chair, and side table.
2. Provide a labeled waste container. All disposable items (e.g., patient water cup, side table covering, and gloves) go in the waste container.
3. Linens and patient isolation gown will be surveyed after use. If contamination exists, they will go in the waste container. If no contamination exists, they can go in soiled linen bags for cleaning.

C. Iodine-131 Dose Preparation and Administration

1. The dose shall be corrected for decay from the manufacturer's assay.
2. The dose must be assayed in the dose calibrator and compared to the manufacturer's assay. Values must assay within 10% in order to proceed with the administration of iodine-131 or must be approved by the authorized user before administration occurs.
3. The dose should be placed on a tray having absorbent coverings and appropriate shielding to reduce external radiation levels below 10mR/hr at 12 inches from the container.
4. The administration of the dose and the time immediately thereafter represent the period of greatest radiation safety concern. If liquid iodine-131 is used, then volatile iodine can represent an exposure to personnel therefore only experienced personnel should handle the dose. The patient may regurgitate the iodine dose immediately after administration and cause elevated air concentrations as well as gamma levels. The Radiation Safety Office is to be notified immediately if the patient regurgitates.

5. Decontamination supplied should be readily available during the time following the administration of the iodine-131.
6. The standard safety procedures such as wearing a buttoned-up lab coat, ring dosimeter, whole body monitors, and gloves are required.

D. Outpatient Documentation Reminders

1. Patients that are authorized to be released; and isolated to, their homes on an outpatient contingent basis must complete appropriate documentation to ensure the safety of family and visitors who may come into contact with the patient after treatment.
2. A questionnaire regarding their living arrangements, the number and ages of cohabitants, suitability of sleeping/restroom facilities, and other pertinent living conditions must be completed and assessed by the appropriate authority. The "Calculation for Immediate Patient Release following I-131 Therapy" must be completed per U.S. NRC Regulatory Guide 8.39 to ensure that anyone who lives with, or comes into contact with, the patient will not receive a dose > 0.5 rem during the isolation period.
3. After the treatment and prior to release from the medical facility, staff will perform a survey of the patient at one (1) meter and record the value. After the isolation period, the patient will return to the medical facility for another survey at on (1) meter and then be released from the isolation state. Readings will be assessed with the Radiologist and/or Radiation Oncologist to determine if the patient may be released from isolation.

XIV. ADDITIONAL GUIDELINES FOR THERAPEUTIC SODIUM IODIDE IODINE-131 PROCEDURES REQUIRING A WRITTEN DIRECTIVE.

A. Personnel Safety

1. Radiologist and/or Radiation Oncologist

The training of the radiologist or radiation oncologist includes the procedures to be carried out during an iodine-131 therapy administration. It is the responsibility of the radiologist or radiation oncologist to ensure that his staff reviews the applicable procedures just prior to any administration.

A QMP form must be filled out by the authorized user prior to the administration of the I-131. The administration must conform to the QMP form. Any deviation greater than 10% of the prescribed dose or the route of administration must be confirmed, recorded and signed on the QMP form by an authorized user.

2. Personnel Present at Administration

This group includes a radiologist or radiation oncologist and may also include any or all of the following: physicians, physicists, dosimetrists, nuclear medicine technologists, and radiation safety personnel.

3. Iodine I-131 Dose

The administration of iodine-131 will occur in pill form whenever possible. The use of iodine-131 in pill form greatly reduces the risk of contamination to support personnel during administration process.

4. Bioassay

No bioassay will be required on personnel present at the time of the administration when an iodine-131 capsule is administered. If the liquid form of iodine-131 is administered to the patient, a thyroid uptake measurement must be performed on all personnel in the room at the time of administration within 72 hours of the administration.

5. Dose Preparation

The administration of a high activity of liquid I-131 can present a radiation exposure to staff. It is possible for a small thyroid uptake from a liquid iodine-131 therapy dose to occur if standard safety practices are not followed, so all doses must be opened only inside the hood.

6. Ventilation

For inpatients, only rooms with adequate ventilation should be chosen for isolation.

7. Nursing Personnel

Due to the extremely low number of iodine-131 inpatients, nursing personnel are educated on radiation safety for iodine-131 therapies only when an inpatient treatment will occur in their respective area. In addition, an instruction form is handed out. Questions regarding the administration of an iodine-131 therapy dose and care of the patient should be referred to the Radiation Safety Office. Personnel monitoring as required by Radiation Safety will be provided. Thyroid uptake counts may also be required at the discretion of the Radiation Safety Office.

8. Environmental Services

Personnel are not to enter the patient's room without the permission of the Radiation Safety Office. The Radiation Safety Office will post a green sign on the door to notify personnel when the room has been decontaminated and is ready to be put back into service.

9. Visitors

Visitors for inpatients are not to enter the I-131 patient's room unless authorized by the Radiation Safety Office. When authorized, visitors are subject to the posted time limits. Visitors may also stand outside of the room to visit. There is to be no contact between the patient and visitors.

B. Room Survey

1. The radiation survey of the patient's room must be performed immediately after the dose has been administered to the patient and before any bedside nursing care is given.
2. A calibrated survey meter shall be used to determine radiation levels at bedside, at six feet from patient, in adjoining patient rooms, and in the hallway. Iodine-131 therapy administration limits of exposure are to be posted at the entrance to the patient's room.
3. The frequency of surveys is to be determined by the physicist or RSO. Physical decay of iodine-131 and biological elimination from the patient may decrease radiation levels sufficiently to permit more lenient time limits for nurses.

4. The patient's urine should not be stored unless it is in the bathroom and in a sealed container. Containers storing urine should be emptied as soon as possible and only in the approved toilet.

C. Patient Discharge

1. The patient will be discharged in accordance with NRC Regulatory Guide 8.39, Release of Patients Administered Radioactive Materials. Restrictions for household members are given in the form of instructions to the family of a released patient which should be given to the appropriate household members before the patient is discharged.
2. The patient will be presented with a patient release card stating the patient has had a medical procedure. The card shall include:
 - a. The patient's name.
 - b. The radionuclide administered and its activity.
 - c. The facility name which administered the radionuclide
 - d. The date of administration
 - e. The expiration date of the card

Note: The card is not applicable to those patients who are institutionalized (Hospitals, Nursing Homes, Correctional Institutions, etc.) or whose radiation levels do not exceed 0.1 mR/hr at one meter.

D. Room Decontamination & Waste Disposal

1. The Radiation Safety Office must survey all areas likely to have been contaminated prior to their release for unrestricted use.
2. Door signs must remain until decontamination is completed.
3. The room must be cleaned to less than 200 dpm/100 cm² removable contamination.
4. Standard procedures for decontamination are to be followed.
5. Some items (e.g., telephone) may require removal for radioactive decay in storage.

6. When the decontamination is complete the Radioactive Materials posting will be removed and a green sign will be posted indicating that the room has been released for unrestricted use.
7. Although the patient's urine will likely contain large quantities of radioactive iodine-131, disposal of the material in the sanitary sewer system is permitted because of the large dilution factor.
8. If necessary, the urine can be stored in a sealed container until the activity decays to background level.
9. All other waste materials (e.g., food, trays, paper, plastic, and bedding) must be stored for decay in plastic bags for ten half-lives and background readings are obtained. These plastic bags must have the "Caution-Radioactive Materials" tag, identifying the date of collection and the radionuclide present.
10. A record shall be kept showing that items were monitored prior to return for use or disposal.
11. The patient's room cannot be released to nursing services without the approval of the Radiation Safety Office.

E. Record Keeping Requirements

1. Inpatient Radiation Safety Room Survey Form

This form is to be used to record the radiation levels in and around the patient's room. The measurements may be made by anyone experienced with the survey meter (physicist, dosimetrist, technologist, or physician). This form will be saved in the patient's file. It will also be the source of the calculated values to be placed on the "Limits of Exposure" form.

2. Limits of Exposure (Inpatient)

This form will provide the nursing personnel and visitors with specific limits of time of patient visit. This form is to be posted at the entrance to the patient's room.

3. Calculation for Immediate Release

This form will be completed by Nuclear Medicine personnel or a physicist. Patient-specific factors for post-thyroidectomy I-131 therapy are based upon assumed uptake, effective half-life, and occupancy factors recommended by the NRC.

4. Radiation Precautions for Nursing Personnel

This is a list of precautions to be taken by all nursing personnel to provide exposures as low as reasonably achievable.

5. Inpatient Instructions

This is a list of precautions to be taken by the patient to provide for minimum contamination and exposures as low as reasonably achievable.

6. Internal Dose

This is a sticker to be attached to the outside of the patient's chart. This helps indicate that the patient contains radioactive material.

7. Instructions for Family of Released Patient

This form is the set of written instructions given to the patient's family. A copy of this should be maintained in the Nuclear Medicine Department.

8. Outpatient Release Instructions

This form is a set of written instructions given to the outpatient. A copy of this form should be maintained in the Nuclear Medicine Department.

9. Outpatient Release Exposure Rate

This form details dose-rate at 1 meter from the patient's abdomen and thyroid. This form shall be maintained in the Nuclear Medicine Department.

F. Record Keeping Requirement Summary for Therapeutic Administration of Sodium Iodine-131 Requiring a Written Directive in Quantities Greater than 1.22 Giga-becquerels (33 millicuries).

Form Title	Disposition of Form While In-Patient	Permanent Disposition of Form
Inpatient Radiation Safety Survey	Patient's Room Entrance	Nuclear Medicine Dept. Files
Limits of Exposure Inpatients	Patient's Room Entrance	Nuclear Medicine Dept. Files
Calculations for Immediate Release	Not Applicable	Nuclear Medicine Dept. Files
Radiation Precautions for Nursing Personnel	In-Patient Chart	Patient Chart
Inpatient Instructions	Patient Room	Discard after Patient Discharge
Internal Dose Caution Sticker	Cover of In-Patient Chart	Discard
Instructions for Family of Released Patient	In-Patient Chart	Nuclear Medicine Dept. Files & Copy to Patient Family
Outpatient Release Instructions	Not Applicable	Nuclear Medicine Dept. Files & Copy to Patient
Outpatient Release Exposure Rate	Not Applicable	Nuclear Medicine Dept. Files



Radiation Precautions for Nursing Personnel During Iodine-131 Therapy Applications

1. Permissible time limits at patient's bedside and at six (6) feet for nurses will be posted at the entrance to the room.
2. Gloves, gowns, and shoe covers must be worn when entering the patient's room.
3. Visitors are NOT to enter the patient's room without prior authorization from the Radiation Safety Office. There is to be no physical contact between the I-131 patient and visitors.
4. Utensils, bedding, and clothing of attendants and nurses, etc., that may be contaminated by the patient should be kept in the container provided. They will be checked by the Radiation Safety Office.
5. Unless otherwise notified, all excreta can be disposed of in the normal manner. When other precautions are required, specific orders will be written in the patient's chart.
6. When permitted, urinals, bedpans, and urine collection bottles may be used by the patient. These will not be "hot" and should be handled only by the patient or radiation safety, unless otherwise instructed.
7. Personal dosimeters may be necessary for personnel monitoring when specified by Radiation Safety.
8. If any emergency should arise regarding radiation safety, the Radiation Safety Office must be called promptly.



Inpatient Instructions

1. You may eat three (3) hours after treatment and your diet need not be altered.
2. Prior to urination, place 3 caps full of Radiacwash cleaning solution in the toilet bowl water. If you need assistance, call the nurse.
3. Urinate directly into the toilet, taking care so that the area around the toilet is not soiled with urine.
4. Flush the toilet three (3) times.
5. Always wash hands thoroughly after urinating.
6. After showering, place three (3) caps full of Radiacwash in the shower and let the water run for three (3) to five (5) minutes.
7. You should limit physical contact with patient care workers and have NO physical contact with visitors.

Instructions for Family of Released Patient

Home precautions to be taken by patient after receiving a therapeutic dose of radioiodine (Iodine-131):

1. The patient should sleep alone and except for brief periods, others should remain at a distance greater than six (6) feet. This is especially important for children and other people under 45 years of age.
2. Whenever possible, use separate toilet facilities, that is, a toilet not used by other members of the family.
3. After urinating, always place 3 caps full of Radioiodine cleaning solution into the toilet bowl. Then flush the toilet three (3) times.
4. Use care so that the area around the toilet is not soiled with urine.
5. If you return to work within two weeks, take a 3-ounce bottle of Radiacwash cleaning solution with you and use as above each time.
6. Bed linen and clothing need no special precautions, except when there are young children in the family, in which case your linen and clothing should be washed separately with soap or detergent, after the other clothing has been washed. Then the tub or washing machine should be rinsed three (3) times
7. Wash out bathtub or shower with soap or cleanser after use.
8. Use stringent contraceptive measures to avoid pregnancy during the three (3) months after treatment. Do not breast feed during this time.
9. If any questions arise regarding these instructions, please feel free to call 383-6363 or 383-4301 to discuss them.

The above instructions have been explained to me. I understand that these recommendations are being made to minimize any risk of radiation exposure to my family members.

Patient _____ Date _____

Witness _____ Date _____

APPENDIX A.

Minimum Training and Experience Required for Authorized Users (Non-Human Use)

Authorized Users are generally the principal investigators in laboratories using radioactive materials and are responsible for supervising the proper purchase, use, security, and disposal of radioactive materials within their individual laboratories. Authorized Users, along with the RSO, are responsible for the training of all others using radioactive materials within their individual laboratories. Authorized Users are subject to the directives of the Ohio Department of Health Ohio Administrative Code, the Radiation Safety Committee, the Radiation Safety Officer, and all University of Toledo policies and procedures. Authorized users will take action to restrict exposure to radioactive materials. This is in keeping with the need to limit exposure to as low as reasonably achievable.

- A. All requests to be an authorized user will be reviewed and approved or denied by the Radiation Safety Committee. If approved the individual must first complete the University of Toledo 3-Hour Radiation Safety Seminar.
- B. An authorized user must be a faculty member with a Ph.D. in biological, chemical, or engineering sciences.
- C. The minimum training and experience required for the approval of authorized users is forty (40) hours of training in basic radionuclide technique.
- D. The training may be obtained in a formal course or incorporated in a program using byproduct materials. The training should include general training in basic radionuclide handling techniques including:
 - 1. A working knowledge of principles and practice of radiological health safety; radioactivity measurements; standardization of monitoring techniques and instruments; mathematics and calculations basic to the use and measurements of radioactivity; and biological effects of radiation.
 - 2. Experience in the use of byproduct material for the type and quantities for which the application is being made or equivalent experience.

APPENDIX B.

Procurement of Radionuclides

The purchasing department will not honor a requisition for radionuclides unless it is approved, stamped, and dated by the Radiation Safety Office prior to submission.

A. Health Science Campus Procedure for Routine Requisitions

1. Fill out a standard purchase requisition. Make sure to mark it “**RADIOACTIVE MATERIAL**”.
2. On purchase requisitions, make sure to spell out whether quantities are in MILLICURIES or MICROCURIES. Make sure the quantities requested are within the allowable limits per the authorized user’s Certificate of use.
3. The purchase requisition must be signed by the authorized user.
4. Email or bring the purchase requisition to the Radiation Safety Office for approval. After approval, the Radiation Safety Office will email the approved requisition to Purchasing and copy the authorized user on the email.
5. The Receiving Department will automatically forward all shipments of radioactive material that are received to the Radiation Safety Office, unless prior arrangements are made and approved.
6. If damage to the package is suspected, the Receiving Department is to attempt to detain the deliverer of the package and is immediately to place the package into a secure storage area where no unauthorized person has access and notify the Radiation Safety Office.
7. The Radiation Safety Office will notify the authorized user of the arrival of a shipment. The authorized user will pick up the shipment within an hour unless otherwise arranged with the Radiation Safety Office and sign a copy of the packing slip to indicate that it has been received. This copy remains on file in the Radiation Safety Officer. A Receipt and Disposition Log will be given with each package.

8. Packages containing radiation material shall be opened according to the rules given in Appendix C. (Printed on the back of the Receipt and Disposition Log). The radionuclide Receipt and Disposition Log form provides an area for this documentation.
9. All personnel are **PROHIBITED** from purchasing with a p-card and/or having any radioactive material delivered directly to their lab.

B. Main Campus Procedure for Routine Requisitions

1. Fill out a standard purchase requisition. Make sure to mark it “**RADIOACTIVE MATERIAL**”.
2. On purchase requisitions, make sure to spell out where quantities are in MILLICURIES or MICROCURIES. Make sure the quantities requested are within the allowable limits per the authorized user’s Certificate of Use.
3. The purchase requisition must be signed by the authorized user.
4. Email the purchase requisition to the Radiation Safety Office for approval. After approval, the Radiation Safety Office will email the approved requisition to Purchasing and copy the authorized user on the email.
5. The Receiving Department at the Student Union Building will receive the package.
6. If damage to the package is suspected, Central Receiving is to attempt to detain the deliverer of the package and is immediately to place the package into a secure storage area where no unauthorized personnel have access and notify the Radiation Safety Office.
7. The Receiving Department will notify the authorized user or designated individual of the arrival of a shipment. The authorized user or designated lab personnel will then pick up the shipment and sign a log sheet to indicate that it has been received. It is **REQUIRED** that the package be picked up that same day as soon as possible within reason. Lab personnel are not authorized to transport packages by vehicle.
8. The lab will email the Radiation Safety Office a copy of the packing slip. This copy remains on file in the Radiation Safety Office. A Receipt and Disposition

Log form for packages is available on the University of Toledo Environmental Health and Radiation Safety webpage.

9. Packages containing radioactive material shall be opened according to the rules given in Appendix C. (Printed on the back of the Receipt and Disposition Log). The radionuclide Receipt and Disposition Log form provides an area for this documentation.
10. All personnel are **PROHIBITED** from purchasing radioactive material with a purchase card (p-card) and/or having any radioactive material delivered directly to their lab.

C. Replacement Orders

1. You must notify the Radiation Safety Office immediately when replacement orders are required. The Radiation Safety Office needs to know the purchase order number and estimated date of arrival.
2. All replacement orders must be delivered to the normal delivery location for radioactive material packages. No package may be delivered directly to a lab.

D. Procedure for No-Charge Shipments or Shipments from another Institute

1. All no-charge shipments or shipments from another institute must have prior approval of the Radiation Safety Office. Written notification (email is acceptable) shall include the anticipated date of arrival of the shipment, the isotope, the amount in millicuries or microcuries and chemical form.
2. All Health Science Campus shipments must be delivered through the Radiation Safety Office and picked up by authorized personnel. Main Campus shipments must be delivered to Receiving at the Student Union Building and picked up by authorized personnel.

APPENDIX C.

Procedure for Safely Opening Packages Containing Radioactive Material

Shipping packages received that are known to contain radioactive material will be monitored for radioactive contamination and radiation levels if the package is labeled according to the U.S Department of Transportation rules (e.g. labeled with Yellow II or Yellow III) as containing radioactive material or if there is evidence of damage to the package. Such packages will be monitored within 3 hours of receipt if received during normal working hours or within 3 hours of the beginning of the next working day if received after normal working hours. The ODH/BRH will be notified if removable contamination exceeds 7200 dpm/300 cm².

A. Procedures Prior to Opening the Package

1. Put on gloves and a lab coat that is buttoned up to prevent any possible contamination of the hands or clothes.
2. Visually inspect the package for any signs of damage (e.g. wet package, crushed package). If damage is noted, stop the procedure and contact the Radiation Safety Officer.
3. Measure the exposure rate at 1 meter from the package and then measure the exposure rate at the package surface. If the exposure exceeds 10 mR/hr at 1 meter or 200 mR/hr at the surface, stop the procedure and contact the Radiation Safety Office.
4. Wipe the external surface of the package at several locations and count the wipe sample in the appropriate wipe counter, for the appropriate radionuclide, for a time sufficient to provide adequate sensitivity. Employ the detection efficiency factor and wiped area to determine the dpm/100cm². If the contamination exceeds 2400dpm/100cm², take precautions against the spread of contamination and contact the Radiation Safety Officer.

B. Opening the Package

1. Open the outer package following the supplier's instructions, if provided, and remove the packing slip.
2. Open the inner package and verify that the contents agree with the packing slip. Verify that the material received was the material ordered.
3. Check the integrity of the final source container. Look for broken seals or vials, loss of liquid, moisture or stains on packing material.
4. If there is any reason to suspect contamination, wipe the surface of the final source container and count the wipe sample as above.
5. Monitor any packing material and empty packages for contamination with an appropriate survey before discarding.
 - a. If the packaging material is contaminated, treat it as radioactive waste.
 - b. If the packaging material is NOT contaminated, remove or completely deface the labels before discarding into the regular trash.

TRIGGER LEVELS: Per DOT regulations, removable surface contamination may not exceed 24 dpm/cm² (7200 dpm/300 cm²) for beta and gamma emitters and may not exceed 2.4 dpm/cm² (720 dpm/300 cm²) for alpha emitters. The department action level to begin decontamination is 200 dpm/100cm².

APPENDIX D.

Area Survey Procedures

The following frequency for radiation surveys in radionuclide laboratories shall be followed by the authorized user or a designated individual. The authorized user is ultimately responsible for compliance. In all laboratories, consideration should be given to the possibility of cross-contamination. It may be necessary to monitor before and after each procedure for experimental accuracy.

A. Area Survey Procedures

1. All elution, preparations, and injection areas will be surveyed daily with a low-range thin-window G-M survey meter and decontaminated if necessary (Nuclear Medicine Areas). These areas will also be monitored for contamination using a wipe test weekly.
2. Laboratories using greater than 1 mCi per procedure shall monitor the lab for contamination at least once every two weeks (research labs only).
3. Laboratories using less than 1 mCi per procedure shall monitor the lab for contamination at least once per month. (research labs only)
4. Laboratories using higher energy or volatile radioactive material will be considered on an individual basis.
5. The laboratory survey will consist of:
 - a. A series of wipe tests to measure contamination levels. The method for performing wipe tests will be sufficiently sensitive to detect 100 dpm/100 cm² for the contaminant involved.
 - b. Action levels for radioactive contamination is 200 dpm/100 cm².
6. A record will be kept for all survey results, including negative results. The record will include, as the minimum, the following information:
 - a. Location, date, and model & serial number of equipment used.
 - b. Name of person conducting the survey.
 - c. Drawing/schematic of area survey identifying relevant features such as active storage areas, active waste areas, restricted benchtops, etc.

- d. Detected contamination levels should be keyed to locations on the drawing/schematic.
- e. List of corrective actions taken in the case of contamination or excessive exposure rates to include the reduced contamination levels or exposure rates after the corrective action. Please include any appropriate comments/explanation.
- c. Area will be cleaned (decontaminated) if the contamination exceeds the trigger level of 200 dpm/100 cm².
- f. These records are to be kept for 3 years.

APPENDIX E.

Dose Equivalent to an Embryo / Fetus Declared Pregnant Women OAC 3701:1-38-12

- A. A woman that desires to have her dose equivalent to the embryo or fetus during the entire pregnancy limited to the values listed in OAC 3701:1-38-12 must declare her pregnancy in writing to the Radiation Safety Office as soon as possible after discovering she is pregnant.
- B. The written declaration must be made to request fetal badge monitoring. The voluntary declaration form is in the Radiation Safety Office or on the Radiation Safety website.
- C. If by the time the woman declares pregnancy to the Radiation Safety Office, the dose equivalent to the embryo or fetus has exceeded 0.5 rem, the University of Toledo shall be deemed to be in compliance with paragraph (A) of this rule, provided that the additional dose equivalent to the embryo or fetus does not exceed (0.05 rem), during the remainder of the pregnancy.
- D. The Radiation Safety Office shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in 3701:1-38-12.
- E. The Radiation Safety Office will council the declared pregnant female according to Reg. Guide 8.13 "Instruction Concerning Prenatal Radiation Exposure."
- F. The Radiation Safety Office will monitor the radiation exposure of the female to ensure that the exposures to the embryo/fetus are maintained below the 0.5 Rem for the term of the pregnancy.

APPENDIX F.

Contamination Levels in a Controlled Area

A. Loose Contamination on Surfaces

1. Beta and Gamma Emitters: 200 dpm/100 cm²
2. Alpha Emitters: 200 dpm/100 cm²
3. ACTION LEVEL: Loose contamination is not acceptable and is to be removed if it exceeds 200 dpm/100cm².

B. Fixed Contamination on Surfaces

1. Contamination is deemed fixed if the wipe tests show no contamination, but the survey meter still reads positive for contamination.
2. Radiation levels must be such that individuals present will not receive an exposure in excess the maximum permissible dose specified per calendar year in 3701:1-38-12.

APPENDIX G.

Suggested Agents for Removal of Contamination

Contamination Area	Decontaminating Agent	Remarks
Skin / Hands	Mild Soap and Water	Wash for 2 to 3 minutes and monitor. Do not wash more than 3-4 times.
	If needed, follow by soft brush, heavy lather, and tepid water	Use light pressure with heavy lather. Wash for 2 minutes, 3 times.
	If needed: A mixture of 30% Tide, 50 % corn meal, 20% water	Mix into a paste. Use with additional water with mild scrubbing action. Use caution not to erode the skin.
Hair	Liquid soap and rinse with water	Make repeated applications and rinses. Use towels to keep water from running onto face and shoulders. Acid goggles can be used to protect the eyes. Thoroughly dry hair before surveying.
Wounds (cut or breaks in the skin).	Running tap water. Report to the Medical Officer and Radiation Safety Office as soon as possible.	Urine and fecal analysis may be necessary to determine the amount of radionuclide in the body
Ingestion by swallowing	Report to Medical Officer and radiation Safety Office as soon as possible	Urine and fecal analysis will be necessary to determine the amount of radionuclide in the body
Clothing	Wash, if levels permit	Use standard laundering procedures. 3% Versene may be added to wash water.
Glassware	Soap or detergent, and water. Chromic acid cleaning solution or concentrated nitric acid	Monitor wash water and plan for disposal

APPENDIX H.

Disposal of Liquid Waste to Sewer System

Liquid waste may be disposed of via the sanitary sewer system at the University of Toledo provided that the following conditions are met:

1. Each authorized user of radionuclides must only use one sink for the disposal of liquid waste (designated "HOT SINK" unless prior authorization is given by the Radiation Safety Officer.
2. Each sink must be identified as being a radioactive sink with the appropriate caution sign displayed.
3. The daily limits of radioactive material released have been determined by the Radiation Safety Officer and is listed on your Sink Disposal Log form.
4. All releases of radioactive material must be followed by flushing the sink with copious amounts of water.
5. The liquid waste must be readily soluble or dispersible in water.
6. Flammable solvents that are not miscible with water shall not be put down the drain.
7. Radioactive material that can be conveniently decayed in storage should not be disposed via the sewer.
8. The Sink Disposal Log form must be returned to the Radiation Safety Office at the end of each month to ensure compliance with regulatory limits.

APPENDIX I.

Bioassay

The intent of bioassay is to monitor the radiation worker from the standpoint of possible INTERNAL exposure (as the dosimeter monitors possible EXTERNAL exposure). Inherently, however, bioassay is fraught with assumptions and unknowns and is relatively expensive. Therefore, it is unrealistic to use as a routine tool for those radiation workers using relatively low biohazard radionuclides.

For work with low levels of radiation, the control of possible internal radiation exposure is best accomplished by the education and enforcement of the standard laboratory rules. There are occasions, however, when the quantity of radionuclides is such that, should an ingestion or inhalation occur, it is likely that the bioassay procedure would determine that internal dose with some degree of accuracy.

The first column in the following table is a "threshold" quantity of radionuclide which, if exceeded, mandates the use of the bioassay schedule as presented. Other forms of bioassay (whole body counts) could become necessary should this examination be performed and some activity be found.

Quantity/Use Necessitating Bioassay	Type of Bioassay	Frequency of Exam
Single use of:		
1 Curie of Tc-99m	Thyroid	Immediate
100 mCi of Tl-201	Urine	Immediate
100 mCi of S-35	Urine	Within 14 days
100 mCi of P-32	Urine	Within 14 days
100 mCi of Cr-51	Urine	Within 14 days
10 mCi of I-125	Thyroid	Within 24-48 hours
30 mCi of liquid I-131	Thyroid	Within 18-72 hours
100 mCi of Co-57	Urine	Within 14 days
100 mCi of Hg-203	Urine	Within 14 days

Quantity/Use Necessitating Bioassay	Type of Bioassay	Frequency of Exam
Single use of:		
100 mCi of H-3	Urine	Within 14 days
100 mCi of C-14	Urine	Within 14 days
Multiple use of:		
10 mCi I-125 per Quarter	Thyroid	Quarterly
Continuous use of:		
10 mCi of H-3 organic	Urine	Weekly
10 mCi of C-14 organic	Urine	Weekly
10 mCi or H-3	Urine	Weekly
10 mCi of C-14	Urine	Weekly

APPENDIX J.

Guidelines for the Handling of Radioactive Cadavers

All uses of radiation are carried out under the direction of the Radioactive Materials Safety Committee which has the administrative responsibility of insuring the safe use of ionizing radiation within the hospital. The radioactive patient who expires and presents a radiation safety problem is a rare one, since therapeutic quantities of radioactive materials are seldom administered, and then not to the moribund patient. It is possible for a radiation safety problem to occur in this manner, however. In radiation safety, any reduction in personnel exposure that can be affected should be used, and this policy is presented.

The following table lists all sources of use of ionizing radiation within the hospital and whether safety procedures are needed.

Sources of Ionizing Radiation within UTMC	In Case of Death are Safety Procedures needed
Diagnostic Sources	
X-rays	No
Nuclear Medicine scans	No
Therapeutic Sources	
External Beam Radiation Therapy	No
Temporary implant or application of sealed sources that do not decay and must be removed.	No, once the sources have been removed.
Permanent implant of sealed sources that decay and need not be removed.	Yes
Liquid or capsule dose of I-131 or therapeutic radioactive material.	Possibly

General Procedures:

1. Patients who have received diagnostic quantities of radioactive material need no special procedures.
2. Patients who have received external beam therapy are not radioactive and no procedures are needed.
3. Patients who expire during a temporary intercavitary or interstitial implant present no safety problem once all the sources are removed. If during an autopsy, a small piece of metal is found, this may be a missing sealed source. Stand away from this source a minimum distance of ten feet. Call the Radiation Safety Officer.
4. Expired patients who had received either permanent implants, liquid, or capsule doses of radioactive material may require special handling. The range of doses a patient might receive is large, and is also dependent on date of treatment. The patient may have received a very small amount of radioactivity, and the procedure may simply be to treat the expired patient in a normal fashion. On the other hand, the dose and type of radiation may be such that the Radiation Safety Officer may have to monitor the pathologist during the entire procedure.
5. If a patient who is known to contain radioactive material dies outside of the hospital, the Radiation Safety Office should be contacted.
6. The physician who pronounces the patient dead is responsible for notifying the Radiation Safety Office so that a radioactivity tag may be attached to the body. The physician in charge must also be notified at once.
7. If an autopsy is not performed, the Radiation Safety Office will fill out the radioactivity report to be attached to the death certificate and forwarded to the funeral director.
8. If an autopsy is to be performed, the Radiation Safety Office will provide specific instruction to reduce personnel exposure during autopsy.
9. Cremation of an expired radioactive patient cannot occur without the written permission of the Radiation Safety Office.
10. Nothing in these procedures is to be taken as the proper procedure to follow in the event of a death due to radiation accident at a radiation facility. In this case, the prevention of contamination is the overring concern.

APPENDIX K.
Radiation Exposure to Individuals
Less Than 18 years Of Age

The exposure of individuals less than eighteen years of age must be limited in all instances to 3701:1-38-12(G) regulations. These regulations can be met if all of the guidelines below are followed:

1. Each authorized user is responsible for the immediate supervision of individuals less than 18 years of age working in their laboratory.
2. Under no circumstances may such individuals work with radiation sources without prior approval of the Radiation Safety Office.
3. Individuals less than eighteen years of age must be denied access to laboratories, experiments, or environments which could result in their receiving greater than one-tenth of the maximum permissible dose for a radiation worker. (3701:1-38-12).
4. Individuals less than eighteen years of age must be provided with appropriate dosimeters as necessary to evaluate any possible exposure.
5. Individuals less than eighteen years of age must have explained to them the extent of any radiation hazards associated with the work intended.
6. The Radiation Safety Office must be notified of the intent, on the part of the authorized user, to permit individuals less than eighteen years of age to be present to observe work with radiation or radioactive materials. Minors may not manipulate or handle radioactive materials. (Refer to "University of Toledo Minors in Research Laboratories" Procedure # HM-08-015). Requests must be made prior to any actual observation by individuals less than eighteen years of age. The purpose of this request is to permit the Radiation Safety Office to evaluate the conditions of intended work in the light of the above guidelines and to grant approval for such individuals to observe in a radiation laboratory.
7. Minors must be attended at all times by the authorized user or authorized designee as they observe in laboratories.
8. Minors must complete all training requirements for laboratory safety and health.

9. The “Parental Consent for Minors Entering a Research Laboratory at The University of Toledo” form must be completed before the minor can be present in research laboratories.
10. Individuals less than eighteen years of age must be denied access to laboratories or areas or experiments which have a bioassay or dosimeter badge immediate history greater than the ALARA action levels.

TO REITERATE: ALL AUTHORIZED USERS MUST RECEIVE APPROVAL FROM THE RADIATION SAFETY OFFICE PRIOR TO PERMITTING INDIVIDUALS LESS THAN EIGHTEEN YEARS OF AGE TO ENTER RADIATION AREAS.

Maximum Permissible Dose

Critical Area	Max Permissible Annual Dose to an ADULT	Max Permissible Annual Dose to a MINOR
Whole Body Total Effective Dose Equivalent		
External	5 Rem	0.5 Rem
Deep Dose Equivalent	5 Rem	0.5 Rem
Shallow Dose Equivalent (skin)	50 Rem	5.0 Rem
Lens of the Eye Dose Equivalent	15 Rem	1.5 Rem

GLOSSARY

Activity: The number of nuclear transformations occurring in a given quantity of material per unit time. (See Curie).

Background Radiation: The natural radiation that is always present in the environment. It includes cosmic radiation which comes from the sun and stars, terrestrial radiation which comes from the Earth, and internal radiation which exists in all living things. The typical average individual exposure in the United States from natural background sources is about 300 millirem per year.

Becquerel (Bq): The SI unit of activity. One Becquerel equals 1 nuclear transformation per second.

Bioassay: The determination of kinds, quantities, or concentrations and, in some cases, locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed (in vitro) from the human body.

Calibration: The adjustment, as necessary, of a measuring device such that it responds within the required range and accuracy to known values of input.

Contamination (Radioactive): Undesirable radiological, chemical, or biological material (with a potentially harmful effect) that is either airborne, or deposited in (or on the surface of) structures, objects, soil, water, or living organisms in a concentration that makes the medium unfit for its next intended use.

Controlled Area: A defined area in which the occupational exposure of personnel to radiation or to radioactive material is under the supervision of an individual in charge of radiation protection. (This implies that a controlled area is one that requires control of access, occupancy, and working conditions for radiation protection purposes.)

Curie (Ci): In physics, unit of activity of a quantity of a radioactive substance, named in honor of the French physicist Marie Curie. One Curie (1 Ci) is equal to 3.7×10^{10} Becquerel (Bq). In 1975 the Becquerel replaced the curie as the official radiation unit in the International System of Units (SI). Several fractions of the Curie are in common usage: millicurie (mCi) = 10^{-3} Curies, microcurie (uCi) = 10^{-6} Curies

Decay (radioactive): The spontaneous transformation of one radionuclide into one or more different isotopes (known as “decay products” or “daughter products”), accompanied by a decrease in radioactivity (compared to the parent material). This transformation takes place over a defined period of time (known as a “half-life”), as a result of electron capture; fission; or the emission of alpha particles, beta particles, or photons (gamma radiation or x-rays) from the nucleus of an unstable atom. Each isotope in the sequence (known as a “decay chain”) decays to the next until it forms a stable, less energetic end product. In addition, radioactive decay may refer to gamma-ray and conversion electron emission, which only reduces the excitation energy of the nucleus.

Declared Pregnant Woman: A woman who is an occupational radiation worker and has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

Decommissioning: The process of safely closing a facility, laboratory, or area where nuclear materials are handled to retire it from service after its useful life has ended. This process primarily involves decontaminating the facility to reduce residual radioactivity and then releasing the property for unrestricted or (under certain conditions) restricted use.

Decontamination: A process used to reduce, remove, or neutralize radiological, chemical, or biological contamination to reduce the risk of exposure. Decontamination may be accomplished by cleaning or treating surfaces to reduce or remove the contamination; filtering contaminated air or water; subjecting contamination to evaporation and precipitation; or covering the contamination to shield or absorb the radiation. The process can also simply allow adequate time for natural radioactive decay to decrease the radioactivity.

Dose: A general term denoting the quantity of radiation or energy absorbed. For special purposes, it must be appropriately qualified. If unqualified, it refers to absorbed dose.

Dose (absorbed): The amount of energy that ionizing radiation sources deposit in materials through which they pass, and is measured in units of radiation-absorbed dose (rad). The related international system unit is the gray (Gy), where 1 Gy is equivalent to 100 rad.

Dose (cumulative): The total dose resulting from repeated exposures to radiation.

Dose (equivalent): A measure of the biological damage to living tissue as a result of radiation exposure. Also known as the “biological dose,” the dose equivalent is calculated as the product of absorbed dose in tissue multiplied by a quality factor and then sometimes

multiplied by other necessary modifying factors at the location of interest. The dose equivalent is expressed numerically in rems or sieverts (Sv).

Dosimeter: Device used to detect and measure an accumulated dose of radiation.

Exposure (external): External exposure occurs when all or part of the body is exposed to a penetrating radiation field from an external source. During exposure this radiation can be absorbed by the body, or it can pass completely through, similar to a chest x-ray. Note that exposure to a radiation field does not cause an individual to become radioactive; the radiation exposure ceases as soon as the individual leaves the radiation field. All ionizing radiation sources produce an external radiation field. However, some fields are so small they pose no external radiation risk at all. Examples include these low and moderate energy beta radiation emitters. Examples include:

- H-3
- C-14
- Ni-63
- P-33
- S-35

Other sources of ionizing radiation produce much higher energy external radiation fields, and care must be taken to shield the source and to monitor exposure while working near these sources. Examples include:

- Am-241/Be neutron sources
- P-32 beta sources
- Cs-137 gamma sources
- Co-60 gamma sources
- X-ray machines (only when the machine is energized)

Exposure (internal): External exposure involves contamination with radioactive material. Contamination means that radioactive material in the form of gases, liquids, or solids are released into the environment and contaminate people externally (such as on the skin), internally (such as by ingestion), or both. Contamination by radioactive material can lead to incorporation of radioactive material into the body. This can be the result of uptake of radioactive material by body cells, tissues, and target organs such as bone, liver, thyroid, or

kidney. In general, radioactive materials are distributed throughout the body based upon their chemical properties.

External Radiation: Exposure to ionizing radiation when the radiation source is located outside the body.

General Population: All individuals who are not designated as being specifically engaged in a field of endeavor which subjects them to exposure of ionizing radiation. Further, by law, this population is limited to dosages of ionizing radiation of only one-tenth that allowed for the occupational population.

Gray (Gy): The unit of absorbed dose equal to 1 J/kg in any medium. 1 gray = 100 rad.

Half-life (biological): The time required for a biological system, such as that of a human, to eliminate, by natural processes, half of the amount of a substance (such as a radioactive material) that has entered it.

Half-life (effective): The time required for the activity of a particular radionuclide deposited in a living organism, such as a human or an animal, to be reduced by 50 percent as a result of the combined action of radioactive decay and biological elimination.

Half-life (radiological): The time required for half the atoms of a particular radionuclide to decay into another isotope. A specific half-life is a characteristic property of each radionuclide. Measured half-lives range from millionths of a second to billions of years, depending on the stability of the nucleus. Radiological half-life is related to, but different from, the biological half-life and the effective half-life.

Ionization: The process of adding one or more electrons to, or removing one or more electrons from, atoms or molecules, thereby creating ions. High temperatures, electrical discharges, or nuclear radiation can cause ionization.

Maximum Permissible Dose (MPD): The maximum dose that the body of a person or specific parts thereof shall be permitted to receive over a stated period of time.

Nuclear Regulatory Commission (NRC): is an independent agency of the United States government tasked with protecting public health and safety related to nuclear energy.

Nuclide: also called nuclear species, species of atom as characterized by the number of protons, the number of neutrons, and the energy state of the nucleus. A nuclide is thus characterized by the mass number (A) and the atomic number (Z). To be regarded as distinct, a nuclide must have an energy content sufficient for a measurable lifetime, usually

more than 10^{-10} second. The term nuclide is not synonymous with isotope, which is any member of a set of nuclides having the same atomic number but differing mass number. A radioactive nuclide is often referred to as a radionuclide.

Occupationally Exposed Population: All individuals designated as specifically engaged in a task which may subject them to possible exposures of ionizing radiation.

Rad (radiation absorbed dose): One of the two units used to measure the amount of radiation absorbed by an object or person, known as the “absorbed dose,” which reflects the amount of energy that radioactive sources deposit in materials through which they pass. The radiation-absorbed dose (rad) is the amount of energy (from any type of ionizing radiation) deposited in any medium (e.g., water, tissue, air). An absorbed dose of 1 rad means that 1 gram of material absorbed 100 ergs of energy (a small but measurable amount) as a result of exposure to radiation. The related international system unit is the gray (Gy), where 1 Gy is equivalent to 100 rad.

REM (roentgen equivalent man): One of the two standard units used to measure the dose equivalent (or effective dose), which combines the amount of energy (from any type of ionizing radiation that is deposited in human tissue), along with the medical effects of the given type of radiation.

Restricted Area: Any area to which access is controlled for the protection of individuals from exposure to radiation and radioactive materials.

Roentgen (R): A unit of exposure to ionizing radiation. It is the amount of gamma or x-rays required to produce ions resulting in a charge of 0.000258 coulombs/kilogram of air under standard conditions.

Scintillation Detector: The combination of phosphor, photomultiplier tube, and associated electronic circuits for counting light emissions produced in the phosphor by ionizing radiation.

Sealed Source: Any radioactive material or byproduct encased in a capsule designed to prevent leakage or escape of the material.

Shallow-Dose Equivalent (SDE): The external exposure dose equivalent to the skin or an extremity at a tissue depth of 0.007 centimeters (7 mg/cm²) averaged over an area of 1 square centimeter.

Survey (radiological): Evaluation of the radiation hazards incident to the production, use, or existence of radioactive materials or other sources of radiation under a specific set of conditions. Such evaluation customarily includes a physical survey of the disposition of materials and equipment, measurements or estimates of the levels of radiation that may be involved, and a sufficient knowledge of processes using or affecting these materials to predict hazards resulting from expected or possible changes in materials or equipment.

Survey Meter: Any portable radiation detection instrument especially adapted for inspecting an area or individual to establish the existence and amount of radioactive material present.

Total Effective Dose Equivalent: The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Unrestricted Area: The area outside the owner-controlled portion of a nuclear facility (usually the site boundary). An area in which a person could not be exposed to radiation levels in excess of 2 millirem in any one hour from external sources (see 10 CFR 20.1003).