Radiation Safety Manual

Chemical Control Centre

University of Windsor

RADIATION SAFETY PROGRAM

RESEARCH SAFETY COMMITTEE
UNIVERSITY OF WINDSOR

11th Edition

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1.1. Policy:

The purpose of this manual is to describe policies and procedures for the use of nuclear substances (radioisotopes) in both research and academic laboratories and other facilities at the University of Windsor, and to promote radiation protection and safety for all personnel at the University.

The University of Windsor is committed to the safety and well-being of all students, staff, faculty, and visitors to our campus. This includes ensuring that all activities involving ionizing radiation or radiation emitting devices be operated in a safe manner to limit the hazards associated with radiation to all individuals on campus. The President of the University of Windsor has appointed the Research Safety Committee to oversee the operations of the University Radiation Safety Program. The details surrounding the committee are contained within the Terms of Reference of the Committee. The various individuals and committees associated with the Radiation Safety Program at the University of Windsor are given in the Organizational Chart below (Figure 1).

The policies and procedures in this manual are consistent with the Radiation Protection Regulations of the Nuclear Safety and Control Act administered by the Canadian Nuclear Safety Commission (CNSC) and the Occupational Health and Safety Act and its regulations regarding X-ray sources, lasers, and sound. Furthermore, all persons involved in activities involving ionizing radiation and/or radiation emitting devices are expected to comply fully with policies and regulations contained herein.

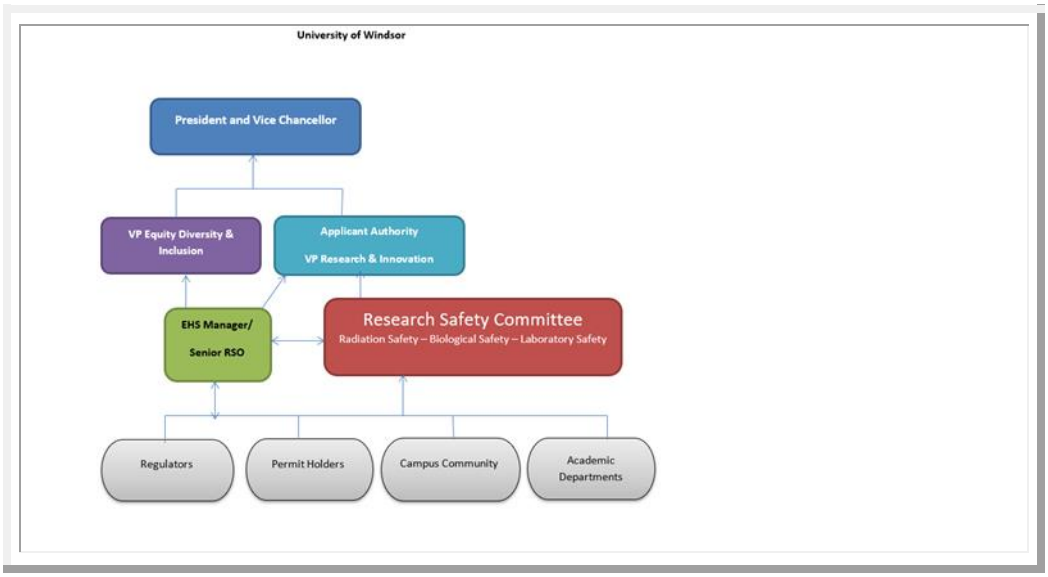

Figure 1: University of Windsor Research Safety Committee Organizational Structure

1.2. Scope:

The University of Windsor's Radiation Safety Policy and Procedures will apply to all activities which;

1. Utilize radioisotopes and radiation emitting devices including, the University of Windsor teaching programs, research projects, and research funded by other agencies through the University of Windsor.
2. Store and/or manipulation of radioactive materials within buildings and/or grounds operated by the University of Windsor.
3. Any other projects that the Committee deems are within the jurisdiction of the Committee.

1.3. ALARA Policy:

The University of Windsor will ensure that all radiation doses are kept as low as reasonably achievable (ALARA) and within the CNSC prescribed dose limits to staff, students and the public. The University of Windsor Radiation Safety Program will keep exposures to ALARA through:

1. Management control over work practices.
2. Personnel qualification and training.
3. Control of occupational and public exposure to radiation.
4. Planning for unusual situations.

1.4. University of Windsor Research Safety Committee

1.4.1. Function:

The Research Safety Committee (hereafter referred to as the Committee) has the responsibility of, and authority for, establishing and enforcing the University's Radiation Safety Program. This program encompasses the procedures for ordering, usage, handling, monitoring, storage and disposal of radioactive materials. The Committee formulates and enforces such policies as are necessary to ensure that the doses of ionizing radiation received by any person involved with the use of radioisotopes do not exceed the limits specified in the Canadian Nuclear Safety Commission (CNSC) Regulations and are kept *as low as reasonably achievable* (ALARA principle). It is the goal of the University of Windsor's radiation protection program to develop policies and procedures which keep the amount of exposure to personnel and the effective dose and equivalent dose received by and committed to persons as low as is reasonably achievable, social and economic factors being taken into account, through the implementation of:

- Management control over work practices.
- Personnel qualification and training.
- Control of occupational and public exposure to radiation.
- Planning for unusual situations.

1.4.2. Membership:

The Vice-President, Research & Innovation (VPRI) and the Vice-President, Equity Diversity & Inclusion (VPEDI), have delegated the oversight of the program to the Environmental Health & Safety Manager (Manager EHS) and the management of the program to the University of Windsor's Research Safety Committee (RSC), and its chair. The RSC is comprised of three sub committees, the Biological Safety Committee, the Radiation Safety Committee and the Laboratory Safety Committee. The RSC is responsible for the development and promulgation of safety standards for the conduct of research and teaching activities involving potentially hazardous materials by members of the University.

The EHS Manager is designated as the Senior Radiation Safety Officer (RSO) for the University, sits on the RSC and is responsible and accountable for the administration of the Radiation Safety program to ensure that the associated activities are being performed in accordance with licenced activities and the program. The EHS Manager reports to the VPRI and VPEDI for all matters pertaining to radiation safety. The Chemical Control Centre (CCC) Coordinator under the direction of the EHS Manager provides advice and assistance in matters related to radiation safety, performs laboratory inspections and assists in the administration of the radiation safety program. The chairperson, and core members are appointed by the VPRI for a term up to 3 years by the VPRI ending December 31 of the third year. Ex officio members include the EHS Manager, Animal Care Committee Chair, Research Ethics Board Chair and the Director of Research & Innovation Services. Ex officio members or their delegates are full voting members until they no longer hold office. The core committee members are comprised of members from Chemistry & Biochemistry, Biological Sciences, Physics, Creative Arts, Engineering, Great Lakes Institute for Environmental Research (GLIER) and Human Kinetics. One member that utilizes x-rays or lasers, and one member that utilizes radiation in their academic or research programs. One member at large to represent the University Community and one student representative that utilizes radiation and/or biologicals in their academic or research studies.

1.4.3. Meetings:

The Committee shall meet a minimum of twice a year. Meetings, other than regular meetings, may be called by the chairperson, the RSO, or any three members of the Committee. Minutes of the meetings shall be recorded and mailed to the membership of the Committee. The meetings shall generally be conducted according to the principles of Robert's Rules of Order and the chairperson shall use them as a guide at the request of a committee member.

1.4.4. Role of the "Research Safety Committee" (RSC):

- Establish and review periodically the training and experience requirements for users of radioactive materials to ensure that they are able to perform their duties safely and in accordance with regulatory requirements.
- Maintain a program to ensure that all persons, whose duties may require them to work in the vicinity of radioactive material, are properly instructed.
- Assess the results, and determine the effectiveness, of the institution's programs to train persons in the safe use of radioactive materials.
- Be available for consultation on problems dealing with radioactive materials and radiation hazards.
- Review and authorize, taking into account the University of Windsor's Radiation Safety Policies, all requests for the use of radioactive material within the institution by issuing, through the RSO, user permits.
- Review the radiation safety program every two years, including review the results of internal inspections of facilities, premises, equipment and work practices that assess whether radioactive materials are used safely in licenced activities.
- Receive reports from the Radiation Safety Officer and recommend remedial action to correct any deficiencies.
- Maintain written records of all meetings, actions, incidents or unusual occurrences, recommendations and decisions, and supply the CNSC with a copy of these.
- Review the Annual Compliance Report that is required by the CNSC.
- Advise university administration of the resources necessary to set up and maintain an adequate radiation safety program which will incorporate the ALARA principle, taking into account social and economic factors.
- Approve designs for new laboratories in accordance with CNSC Regulatory Document R-52 (Revision I) entitled "Design Guide for Basic and Intermediate Level Radioisotope Laboratories."
- Report regularly on its activity to the Vice-President, through the RSO.

1.4.5. Roles of the "Radiation Safety Officer" (RSO):

The Radiation Safety Officer (RSO) shall provide administration and control of radiation protection programs on behalf of the institution, including the consolidated radioisotope licence issued to the University by the CNSC and shall coordinate all aspects of the radiation safety program at the University of Windsor.

The RSO should understand methods and technology to control, use, handle, store and dispose of the radioactive materials, and to monitor and control radioactive contamination, radiation fields and radiation exposures. They should also understand pertinent regulatory processes and requirements, such as relevant legislation and licence conditions. The RSO requires RSO training or refresher training every 3-5 years.

The RSO shall report directly to the office of the Vice President, Equity Diversity & Inclusion and the office of the Vice President, Research & Innovation in relation to all aspects pertaining to the utilization of radioisotopes on campus.

Agent:

- Act as the agent of the University with respect to licensing matters; in conjunction with managers and the RSC, supervise, advise and consult regarding issues related to the institution's use of radioactive materials in accordance with legislation and any relevant conditions of the CNSC licenses.
- Review, either independently or in concert with the RSC, requests for authorization to purchase or use radioactive materials in order to ensure that the proposed uses and locations of use are acceptable and comply with the institution's radiation protection program, relevant legislation, and licence conditions.
- Authorize only those purchases and uses of radioactive materials, and those work procedures, and conditions and locations of use, that assure compliance with the institution's radiation protection program, relevant legislation, and licence conditions.
- Authorize qualified persons to possess, use or handle radioactive materials in accordance with the institution's policies and relevant legislation, procedures and licences.

UWin Radiation Information System:

- Ensure that each user Permit is reviewed every two years, and amended when necessitated by changes to facilities, equipment, policies, isotopes, conditions of use, procedures and personnel. The RSO can review a permit at any time.

- Maintain a record of the status of all designated laboratories that use radioactive materials.
- Ensure that records and reports that are required of the institution by legislation and licences are prepared, maintained or submitted as required

UWin Radiation Safety Program:

- Establish, implement and maintain a radiation safety control and assessment program in consultation with the Research Safety Committee.
- Systematically and periodically review survey programs for radiation and contamination levels in all areas where radioactive materials are used or stored.
- Audit the radiation safety program every two years.
- Develop and implement programs to inspect and critically review the conduct of licensed activities, the adequacy of locations and facilities where radioactive materials are used and stored, and the adequacy of personnel training and safety procedures.
- Implement remedial actions to correct any deficiencies identified in the inspection programs referred to above.

UWin Radiation Training Program:

- Ensure that all staff who work in areas where radioactive substances are used or stored are provided with appropriate training.
- Assess the qualifications and competence of persons who apply to use or handle radioactive materials, to determine whether they can do so safely and in compliance with relevant legislation and licences.
- Ensure that radiation protection programs appropriate to the organization's undertakings are developed, implemented and maintained.

UWin Radiation Monitoring Program:

- Design and implement, in accordance with regulatory requirements, appropriate personnel monitoring and bioassay programs to measure “external” and “internal” exposures to ionizing radiation.
- Ensure radiation monitoring instruments are available in sufficient number, and are calibrated and serviced annually.
- Administer the University of Windsor’s Dosimetry monitoring program, including receiving, reviewing, and notify end-users of results dosimetry monitoring program to ensure that any person working with or handling radioisotopes does not receive a nuclear dose exceeding 1mSv/year or 50mSv/year for Nuclear Energy Workers. (See section 1.5.6 for more details)

- Recommend ways of reducing radiation exposures in the interest of the ALARA principle.
- Ensure that sealed radiation sources are leak-tested in accordance with the institution's procedures and regulatory requirements.

- Investigate all overexposures, accidents and losses of radioactive materials and submit a written report to the CNSC.
- Assess the adequacy of survey programs for measuring or managing radiation fields and radioactive contamination during licensed activities, such as during the use, storage and disposal of radioactive materials.

Radiation Spill Response:

- Supervise decontamination procedures should a minor or major spill of a radioactive substance occur.
- Coordinate the plans to be used in case of an emergency involving radioactive materials.

Radioactive Waste Management:

- Develop and monitor waste disposal procedures in accordance with conditions of the radioisotope licence.
- Authorize the disposal of radioactive materials in accordance with legislation, the CNSC licence, and the institution's policies and procedures; designate Nuclear Energy Workers (NEWs) in accordance with Nuclear Safety and Control Act SOR/200 205 SOR/2000 203.

1.4.6. Duties of the RSO with respect to the RSC:

- Be a member of the Committee.
- Review the radiation safety manual every two years in consultation with the Committee.
- Provide input in matters pertaining to:
    1. facility and equipment design.
    2. Work practices and procedures.
    3. Waste storage and disposal management.
    4. Evaluation, issuance and enforcement of user permits.
    5. Identify program associated problems, initiate, recommend, or provide corrective actions, stop unsafe operations and verify implementation of correction actions Radiation safety training.

6. Prepare, in consultation with the Committee, the Annual Compliance Report for the CNSC as required by CNSC ACR Form 815.

1.4.7. Role of the "Permit Holder":

The purpose of user Permits is to control the purchase, receipt, use, and disposal of radioisotopes. Such Permits are issued by the RSO for a period not exceeding 2 year and a list of permits issued by the RSO is included in the Annual Compliance Report submitted to the CNSC. The permit holders are responsible for the following:

- Overseeing the storage, utilization, and disposal of all radioisotopes acquired under their permit, including the supervision of approved end-users.
- Ensuring that an up-to-date permit, reflecting approved end-users and radioisotopes, is posted within all licensed areas.
- Ensuring that the conditions stated in the permit (above) are fulfilled and that safe laboratory practices are followed.
- Posting signs and/or labeling experimental areas and storage locations as "RADIOACTIVE" within the licensed area. In addition, will ensure that radiation warning signs are not frivolously posted where radiation or radioactive material is not present.
- Ensuring that in all licensed locations under his/her permit is a legible sign which indicates the name or job title and telephone of a person who can be contacted 24 hours per day with respect to any incident involving radioactive material. The RSO can provide a pre-printed "Emergency Contact" signs for posting.
- Ensuring that the appropriate sign is posted in a conspicuous location indicating the laboratory classification of the licensed laboratory (i.e. Basic or Intermediate).
- Ensuring that all required leak tests are performed and recorded.
- Responsible for ensuring that all inventory, tracking, and disposal records are up-to-date.
- Ensuring that all students and/or staff under their supervision are using radioactive materials have been authorized and properly trained to use radioactive materials.
- Ensuring that all staff using radioisotopes have been issued and wear a thermo-luminescent dosimeter (TLD) and participate in the bioassay program, if required.
- Designating specific work and storage areas for radioactive materials and ensuring that these areas are kept clean, properly labeled, have adequate ventilation, and are adequately shielded.

- Providing specific training in radioisotope handling that is necessary for the safe use of the radioisotopes in their laboratories.
- Report all lost or stolen or unauthorized use of nuclear substances to the Radiation Safety Officer.
- Reporting all radiation incidents to the Radiation Safety Officer.
- Ensuring that all radioactive material is stored in a secured storage facility (refrigerator, freezer, cabinet).

1.4.8. Roles of the "End-User":

- To inform their direct supervisor and/or RSO of any accidental release of radioisotopes to the environment.
- To record the usage of all radioisotopes within the Laboratory Radioisotope Inventory records.
- To follow the direction provided by either the permit holder and/or RSO in relation to the safe utilization, storage, and disposal of radioactive materials.

1.4.9. Roles of the "X-Ray Worker":

Users of X-ray equipment are responsible for complying with the University of Windsor's Radiation Safety Policy and Procedures, the Occupational Health and Safety Act, its Regulations and also the owner's instructions regarding the use of the X-ray producing equipment.

Users of X-Ray equipment are required to participate in the University of Windsor's Personal Monitoring Program when using X-ray producing equipment. (Please refer to the x-ray safety manual)

1.5. Enforcement of Radiation Safety Regulations:

In the event that a Permit Holder fails to observe the rules and regulations governing the safe use of sources of ionizing radiation, the RSO, shall advise such Permit Holder of the violation(s) and shall report same to the Committee.

The Committee shall review reports of violations and when appropriate issue a written warning to the Permit Holder and/or suspend or withdraw approval of the user(s) permit.

If, in the judgment of the RSO, there is an emergency situation involving a radiation hazard, they shall take immediate action to ensure the safety of personnel and the environment. A meeting of the Committee shall be called as soon as possible following such a situation to review the circumstances of the event.

Decisions of the Committee will be reported to the VPRI and VPEDI, through the RSO, for action. Disagreement with any Committee decision may be appealed to the President of the University. Such appeals must be forwarded in writing to the President and a copy must be sent to the Committee.

1.6. University of Windsor Radioisotope Permits:

The Research Safety Committee, via the RSO, is responsible for the issuance of internal permits to qualified individuals under the University of Windsor's consolidated licence with the CNSC. These permits do not permit experiments directly involving human subjects, where more than an exemption quantity is being used unless specifically authorized.

Permits are reviewed annually by the RSO and Committee to ensure that a demonstrable need for a radioisotope permit continues to exist. Permit Holders who have not used radioisotopes during the past 12 months, and who have no firm plans to use radioisotopes in the coming 6 months, will have their permits inactivated. Inactive Permits will be kept on file and re-activated upon a request from the permit holder, and any details of the permit changed.

Where permits have been de-activated, the laboratory will be decommissioned and any remaining inventory of radioisotopes (if any) stored elsewhere in a locked cabinet, refrigerator or freezer where other radioisotopes are stored under a Permit. If a Permit is re-activated, all required radioactive warning and safety posters will be put in place, and students must be trained in the safe handling of radioactive substances established before work with radioactivity can resume.

Contact the Radiation Safety Officer to apply for a University of Windsor Radioisotope Permit or visit the Radiation Safety Website for more information (www.uwindsor.ca/radiation).

1.6.1. New Permits:

Application Procedure:

1. Complete in full the form "Application for a Radioisotope User's Permit" and forward the form to the RSO. The application form is also available on the Radiation Safety website (www.uwindsor.ca/radiation). Note: The application for a radioisotope user's permit requires the approval of the Department Head of which the licensed area is located.

2. The applications will be initially reviewed by the CCC Coordinator. If approved by the RSO, the application will be forwarded for review and approval by the Research Safety Committee. If approved by the committee an internal permit will be issued, signed by both the RSO and the Chair of the Research Safety Committee.

3. A copy of the approved permit will be forwarded to the applicant outlining approved quantities and types of isotopes that can be acquired, stored and utilized under the permit. An additional copy will be placed in the Permit Holder's file at the Chemical Control Centre.

The Permit Holder is required to adhere to the conditions outlined in the licence. Failure to comply with the conditions/stipulations contained within the licence may result in suspension or cancellation of the permit. Non-compliance can also place the institution's consolidated licence in jeopardy.

1.6.2. Alterations to Issued Permits:

Any requested alternations to a previously issued permit can be made by e-mail or in writing directed to the RSO. If major changes are required to the permit it may require approval of the Research Safety Committee; for example, changes in the classification of a laboratory require additional mechanisms to ensure that people, property, and the environment are protected and therefore will require approval of the chair of the Research Safety Committee.

1.6.3. Renewal of Permits:

All internal radioisotope permits have a defined expiry date listed on the permit. Prior to the expiration of the permit, the Radiation Safety Officer will send a renewal package to the permit holder. The renewal package will contain information outlining the renewal process and an "Application for Radioisotope Permit Renewal" for submission to the Radiation Safety Officer. It is the responsibility of each permit holder to submit the application for renewal two (2) weeks prior to the expiration of their permit. The renewal form must be signed by the Department Head. Renewals of existing permits that do not require major amendments may be granted by the RSO and RSC Chair. Renewals that involve major amendments will be forwarded to the Research Safety Committee for approval.

1.6.4. Decommissioning of Laboratories and/or Cancellation of Permits:

It is the responsibility of the permit holder, prior to leaving the University, to decommission their laboratory as follows:

1. Provide sufficient information to the RSO, at least two (2) weeks prior to the decommissioning, on the specific radiation sources used in this laboratory.

2. Put all radioactive materials in appropriate containers; one for each isotope and call the Chemical Control Centre to request a pickup of such materials.
3. Draw a map of the laboratory showing where wipe tests are to be taken.
4. Perform wipe tests and analyze the counts to identify contaminated areas if any. For the purposes of decommissioning, the limits are defined as allowable detection limits for public areas that are outlined in the University of Windsor's consolidated licence (see
5. Appendix 2).
6. Decontaminate and clean any areas found contaminated in the initial wipe tests.
7. Perform a second series of wipe tests, and if no contamination is found keep the results together with the results of the initial wipe test(s).
8. Remove all radiation warning signs, licenses, etc. from the laboratory.
9. Inform the RSO of the wipe test results and completion of the decommissioning procedures in writing.

If the permit holder leaves the institution prior to decommissioning their laboratory the Department will be responsible for all labour costs associated with the decommission process. Furthermore, the institution may take financial steps to recover the costs associated with the decommissioning of a licensed laboratory prior to transferring any remaining research funds. The RSO will provide both the Permit Holder, Department Head and the CNSC with written confirmation of the successful decommission of a licensed radioisotope laboratory after completion of the above mentioned steps.

1.6.5. Laboratory Inspection Process:

All licensed laboratories will have an inspection conducted annually. To facilitate the inspection process the RSO shall be provided with complete access to all permitted locations at all times. The inspections shall be conducted on a regular basis and may not be announced. Laboratories classified as "Basic" will be inspected once per annum. Laboratories with a classification above "Basic" will be inspected at least twice a year. The inspection process will review aspects associated with the Radiation Safety Program, including:

- Administrative requirements; such as permit posted, supervision, training, and dosimeters utilized.
- Inventory control; including monitoring, inventory, and bioassays (if applicable).
- Safe storage and handling; including receipt of materials, storage, and work area safety.

- Personal protective equipment; examples include laboratory coat, gloves, shielding, and fume hoods.
- Ability to effectively handle spills and contamination; including procedures, and cleaning.

The results of the inspection process will be documented, with a copy placed in the permit holder's file and a copy provided to the permit holder. Items identified during the inspection process will be outlined including required action steps. The inspection results will then be provided to the Research Safety Committee. If the inspection process identifies significant violations to the University of Windsor's Radiation Safety Program, that place people, property, or the environment at risk the permit holder will be requested to take immediate action. Failure to correct identified deficiencies after the completion of the inspection process may lead to the permit to be revoked and/or laboratory facilities to be closed.

1.7. Dose Limits:

The Canadian Nuclear Safety Commission has created two different classifications for individuals who handle radioactive material: (1) Members of the General Public; and (2) Nuclear Energy Workers.

1.7.1. Members of the General Public (MGP):

All University of Windsor faculty, staff, and students are automatically considered a "Member of the General Public" (MGP) regardless of the need for the handling of radioactive materials. All workers, working directly with radioactivity are categorized as an End Users.

The effective dose limit for a member of the general public (i.e. non-NEW) is 1 mSv per annum.

1.7.2 Nuclear Energy Workers (NEWs):

A "Nuclear Energy Worker" is defined within the Nuclear Safety and Control Act as an individual who, in the course of their occupation, has a reasonable probability of receiving a dose of radiation that is greater than the prescribed limit for the general public (i.e. 1 mSv per year). A review of the internal radioisotope user permit application by the RSO and committee will be conducted on each application, renewal and amendment to identify any individuals (End Users) working with radioactive materials who may exceed the dose limits and will be designated by the University of Windsor as a Nuclear Energy Worker (NEW). These individuals consist of employees who are responsible for radiation safety and/or have special experimental conditions which require a high concentration of materials to be on-hand at a given time.

All individuals who are designated as a Nuclear Energy Worker will be provide with an informational pamphlet outlining the risks associated with radiation exposure as stipulated in Section 7 of the Radiation Protection regulations under the Nuclear Safety and Control Act. The designated NEW will be provided with a written confirmation of their designation by the RSO.

In consideration of the ALARA principle, the University of Windsor has established action levels for radiation doses below the limits listed (see below). These limits are outlined in Appendix I.

Organ or Tissue	Period	Dose (mSv)	
		Nuclear Energy Workers (NEW) [2]	Members of the Public
Whole Body	One year	50	1
	Five years[1]	100	-
Lens of eye	One year	50	15
Skin	One year	500	50
Hands and Feet	One year	500	50

Figure 2: Dose Limits

Comments:

(1) The average limit associated with a whole body dose is 20 mSv per year, assuming that the dose is delivered at a uniform rate.

(2) For pregnant nuclear energy workers (NEW) the limit is reduced to 4 mSv for the balance of the pregnancy.

2. RADIATION PROTECTION

2.1. Safe Handling of Radioactive Materials:

To ensure protection to people, property, and equipment it is necessary to ensure that all radioactive materials remain locked unless an authorized individual is present. Unsecured licensed laboratories are subject to having their permit revoked.

2.1.1. General Laboratory Safety Principles:

1. A copy of the current permit must be clearly posted in all rooms listed on the permit (photocopies are acceptable). The internal permit lists permissible isotopes, quantities, safety information, and consolidated licence conditions pertaining to hazards and precautions which must be taken.

2. A copy of the CNSC publication "*Rules for Working with Radioisotopes in a Basic/Intermediate/High Level Laboratory"* or updated information must be posted in each room where radioactive material is handled.

3. Work areas must be clearly defined and all work confined to the designated area or bench within the licensed laboratory. The designated area should not be located within a high traffic area. Ideally, the manipulation of radioactive material should be limited to a single section of the lab.

4. All radioisotope usage areas must be clearly labeled.

5. In keeping with ALARA, radioactive waste must be shielded to reduce potential for radiation exposure to personnel working in the laboratory. Do not store waste for decay purposes within a licensed lab. Refer to "Radioactive Waste Disposal" for requesting pick-up of waste containers.

6. The defined work area must be covered with disposable absorbent materials (e.g. Benchcoat – CCC Part No. LAB0056), which must be immediately discarded if there has been a spillage of any kind. Disposable absorbent material must be replaced on a regular basis.

7. To reduce contamination of items which are not related to the manipulation of radioisotopes, designated areas must be kept free of non-related materials. For example, laboratory records and books should not be stored within designated work areas.

8. If there is the potential for radioactive materials to become volatilized by dispersion of dust, or by spraying or splattering manipulation of radioactive material must be completed within a certified fume hood. Furthermore, when dry radioactive materials are manipulated a dry-box or transfer-hood must be used. The appropriate personal protective equipment must be selected based on physical properties. Due to the volatile nature of iodine, all experiments involving radioactive iodine must be performed in a fume hood.

9. The fume hood must not be crowded with materials which may disrupt the air flow and must be equipped with an alarming flow monitoring device. Certification of fume hoods must be completed annually with certification notification posted on the outside of the unit. Fume hoods must not be used for storage unless the materials produce hazardous discharges.

10. As part of the University's commitment to radiation safety, a radiation dosimeter (whole body) must be worn at all times. For more information related to the University of Windsor Personal Monitoring Program, refer to the section contained within.

11. Individual research laboratories must complete appropriate monitoring and contamination control checks routinely, within seven days of the usage of radioisotopes at a minimum. If contamination is identified the area must be cleaned without delay and the cleanliness verified by further contamination control checks. Permit holders must maintain a record of all monitoring and contamination control records for inspection purposes. Refer to the internal permit or the Appendix for radioisotope specific "contamination" designations.

12. Eating, drinking, smoking, use of cosmetics or other material in contact with the skin is forbidden in the laboratory. Foodstuffs or food containers must not be stored in a radioisotope laboratory or in a refrigerator used to store radioisotopes.

13. If end-user has a break in his/her skin it must by appropriately protected by a waterproof covering prior to putting on gloves. Appropriate waterproof coverings can be located within all University of Windsor First-Aid kits.

14. All equipment and other items (i.e. pipettors) used during the manipulation of radioisotopes must be appropriately labeled. Permit Holders should separate equipment used in the manipulation of radioactive materials separate from equipment used in general laboratory applications. Warning labels must be removed when the item has been decontaminated.

15. Radioactive solutions must be labeled with radiation warning tape including pertinent information identifying the chemical composition of the solution, radioisotope, and its activity. If the transportation of radioactive solutions is necessary a secondary containment device must be used. All containers used in carrying radioactive materials must be properly covered and labeled.

16. Where feasible, glassware should be designated for radioisotope work and washed separately, preferably with a detergent specifically designed for radioisotope work. The glassware should be stored in a separate marked area, to avoid mixing with general laboratory glassware. Before being returned to general use, all such glassware must be properly decontaminated.

17. If possible, a designated sink should be used for the decontamination of glassware and equipment used in the manipulation of radioactive materials. The sink must be clearly labeled.

18. If a spill occurs, radioactive material must be immediately covered with absorbent material to prevent the spread of material. The spill area must be identified to warn other personnel of its location. Decontamination of the area must begin as soon as possible. Refer to “Radioactive Material Spill and Decontamination Procedures” for more information.

19. Laboratory equipment can be decontaminated by using a commercial laboratory detergent (e.g. Sparkleen – CCC Part No. LAB0621). If contamination can not be removed a complexing agent (BASE0092) or ultrasonic cleaning may be used. If the equipment cannot be satisfactorily decontaminated, it may be stored until the radiation has decayed sufficiently or it must be discarded as radioactive waste. Consult the RSO for assistance.

20. Coat hooks should be placed near the exit door to encourage laboratory personnel to remove such clothing before leaving the laboratory. Laboratory clothing must not be worn outside the laboratory.

21. If laboratory maintenance is required decontamination must be completed prior to the start of such work. A “Safe to Work” notice must be posted in the vicinity where maintenance work is to be completed identifying the area, principal investigator, date cleaned, and emergency contact information.

Protective Clothing: As an employer, all employees of the University of Windsor are required by law to utilize the personal protective equipment issued to them by their supervisor. Furthermore, if an employee is uncomfortable or required additional training and/or equipment they are obligated to inform their supervisor.

Direct contact with radioactive materials must be avoided by the proper use of protective clothing. As a minimum, this consists of a laboratory coat and disposable, impervious gloves. Depending on the isotope and operation, double gloves, a full apron and glasses or a face shield may be necessary. Disposable items must be discarded immediately after use. The Chemical Control Centre stocks a wide range of personal protective equipment including gloves, glasses, disposable lab coats, shoe covers, etc.

Gloves: Disposable gloves need to be inspected often for the presence of any small holes which may have formed. In addition, disposable gloves must be removed and placed within the solid radioactive waste stream before leaving the laboratory. If the more than 1 mCi (37 MBq) of an isotope is handled, or when handing radioactive iodine, two pairs of gloves are recommended.

Lab Coats: Laboratory coats must be fully buttoned and the sleeves extended to cover the wrist of the wearer. Laboratory coats should not be worn outside the laboratory working areas and must not be worn to any eating area or cafeteria. Disposable laboratory coats can be worn over-top of an existing lab coat to reduce the potential for contamination. The disposable coat must be discarded in the solid radioactive waste stream prior to leaving the lab.

Eye Protection: Safety glasses/goggles or appropriate shielding must be used when handling high energy emitting radioisotopes, such as Phosphorus-32 (^{32}P). The use of

appropriate eye protection will reduce the irradiation to the eyes and skin while protecting against the possibility of high radiation doses in case of accidental splashing.

2.2. Procedures Regarding Open Source Radioisotopes

1. All Permit Holders shall have a copy of the Radiation Safety Manual and shall instruct their laboratory personnel of the rules and guidelines outlined in this manual.

2. The Permit Holder is responsible for arranging for the training of all new personnel in his/her laboratory before they work with radioisotopes. Radiation Safety Training for End-Users is offered online. Please visit www.uwindsor.ca/radiation for more information.

3. If a new procedure involving radioisotopes is used a test run using non-radioactive materials should be performed to test the procedures. Ideally, a pre-printed procedure should be posted above the designated area outlining the procedure. In addition, all necessary materials and equipment should be placed in the designated working area.

4. To reduce the potential for exposure and costs, use the minimum amount of radioactivity necessary to meet the objective of the procedure and to ensure acceptable results.

5. All laboratories that use open sources of radioactivity must have clearly visible signage posted on all entry points to the laboratory. In addition, defined work areas within the licensed laboratory must be clearly defined.

6. Access to radioactive laboratories must be limited to authorized personnel as determined by the director/principal investigator (e.g. only persons who have been advised of the potential hazards and meet any specific entry requirements are permitted into the laboratory area). Persons under the age of 16 years are not permitted in the laboratory or support areas. Pregnant women and immunocompromised people who work in or enter the laboratory must be advised of the associated risks.

7. A radiation monitor must be available when handling radioactive materials for contamination monitoring. The monitor should be located away from the handling areas to reduce the potential of accidental contamination to both the probe and

meter. While materials such as plastic wrap may be used to prevent contamination of the monitor from routine handling, it must be considered that any material placed over the detector will reduce the efficiency of the unit.

8. The defined work area should be monitored frequently during radioisotope work to detect potential contamination. Attention should also be paid to the floor area located below the defined work area.

9. High energy beta emitters have the ability to produce large amounts of radioactivity and cause high dose rates. Experimentation should never be carried out above an open vial of high energy beta emitters, such as Phosphorus-32 (^{32}P).

10. It is forbidden to pipet liquids by mouth. End-users are to utilize an appropriate tool to safety dispense liquids. If possible, disposable tips are to be used. Radioactive solutions should be transferred carefully using a pipette rather than pouring from one container to another.

11. If it is necessary to heat a radioisotope, a hotplate with an oil bath or water bath must be used. Radioactive solutions must never be heated directly over a flame. Safety glasses and/or face masks must be worn when heating radioactive materials to reduce the potential for exposure. In addition, forceps and heat-resistance gloves must be used.

12. Radioactive solutions must be transported in a labeled outer plastic beaker or tray lined with an absorbent liner to avoid the spread of radioactive contamination in the event of breakage.

13. Upon completion of a radioisotope experiment, all materials must be properly labeled. All material and equipment used during the procedure must be safely stored or prepared for disposal.

14. All liquid waste must be in glass bottles and appropriately labeled. All solid waste must be put in plastic bags separated according to isotope, and properly labeled. Refer to “Radioactive Waste Disposal” for detailed information pertaining to the University of Windsor’s Radioactive Waste Management Program.

15. Possession limits for the use of various radioisotopes at the University of Windsor in a "Basic Level Laboratory" are listed in (Appendix 1). A Permit Holder wishing to use

10,000 times the Exemption Quantity of a radionuclide would need an "Intermediate Level Designation", and a special permit to handle such a quantity. Written permission from the CNSC is required for the purchase and handling of 10,000 EQ.

16. Inventory records outlining the order number, isotope, chemical form, total activity, date received, and permit number must be located within the licensed laboratory at all times. All lots of radioactive materials are uniquely numbered and referenced on all documentation.

17. All users of Radioactivity must follow the general safety practices related to radioactive materials outlined in this manual.

Failure to comply with the following may result in suspension of the licence and revoking the privilege of working with radioisotopes in the laboratory.

2.3. Procedures Regarding Sealed (Closed) Radioisotope Sources:

A radioisotope which is encased in a secondary material preventing the direct manipulation of the radioactive material is classified as a “sealed source”. These sources are typically used in the calibration of research instrumentation, such as a calibrated radioactive source set. In addition, they also can include radioactive sources which are contained within a device including a liquid scintillation counter or gas chromatograph.

All sealed sources of radioactivity are required to be listed under a University of Windsor’s Internal Radioisotope Permit. The permit outlines the information pertaining to the equipment (if applicable), radioisotope, activity, and serial number. It is the responsibility of the permit holder to verify that the information listed on his/her permit is correct. Visible signage must be posted on all entry doors to the licensed room indicating the potential radiation exposure.

An inventory of all sealed sources on campus is maintained with the Radiation Safety Database within the Division of Laboratory Safety at the Chemical Control Centre.

All sealed sources and devices containing sealed sources must be durably and clearly labeled with a radiation warning sign indicating the type and quantity of radioactive material present.

Notification:

Existing permit holders are required to notify the Radiation Safety Officer (RSO) prior to the receipt of any new sealed source or device containing radioactive sources. Permit holders are to complete an application for an internal radioisotope permit indicating the addition of a new source. The application must be completed in full outlining information on the source including the radionuclide, activity, source serial number, device name, device serial number, and location (room # & building). The RSO will make the necessary arrangements for an amendment to the existing permit.

Researchers who have never been issued an internal radioisotope permit are required to apply for a new permit prior to the receipt of any new sealed sources or devices contained radioactive sources. The application can be located on the Radiation Safety Program website (www.uwindsor.ca/radiation) or by contacting the Radiation Safety Officer.

Disposal / Transfer:

Permit holders must notify the RSO for disposal/transfer approval prior to the disposal or transfer of any sealed sources or devices which contain a sealed radioisotope. Notification of the intent to dispose and/or transfer sealed sources must be submitted to the RSO in writing. In the case of requested disposal, the RSO will arrange for the appropriate removal of the source and reissue the internal permit. In the case of transfer, the RSO will revise the permit and make arrangements for the source to be tested for possible contamination under the University of Windsor's Leak Testing Program prior to authorizing the transfer.

2.4. Procedures Regarding Soil Moisture Gauges:

The Radiation Safety Program is designed to promote and ensure safe utilization of all radioactive sources, included sealed sources contained within soil moisture gauges. This section pertains to moisture/density gauges, possession, and use. An internal radioactivity permit is required to possess the sealed sources contained within the moisture gauges.

Due to the low dose rate associated with gauge use, personnel radiation monitoring is not required.

Training:

End-users of the instrument are required to complete a two-part training program appropriate to the use and transportation (TDG) of the soil moisture gauges. First, end-users are to participate in the Radioisotope Training for End-Users (Part 1) which pertains to the nature of radioactivity. In addition, gauge specific training is to be provided by the permit holder prior to use of the device. Approved users will be listed on the University of Windsor Internal Radioactivity Permit. A copy of this permit must be kept with the instrument at all times.

Leak Tests:

Nuclear Gauge Sealed Sources are leak tested annually. The Radiation Safety Officer (RSO) performs the leak test of all gauges stored on or near the University of Windsor's main campus. Refer to the leak test program for more information.

2.4.1 Field Site Use:

The gauge must be used in accordance with the manufacturer's instructions. The gauge must be under constant surveillance by an authorized user or secured from unauthorized use (locked in a vehicle). An instrument log book is to be maintained outlining date, time, and user name when removed/returned to/from storage.

Storage/Security:

Permanent Storage Location: Soil moisture gauges must be stored in a licensed area as stipulated on the University of Windsor Internal Radioactivity permit for the instrument. If there is the need to relocate the gauge to a new location, arrangements must be made with the Radiation Safety Officer.

The following conditions must be met at all times when the unit is in storage:

- The gauge must be stored inside the manufacturer's transport case.

- The gauge and transport case must be locked in a closet or room within a designated/licensed laboratory.
- The storage location must be under the exclusive control of the permit holder or users who are listed on the University of Windsor Internal Radiation Permit
- The storage area must have the following items readily visible in the storage room
    - Radiation Sources Emergency Procedures
    - Readily visible "Caution Radioactive Materials" label on door to storage area (storage cabinet door or entrance to storage room)

Field Site Storage: Gauges must be stored in a locked vehicle when at a field use site. If it is transported to the field site in a pickup truck, the gauge must be stored in the cab when not in use.

Storage by the Chemical Control Centre's - Division of Laboratory Safety: The Chemical Control Centre provides long-term moisture gauge storage and a disposal service for Permit Holder's who want to change their internal permit to "Inactive" status or terminate their permit. Please contact the RSO to make arrangements for transfer of the gauge. The Centre is to follow the regulations pertaining to the permanent storage of nuclear gauges listed above.

2.4.2. Transportation

Usage requiring transport is not allowed.

2.5. Acquisition of Radioactive Materials:

Under the consolidated Nuclear Substances and Radiation Device Licence, issued by the CNSC, the University of Windsor is legally required to maintain a complete record of all radioactive materials acquired under the licence. The acquisition records are reported annually to the CNSC as part of the University of Windsor Annual Compliance Report. In addition, periodically CNSC inspectors perform inspections in which all records must be available on demand.

2.5.1. New Material

All orders of radioactive material must be submitted by either the permit holder, authorized users or Department Head (AAU Head) to the Chemical Control Centre (CCC). The CCC is responsible for the generation of a purchase order for the acquisition of the material. These purchases are then cleared and released through the RSO. All new substances are recorded and labeled through the Chemical Control Centre ReadyTrak system. All new substances and radiation devices are inventoried and regular reports are generated to ensure the University of Windsor does not exceed our licence limit.

Procedure:

1. Please complete a Chemical Control Centre Purchase requisition and submit to the department. In addition, individuals can place orders on-line from the Centre's website at www.uwindsor.ca/ccc.

   The requisition must show the internal radioisotope permit number, the isotope, the activity of material ordered, supplier and any other special delivery information.

2. When the items arrive on campus a copy of the inventory tracking sheet and updated radioisotope holdings will be provided to the permit holder. It is the responsibility of the permit holder to ensure that these documents are placed within the laboratory records.

3. The RSO shall audit the inventories of radioactive materials of the Permit Holders during his/her audits of the laboratories.

Any questions regarding the placement of radioactive orders can be directed to either the RSO or the Chemical Control Centre (ext. 3523).

2.5.2. Gifts and/or Free Samples:

In some cases, vendors or outside institutions provide permit holders with radioactive materials in the form of a gift, exchange, or donation. Any radioactive material which is to be received must be approved by the RSO prior to shipment. The acceptance of no-charge radioactive material will only be permitted if the maximum holding amount under the permit is not exceeded. All shipments of radioactive materials must be sent to the following address:

Chemical Control Centre
Attn: Radiation Safety Officer
2601 Union Street
Windsor, ON N9B 3P4
(519) 253 – 3000 ext. 2055

When the items arrive on campus a copy of the inventory tracking sheet and updated radioisotope holdings will be provided to the permit holder. It is the responsibility of the permit holder to ensure that these documents are placed within the Radioisotope laboratory records.

2.5.3. Special Requests:

If a permit holder requires the acquisition of a radioactive source or radioisotope which does not meet the conditions outlined on their permit they must receive special clearance from the RSO prior to acquisition; examples include the ordering of material which exceeds the issued permit holding limits and the special manipulation of materials (i.e. probe labeling). In cases where the **amount of radioactivity exceeds 10,000 EQ** application must be made to the Canadian Nuclear Safety Commission (CNSC) prior to ordering. Permit holders must make the request to the RSO in writing outlining the following: (1) vendor; (2) catalogue number; (3) activity/volume required; (4) application; and (5) mechanisms for safe handling. Once permission from the CNSC is received, approval documentation will be placed within the permit holder's file and the purchase order will be released to the vendor for fulfillment.

If material is not cleared prior to receipt it will be confiscated by the RSO pending clearance. If special clearance is not approved the item will be either returned to the supplier (at permit holder's expense) or disposed.

2.5.4. Transfer of Radioactive Materials

Permit holder who leave the University or no longer require the radioactive source or radioisotope may transfer material to another permit holder. However, the amount of radioactive material which is transferred to the new permit holder cannot exceed the receiving permit holder's allowed amount. In addition, the transferred radioisotope must be listed on the issued permit and it may not be used in any location which is not indicated on the permit. All requests for the transfer of radioactive material must be made in writing to the RSO outlining the following:

- Donator's & Receiver's internal radioisotope permit number.
- Isotope to be transferred.
- Activity and volume of material to be transferred.
- Inventory Control Number (i.e. CCC Serial Number – 505505).
- Item Number (i.e. CCC Item Number – MOLC0022).
- Date initially received.
- And any other pertinent information.

All radioactive material must not be transported outside the licensed building. If necessary, the RSO will make arrangements for the transportation of material to another building if required. All radioactive packages requiring shipment outside the University of Windsor will be packaged and shipped by the RSO.

2.5.5. Secure Storage of Radioactive Materials

Licensed Laboratories:

All radioisotopes which are held for storage and associated waste products must be stored within a secure location to prevent unauthorized access. Chemical compounds that have been labeled with a radioactive isotope must also be kept within designated storage units, including safety cabinets, refrigerators, and freezers. All storage units must be clearly identified with a radiation warning sign clearly visible on the outside of the unit. In addition, storage units must have a mechanism to prevent unauthorized access or within a separate secured room which cannot be access by non-authorized personnel.

All radioisotope containers must be labeled identifying the radionuclide, activity (include date), radiation warning symbol, and chemical composition. Radioisotopes must be stored with appropriate shielding to prevent exposure to workers. The containers of low energy pure beta emitters, including ^{3}H and ^{14}C, provide adequate shielding. However, higher energy beta emitters, including ^{32}P, require additional shielding.

It is a licensing requirement that the dose rate at any accessible location outside of a storage area not exceed 2.5 µSv per hour. Permit holders shall take steps to ensure sufficient shielding of radioactive material to meet this criterion.

Radioactive Secure Storage:

The Chemical Control Centre can provide secured storage of radioactive materials within their facility (Essex Hall B32). If a permit holder requests that their licence be interrupted they may make arrangements to store items at the Centre. While every reasonable care will be taken, the CCC cannot be responsible for spoilage of any material. All items held within the Centre's radioactive storage facility must be properly labeled including (if applicable): permit holder's name, permit number, activity (date), date received, contact information, radionuclide, chemical composition, CCC item and serial number, and reason for storage. This information is to be recorded within the University of Windsor's Radiation Safety Database for inventory and control purposes.

All radioactive waste material generated on campus that is to be held for either decay-in-storage or transfer to a waste management group is to be stored within the Centre's Radioactive Secure Storage facility. The RSO is responsible for ensuring that the inventory records reflect the current holdings within the secure storage facility.

It is a licensing requirement that the dose rate at any accessible location outside of a storage area not exceed 2.5 µSv per hour. The RSO shall take steps to ensure sufficient shielding of radioactive material to meet this criterion.

Secure radiation storage rooms must post the appropriate visual indicators to inform personnel of exposure risk, including a Radioactive Warning Sign, Emergency Contact Information including Radiation Safety Officer's contact information including both office phone and 24-hour contact number.

2.6. Receiving of Radioactive Materials:

All shipments of radioactive materials must be directed to the Chemical Control Centre (Essex Hall, B37). Under no circumstances can radioactive packages be shipped directly to the permit holder. The Chemical Control Centre is responsible for examining the radioactive materials upon receipt to reduce the possibility of contamination because of a punctured or defective container. The CCC will deliver the radioactive material as soon as possible to the permit holder. Permit holders are responsible for ensuring on arrival of their shipment that it is free of contamination. An approved end-user or permit holder must initial for receipt of the package on the serial tracking sheet and any associated financial documentation. Only those trained in TDG class 7 can receive radioactive packages. Class 7 TDG training is required every 3 years.

Procedure:

1. In a licensed laboratory, while wearing personal protective equipment including a laboratory coat and disposable gloves immediately inspect the package for any signs of damage or leakage of the contents. If the package is suspected of leaking, place the package within a plastic bag and contact the RSO immediately for direction.

2. If contamination or leakage of the radioactive source or isotope is suspected open the package within a chemical fume hood.

3. Open the package and inspect and validate the contents, including: (1) type of radioisotope; (2) activity level; and (3) correct chemical properties. If there is an error in the shipment please report the error to the Chemical Control Centre at ext. 3523.

4. Check for contamination on both the external and internal packing material, e.g. box and lead pig. If no contamination is detected, place the radioactive material according to the manufacturer's instructions and place both the inventory records and serial tracking sheet within your records. (Refer to Section 2.10 Wipe Test Procedure)

5. Remove disposable gloves and wash hands after handing the radioactive material. Check both hands and clothing for contamination.

6. If no contamination is found on the external packaging material remove the radiation warning labels or deface the label to remove all reference to the radioactive material. The external packaging material can be disposed of within the regular solid waste stream.

If the radioactive material is in the form of a sealed source, it must be accompanied by a current Leak Test Certificate. If there is no certificate, do not use the source. Contact the RSO.

2.6.1 Damaged Package

If a package shows evidence of damage, tampering or leakage of its contents, the receiver shall;

- Immediately notify the Radiation Safety Officer
- Limit the possible dispersal of the material
- Post signage at entry point and control entry

The RSO will make a preliminary report to the CNSC immediately after the occurrence and notify the shipper. A final report will be sent to the CNSC within 21 days of the occurrence.

2.7. Radiation Safety Training:

2.7.1 End-User Training:

All new workers (students, technicians, etc.) planning to use radioisotopes in their research must receive radiation training prior to beginning their work with radioisotopes. The University of Windsor's Radiation Safety Program has developed a comprehensive training program in accordance with the principles outlined in the CNSC Draft Regulatory Guide G-313 – *Radiation Safety Training Programs for Workers Involved in Licensed Activities with Nuclear Substances and Radiation Devices, and with Class II Nuclear Facilities and Prescribed Equipment.* Under no circumstances are individuals to work with or around radioactive materials without having receiving appropriate training and authorization prior to beginning the work. Permit Holders who allow the manipulation of radioisotopes without approved training will be subject to suspension of their internal permit.

Under the supervision of the RSO, new workers will be required to accomplish the following:

1. Complete the University of Windsor's Radiation Safety Online Training Program for End-Users. This course provides training to individuals who handle radioactive materials on the receiving, handling, documentation of radioisotopes and waste disposal.

2. Receive additional site and experimental specific training by their supervisor. This training should cover methods to keep exposure 'As Low As Reasonably Acceptable" (ALARA).

3. Successfully complete an online test given at the end of the Online Radiation Safety Training Program for End-Users. In the case of a failing grade, the applicant will be referred to self-study and re-tested. If the applicant fails a second time, the applicant will be required to attend in person training by the RSO and be re-tested prior to working with radioisotopes.

Records of all individuals who have participated in the Radiation Safety Training Program for End-Users will be maintained by the RSO with the University of Windsor's

Radiation Safety Database. These records will be maintained for the duration of the individual's employment with the University and for five years post-employment.

Individuals who continue to manipulate radioisotopes will be required to participate in recurrent training every two years. The "re-fresher" course may be delivered by seminar, or be web-base, or be self-study.

Additional training resources are located on the University of Windsor's Radiation Safety Website (www.uwindsor.ca/radiation).

2.7.2 University of Windsor Employees:

All University of Windsor employees who may come in contact with a radioactive sources and/or radioisotopes in their job are required to attend the an Awareness Training Program offered through Health and Safety and the Chemical Control Centre, which includes;

- Management
- Purchasing and receiving workers
- Campus Police officers
- Cleaning and maintenance staff

The awareness program is designed to provide employees with information pertaining to the risks of exposure to a radioactive source, methods to identify radioactive material, and policies/procedures to be followed in their handling, storage, and disposal on campus.

All staff that may come in contact with radioactive sources and/or radioisotopes will be required to participate in recurrent training every two years. The "re-fresher" course may be delivered by seminar, web-based, or by self-study.

New employees and individuals that are unable to attend the Laboratory Awareness Training Program should be provided with a copy of the materials presented in the course. This information can be downloaded from the institution's radiation safety webpage (www.uwindsor.ca/radiation). It is the responsibility of all supervisors and managers to ensure that employees are provided with this material.

2.8. Contamination Monitoring Requirements:

The Radiation Safety Polices and the Canadian Nuclear Safety Commission's (CNSC) consolidated licence stipulates that all licensed radioisotope laboratories develop and utilize a laboratory specific radioactivity contamination monitoring program. As such, all radioisotope facilities must be monitored for contamination and detailed records maintained supporting the contamination detection program.

All radioisotope laboratories **actively using radioactive materials** must be monitored at least on a weekly basis to detect surface contamination.

If no radioisotopes have been used since the previous survey, permit holders are not required to conduct contamination monitoring until the next usage. However, it should be recorded in the laboratory log book that no radioactive work has been conducted. The results of all wipe tests must be kept within the log-book for 1 year post-expiry of the licence for which they pertain. The inventory records should be kept within the licensed area and available for inspection by either the RSO or CNSC Inspectors.

2.9. Leak Test Monitoring:

The University of Windsor's Radiation Safety Program includes the completion of required annual leak testing of sealed radioactive sources. All sealed sources which contain radioactive materials in excess of 50 MBq must participate in this program. The leak testing program is conducted by the Radiation Safety Officer (RSO) and is capable of detecting leak of 200 Bq or less of the source material. This leak testing program has been developed to ensure compliance with CNSC Application Guide *Appendix AA, REGDOC 1.6.1 Licence Application Guide, v.2* and section 18 NSRD.

Sealed source are required to be tested when they meet the following requirements:

- New sealed sources are to be tested immediately upon receipt of the source and before placing it in service.
- If the source has been stored for in excessive of 12 months, it shall be tested immediately prior to use.
- If the sources have been identified as "In storage", the sources must be tested every 24 months.
- If an incident occurs which may cause damage to the source, it shall be tested immediately after the event.

- If the source is located within a radiation device and currently in service, the source shall be tested annually.
- If the sealed source is not located in a radiation device, the source shall be tested every six months.

At the University of Windsor, we have two common types of encapsulated radioactive sources, including: (2) Electron Capture Detectors within Gas Chromatographs; and (2) calibration sources for use in teaching and/or calibration of instrumentation.

Leak testing shall be performed using procedures approved by the CNSC and be done by suitably qualified persons approved by the Research Safety Committee. Specific testing procedures shall be developed for each individual source based on the manufacturer's instructions for conducting leak testing and the requirements of CNSC Regulatory Document *Appendix AA, REGDOC 1.6.1 Licence Application Guide, v.2*.
. The Radiation Safety Officer shall maintain a list of sources requiring leak testing and shall coordinate the testing at the required frequency. All leak test records will be kept for a minimum of 3 years.

If a leaking source is found, it will be immediately removed from service and the CNSC will be notified.

2.10. Wipe Test Monitoring:

Permit holders must develop an outline of the floor plan of each location listed on the internal radioisotope permit. It should indicate the location of designated work areas, sinks, floor space, and fume hoods which are involved in the manipulation of radioactive material. Each location should be numbered to aid in the documentation process. There should be a minimum of 2 swipe locations per active bench location, including the floor. In addition, secondary test locations should be tested for surface contamination; examples include, doors handles, telephone receivers, and sink taps.

Wipe Test Procedure:

1. Using one wipe (filter paper or cotton swab), per location, lightly moisten the wipe with either alcohol or water. In an "S-shaped" pattern, wipe a representative area, not to exceed 100cm^2, in each of the pre-designated test locations.
2. Allow the wipe to air dry prior to placing in liquid scintillation cocktail (if applicable).
3. Complete a background count using an uncontaminated wipe.

4. Measure the radioactivity on each wipe using appropriate detection equipment (Liquid Scintillation Counter, Gamma Counter).
5. Ensure that the instrumentation is functioning properly by using a positive control. This control can be created by deliberately contaminating a wipe with a small amount (~5 Bq) of the appropriate isotope(s) being used in the laboratory.
6. Any wipe found to have contamination exceeding the regulatory criteria must be identified and decontaminated. Decontaminate with detergent and water or a commercial decontamination solution. Take care not to spread the contamination. Repeat wipe testing the location until the contamination is within the limits permitted in our licence. For further information, refer to "Radioactive Material Spill and Decontamination Procedures" within.
7. Record all results, including pre- and post-decontamination, within the appropriate section of the laboratory records.

2.11. Portable Contamination Survey Monitoring:

Monitoring can be completed using an end-window GM tube to detect high energy beta and/or gamma emitting radioisotopes. The protective cover of the end-window of the probe must be removed prior to use. In addition, for use in contamination monitoring the survey meter must be registered in the University of Windsor's Instrument Calibration Service. The instrument calibration service utilizes an outside contractor for the calibration of all survey instruments. A calibration sticker issued by the contract must be located on the unit for use in a contamination monitoring program. All survey meters allowed to be used in contamination monitoring are listed on the internal radioisotope permit.

Procedure:

1. Ensure that the survey unit is in operational condition including external inspection for damage, validation of calibration sticker, and battery test.
2. Determine the level of contamination registered by the meter at a location that has been determined to be free of contamination.
3. In designated working areas, slowly move the probe over the surfaces, ensuring that the thin-mylar window does not come into contact with the surface.
4. Referring to the posted internal radioisotope permit, determine the action level for contamination listed on the permit. If the level of radioactivity is below the action level for contamination these results can be recorded within the appropriate section of the laboratory records.

5. If the level of radioactivity is higher than the action level stipulated on the internal permit which states the regulatory criteria pertaining to radioactive contamination, the area must be immediately decontaminated. For more information regarding decontamination procedures refer to “Radioactive Material Spill and Decontamination Procedures” within.
6. If a level of radioactivity detected by the survey meter is very high – immediately move away from the area. Additional readings should be taken from various distances away from the location and recorded. Contact the Radiation Safety Officer for additional assistance.
7. If contamination is detected on the floor above the action level it must be cleaned immediately until the level of contamination is below the action level threshold.
8. If contamination is detected on the bench covering, remove it to the solid radioactive waste bin and monitor the surface under it. If contamination is still present, clean the area.
9. The survey instrument will also detect radioactivity from radiation sources other than ones utilized by a permit holder. If sources are within the working area, they must be removed prior to conducting a survey. If they cannot be moved, then swipe tests must be performed instead of a contamination survey using a portable instrument.
10. Clean all areas where contamination is detected until no contamination is detectable. If contamination remains, cover the contaminated area with the appropriate shielding material and notify others of the hazard using radiation tape. The level of contamination remaining should be posted and noted in the appropriate area of the laboratory records.
11. If all contamination is removed record the levels post-decontamination within the log-book.

Survey instruments which have not been calibrated within the last 12 months cannot be used in contamination monitoring as part of the required weekly contamination monitoring program. While not ideal, non-calibrated meters can be used for personal monitoring assuming the steps are taken to ensure that the meter is reliable.

2.12. Institutional Personal Monitoring Program:

The University of Windsor is committed to ensuring that all staff, students, and faculty conduct research or learn in a safe environment. The Chemical Control Centre (CCC) manages the institution’s Personnel Radiation Monitoring program on behalf of all radioisotope and X-ray users. As a condition of the University of Windsor’s consolidated

licence all users of radioactivity are to be considered for participation in the monitoring program. Personal radiation monitoring is designed to reduce the potential of over-exposure by determining the level of radiation exposure over time. Personal monitoring equipment is used to quantify the cumulative dose of radiation (mSV) received from exposure to external radiation fields. The information gathered from the personnel monitoring devices is a useful tool to determine the effectiveness of the University of Windsor's Radiation Safety Program and the implementation of appropriate action levels and processes.

2.12.1 Luminescent dosimeters (TLD) & (OSL):

At the University of Windsor, the most commonly utilized personal monitoring devices are the thermoluminescent dosimeter (TLD) and the optically stimulated luminescence dosimeter (OSL). Ionizing radiation causes temporary defects within the thermoluminescent crystals located within the detectors. The defects remain until the crystal is heated and the TLD releases the excited energy caused by the ionizing radiation in the form of light. Sensitive light detectors are used to quantify the amount of light emitted from the TLD with the level proportional to the amount of radiation absorbed. The TLD system is relatively inexpensive ($24 – 40/year) and sensitive; however, the quantification of exposure requires processing prior to determining radiation exposure. In addition, the external environment (i.e. UV light) can cause incorrect readings when developed. Furthermore, radioisotopes which produce weak beta radiation (i.e. ^{3}H, ^{35}S, ^{14}C) are not detected efficiently by TLDs. OSL dosimeters contain sensitive elements that absorb radiation and store some of the energy in the form of excited electrons. The dosimeter is read by stimulating the sensitive elements using Light Emitting Diodes (LED), which releases some of the stored energy as light. The amount of released light is measured and used to determine the radiation exposure received by the dosimeter's user during the wearing period

TLD dosimeters are available in two formats: (1) badge/whole body; or (2) ring/extremity detectors. OSL dosimeters are available in badge/whole body only. Experimentations which involve the handling of high-energy beta emitters which are often manipulated behind Plexiglas shielding, such as Phosphorus-32, end-users should utilize a ring/extremity TLD.

1. Thermo-luminescent dosimeters (TLD) and Optically Stimulated Luminescence dosimeters (OSL) issued to end-user are to be used at all times when handling radioisotopes and/or within a laboratory classified above the level of "Basic" (i.e. intermediate, high, or storage).

2. At time of issue, each individual will be provided with documentation outlining the procedure related to the proper usage of the dosimeter. This documentation will also contain the starting & end-date(s) related to the dosimeter. For active users of open sources a dosimetry return card will also be provided, Individuals provided with the card will be required to monitor their dosimeter for contamination and record the results on the card provided prior to returning their dosimeters for return to the NDS.

3. Individuals who participate in the University of Windsor's dosimetry program will be provided with the dosimetry results once they are received from the National Dosimetry Service. In addition, a copy of the dosimetry results will be provided to the permit holders to ensure that exposure rates are kept "As Low As Reasonably Achievable" (ALARA).

4. Contamination of the TLD or OLS with beta emitters may result in non-relevant exposures being recorded. The TLD or OLS must not be stored in an area where it could receive a radiation exposure (e.g. on a laboratory coat and left near a radiation source overnight).

5. The RSO shall investigate any single or accumulated doses exceeding the expected limits and shall report same to the CNSC and to the person who received such doses exceeding the limits.

6. When the RSO becomes aware that a dose of radiation received by a person or to an organ has exceeded the applicable dose limit outlined in the University of Windsor's consolidated licence. The RSO will immediately notify the CNSC of the dose. In addition, the RSO will conduct an investigation to determine the magnitude of the dose and to establish the causes of the over-exposure, identify and take any action required to prevent the occurrence of a similar incident, and notify the CNSC within 21 days after becoming aware that the dose limit has been exceeded and the results of the investigation.

Applications for dosimetry service are located on either the CCC's website (www.uwindsor.ca/ca) under "Forms" or on the Radiation Safety Program website (www.uwindsor.ca/radiation).

There is a nominal cost associated with the development and subscription application. For more information, please contact the CCC at ext. 3523 or by e-mail (ccc@uwindsor.ca).

2.12.2 Bio-assay Program:

The Canadian Nuclear Safety Commission has designated a specific quantity of radioactivity which can be ingested. The allowable limits on ingestion (ALI) are the maximum amount of radioactivity which cannot be exceeded. ALARA stipulates that the amount of radiation that is ingested should be kept as close to zero as possible if both social and economic factors are taken into consideration. To ensure that the level of radiation ingested is below the allowable limit the University of Windsor utilizes a bioassay program to monitor the uptake of specific radioisotopes and quantities.

A bioassay is a method for quantifying the amount of a specific radioisotope which has been ingested into the body. There are two methods for performing a bioassay: (1) *in vitro*; and (2) *in vivo. In vitro* bioassays are completed by removing a small sample of body fluid and/or issue. The sample is then analyzed and the amount of radiation quantified. This method of monitoring is used for quantifying the amount of tritium ingested. The *in vivo* bioassay utilizes sensitive detectors which are located on the surface of the body. This technique is uses to determine the amount of radioactive iodine which has migrated to the thyroid or amount of uranium located in the lungs.

All bioassays and associated medical examinations are completed under the collaborative direction of the University of Windsor Research Safety Committee, Provincial Health Authority, and the Canadian Nuclear Safety Commission.

All bioassay results will be provided to the end-user and regulatory authorities (CNSC) as required. Typically, the need for conducting bioassays is only following the manipulation of specific radioisotopes, including iodine and tritium (large quantities). The University of Windsor Internal Radiation Permit will indicate the appropriate conditions which warrant the need for the bioassay. The frequency of the bioassay monitoring is dictated by the radioisotope and its chemical and radiological behaviour in the body.

Radioiodine:

The Radiation Safety Program mandates that End-Users participate in the bioassay program when the amount of open source quantities of radioiodine is used:

Location	Activity	
	MBq	mCi
Open bench within licenced laboratory	2	0.054
Fume hood	200	5.4
Glove box	20000	540.5
Accidental Spill/Release	2	0.54

Figure 3: Allowable amount (MBq/mCi) of open source radioiodine that requires participation in the University of Windsor Bioassay Program

Persons who work with radioiodine, or those who are sufficiently close to the process that a significant intake is possible, must participate in the bioassay program.

Bioassay Frequency: 4 days following the use.

Other Bioassays:

The Radiation Safety Program mandates that End-Users participate in the bioassay program when the amount of open source quantities of other radioisotopes would require bioassay monitoring by the CNSC. Please refer to CNSC Guidance for more information.

Bioassay is recommended for workers that work sufficiently close to the process that a significant intake is possible, and those who are required to wear respiratory protection specifically to limit the intake of radionuclides.

2.13. Action Levels

2.13.1 Internal Ingestion Levels

If a thyroid bioassay results in a detected amount exceeding **1 kBq** the results will be reported to both the RSO and the Chair of the Research Safety Committee and an internal investigation will be conducted

If a thyroid bioassay results in a detected amount exceeding **10 kBq** the results will be reported to both the RSO and the Chair of the Research Safety Committee. The RSO will:

- Perform a detailed investigation to determine the cause for reaching 10 kBq;
- They will identify and take action to restore the effectiveness of the protection program and to prevent future exposures;
- Provide notice to the Canadian Nuclear Safety Commission with 21 days outlining the results of the investigation and actions to be taken to prevent future exposure.

If a urine bioassay results in a detected amount exceeding **100 kBq/L** the results will be reported to both the RSO and the Chair of the Research Safety Committee and an internal investigation will be conducted.

If a urine bioassay results in a detected amount exceeding **1 MBq/L** the results will be reported to both the RSO and the Chair of the Research Safety Committee. The RSO will:

- Perform a detailed investigation to determine the cause for reaching 1MBq;
- They will identify and take action to restore the effectiveness of the protection program and to prevent future exposures;
- Provide notice to the Canadian Nuclear Safety Commission with 21 days outlining the results of the investigation and actions to be taken to prevent future exposure.

2.13.2 Whole Body / Extremity Levels

The University of Windsor' Radiation Protection program has identified three separate action levels when dealing with exposure of radiation to University personnel, including: (1) between 0.3 mSv and 1 mSv (exclusive); (2) greater than 1 mSv and 4 mSv (exclusive); and (3) greater than 4 mSv. While members of the general public can receive up-to 1 mSv per year the radiation protection program's goal is to ensure that radiation exposure is kept as low as reasonably achievable (ALARA).

Action Level I (>0.3 mSv < 1 mSv):

Personnel that receive a dose of radiation under 0.3 mSv in a given wearing period, 3 months, would receive an annual dose equivalent to the allowable dose rate established for members of the general public if the dose rate was held constant.

If the reported dose for a given wearing period exceeds 0.3 mSv and less than 1 mSv the RSO will initiate an investigation to determine the cause. The results of this investigation will be documented and submitted to the Research Safety Committee for review. A copy of the final report will be submitted to both the CNSC and the individual involved. The Research Safety Committee in collaboration with the RSO will take any identified actions or make changes to the Radiation Safety program to prevent a repeated incident

Action Level II (> 1 mSv < 4 mSv):

Members of the General Public (MGP) are allowed to receive an annual dose of radiation of up-to 1 mSv per year. Personnel that receive a dose of radiation in excess of 1 mSv in a given wearing period, 3 months, would receive an annual dose equivalent between 4 – 12 mSv if the dose rate was held constant. If personnel are designated as a Nuclear Energy Worker (NEW) they are allowed to receive up-to 50 mSv per year. Action level II corresponds to the maximum allowable dose of radiation which a pregnant Nuclear Energy Worker may receive for the balance of a self-declared pregnancy. Exposure of 4 mSv would place the individuals at the top range of the 25% of laboratory workers who received doses between the detection limit and 5mSv.

If the reported dose for a given wearing period exceeds 1 mSv and less than 4 mSv the RSO will initiate an investigation to determine the cause. The results of this investigation will be documented and submitted to the Research Safety Committee for review. A copy of the final report will be submitted to both the CNSC and the individual involved. The Research Safety Committee in collaboration with the RSO will take any identified actions or make changes to the Radiation Safety program to prevent a repeated incident.

Action Level III (> 4 mSv):

This action level was established to protect pregnant nuclear energy workers. Four mSv is the allowable dose limit for the balance of the pregnancy for an institutional designated nuclear energy worker. If personnel continued to work with radioisotopes receiving a similar dose of radiation they would receive an annual dose of 16 mSv (80% of NEW annual maximum).

If the reported dose for a given wearing period exceeds 4 mSv the RSO will initiate an investigation to determine the cause. Personnel involved will immediately cease working with all radioactive materials. The results of this investigation will be documented and submitted to the Research Safety Committee for review. A copy of the final report will be submitted to both the CNSC and the individual involved. The Research Safety Committee in collaboration with the RSO will take any identified actions or make changes to the Radiation Safety program to prevent a repeated incident

Personnel involved will not return to radioactive work until authorized by the Research Safety Committee. The Committee may impose additional requirements on the worker (e.g. additional training, more frequent dose monitoring, etc.) to ensure that risk of additional exposure is reduced.

The CNSC shall be notified when both an internal action level and the regulatory dose limits are exceeded.

Action Levels	Amount (mSV / quarter)	
	Minimum	Maximum
I	0.3	<1
II	>1	<4
III	>4	

Figure 4: Action levels identified by the University of Windsor's Radiation Safety Program pertaining to whole body exposure determined by TLD.

2.14. Radiation Detection Equipment:

Radiation detection equipment such as survey meters shall be adequate for the type of radioactive work being done and shall be available in sufficient numbers and must be calibrated annually and in compliance with NSRD20. The RSO will make arrangements to for the calibration of this equipment to ensure compliance with the institution's consolidated licence. Copies of the calibration certificate will be provided to the permit holders for their reference.

2.15. Radioactive Waste Disposal:

The University has two approaches for the disposal of radioactive materials comprised of (1) "delay-and-decay"; and (2) radioisotope transfer.

Delay and Decay:

For short-lived radioactive materials, including radioisotopes that have a half-life of less than 90 days, we use a "delay-and-decay" approach. This consists of the short-term storage of radioactive materials within a secure location on campus (Essex Hall B-32 / Chemical Control Centre Radioisotope Facility). These materials are stored on a temporary basis until the level of radioactivity has decayed until the material is deemed to be non-radioactive (generally 10 half lives). A record of the date received and calculation of 10 half lives is recorded. The non-radioactive material can be released to the environment by utilization of a commercial waste or conventional landfill facility, depending on the specific circumstances and regulatory requirements.

Radioactive Material Transfer:

For longer-lived radioactive materials (half life < 90 days), the institution will transfer its radioactive material to a licenced radioactive waste management facility for disposal. Radioactive materials which are to be transferred to a third-party will be stored on campus (Essex Hall B-32 / Chemical Control Centre Radioisotope Facility) until transfer arrangements can be made.

Documentation:

The University of Windsor is required to keep records associated with the storage, disposal and/or transfer of radioactive materials though appropriate administrative

arrangements. The information collected must be accurate and complete to ensure that the information contained within prepared reports required by procedures, legislation and our Nuclear Substances and Radiation Device Licence.

Documentation must include the following information:

- Laboratory of origin
- Chemical composition
- Radiological characteristics, including identification of radionuclides, concentration, quantities, half-lives, and toxicity.
- Physical state
- Volume
- Mass

Disposal Record must include the following:

- Destination of waste material
- Monitoring, analytical, and decontamination procedures uses to characterize the waste, including the steps taken to remove radioactive contamination on internal and external surfaces.

Figure 5: Schematic outline of the University of Windsor's radioactive waste management program

Procedure:

GENERAL REQUIREMENTS

1. Principal Investigators must ensure, prior to the procurement of radioactive materials that a method of disposal for the materials presently exists or can be worked out to the satisfaction of the Radiation Safety Officer and/or Research Safety Committee.
2. Each Principal Investigator must maintain accurate records of the types, quantities and forms of radioisotopes generated. Isotope inventory sheets and Decay-In-Storage log-sheets fulfill this requirement. Records kept by the Principal Investigator must be based on either calculations or on measurements.
3. It is the responsibility of the Principle Investigator to secure proper storage for radioactive wastes generated in his / her laboratories.
4. Radioactive waste containers shall be stored as close to the work area as feasible to minimize the possibility of spillage during the transfer of waste to the containers.
5. Waste containers shall NOT be stored in hallways, stairwells or other uncontrolled areas.
6. Radioactive waste containers shall be kept closed at all times when not in use. Liquid waste containers must be kept in secondary containment at all times (e.g. placed in deep trays). The Chemical Control Centre offers ¾" plexi-glas shielding apparatuses for waste containers.
7. Regardless of content, each radioactive waste container shall be labeled with a "Caution Radioactive Materials" sticker.
8. When handling or transferring radioactive waste, the individual shall wear appropriate laboratory attire including lab coat, disposable gloves, protective eye wear and closed-toed shoes and a thin-layer dosimetry badges.
9. Radioactive wastes containing carcinogens, biohazards, or extremely hazardous chemicals must be handled separately and packaged in such a way that they present minimal hazards to people who handle the wastes. Contact Radiation Safety Officer for specific requirements.
10. Only Secondary and/or Tertiary Aqueous washes may be disposed of into the Sanitary Sewer system.
11. Do NOT place any radioactive waste in regular trash receptacles.
12. Package the waste properly according to the attached instructions.

2.15.1 Radioactive Animal Waste

Definition:
Animal Waste includes radioactively contaminated animal carcasses, tissue samples, excreta or blood.

Segregation:
All animal tissue containing 0.05 µCi/g or less of ^{3}H and ^{14}C, when averaged over the weight of the entire animal, may be incinerated in an approved pathogenic incinerator. Contact the Animal Care Technician for proper procedures to follow.

Animal tissue containing more than 0.05 µCi/g of ^{3}H, ^{14}C, or other isotopes will be collected for disposal in Chemical Control Centre supplied containers to be stored in a licensed freezer until disposal arrangements can be made.

2.15.2 Radioactive Scintillation Waste

Definition:
Scintillation waste consists of liquid scintillation cocktails (including dissolved or suspended samples) and associated containers such as counting vials.

It is the University of Windsor Radiation Safety Policy to include scintillation media as both hazardous, due to the scintillation cocktail, and radioactive waste.

Segregation:
All liquid scintillation waste that was used in swipe test counting should be collected in an approved waste drum provided by the Chemical Control Centre.

Packing Instructions:
All liquid scintillation vials should be put into an approved waste drum supplied by the RSO and its contents recorded on the provided waste disposal record.

Disposal:
1. Perform a wipe test to the outside of the drum and input the results on the back of the Radioactive Waste Tracking Sheet.
2. Complete all necessary information contained on the radioactive waste tracking form.
3. Contact the Chemical Control Centre (ext. 3523) to schedule a pick-up. When calling, please inform the customer service representative that you require pick-up of a radioactive liquid scintillation waste container.

2.15.3 Lead Pigs

Definition:
Lead pigs are used in the transportation of radioisotopes from the manufacture to the University of Windsor. Typically, they have lead integrated into them as a form of shielding for use in the storage and transportation of source vials.

There are also plastic pigs that do not contain lead which can be recycled. However, one must ensure that all radioactive signs and labels are removed prior to the disposal of the pigs. Please contact the Chemical Control Centre (ext. 3523) to make arrangements for pick-up.

Segregation:
Please ensure that contaminated lead pigs are segregated from non-contaminated pigs.

Packaging Instructions:
Uncontaminated Lead Pigs:

1. Remove all radioactive labels and/or markings from the surface of the pigs.
2. Place all uncontaminated lead pigs in a suitable container for transport (i.e. box).
3. Lead will be recycled. No paperwork or labeling is required.
4. Please label the package indicating pick-up by Facilities Services and delivery to the Chemical Control Centre, Essex Hall B-37 Attn: Waste Technician
5. Notify the Chemical Control Centre to arrange a pick-up (ext. 3523)

Contaminated Lead Pigs:

1. Place all contaminated lead pigs into a thick walled plastic bag.
2. Place a sticker or label stating “Caution Radioactive Materials” to the exterior of the bag.
3. Label bag with isotope and date.
4. Call the Chemical Control Centre to schedule a pick-up (ext. 3523). When calling, please inform the customer service representative that you require pick-up of contaminated lead pigs for disposal and/or recycling.

2.15.4 Radioactive Sharps

Definition:
A "sharp" is defined as an item that has the potential to break an individual's skin if poked, including hypodermic needles, syringes, scalpels, broken glass and razor blades.

Packaging Instructions:
1. All sharps must be placed in a puncture resistant sharps container which is available from the Chemical Control Centre at a modest cost.
2. Place either a sticker or label to the exterior of the puncture resistant container stating "Caution Radioactive Materials".
3. Completely fill-out and attach the Radioactive Waste Tracking Record to the exterior of the container.
4. Call the Chemical Control Centre to schedule a pick-up (ext. 3523). When calling, please inform the customer service representative that you require pick-up of a radioactive sharps container.

2.15.5 Radioactive Liquid Waste

The Chemical Control Centre is responsible for issuing (free of charge) approved containers for the collection of liquid radioactive waste. Liquid waste containers should always be stored in a secondary containment device and shielded.

Definition:
Liquid waste may consist of a variety of chemical constituents, provided that the waste is homogeneous, and is "pourable". Although small amounts of non-soluble materials may be unavoidably present, liquid waste should generally not contain solid materials, especially plastic laboratory equipment such as pipette tips, micro centrifuge tubes, etc.

Segregation:
Liquid waste must be segregated on the basis of chemical composition (Aqueous vs. Mixed):

"Aqueous" Radioactive Liquid: Liquid waste in which the radioactive waste materials are either dissolved in water or evenly distributed in a liquid which is mainly composed of water. Secondary and tertiary aqueous washes may be disposed of into the sanitary

sewer system and recorded on the radioactive waste tracking sheet. A copy of this log-sheet must be forwarded to Radiation Safety Officer on a monthly basis.

"Mixed" Radioactive Liquid: Radioactive liquid waste is deemed to be "mixed" when it is contaminated with a toxic, flammable, poisonous or reactive material. When generation of mixed waste is unavoidable it must be segregated from non-hazardous aqueous solutions. Contact the Chemical Control Centre's Hazardous Waste Technician for assistance in managing mixed waste, ext. 3523.

Packaging Instructions:
For Aqueous Liquids Only

1. Only use the 1-gallon containers provided by the Chemical Control Centre or Radiation Safety Officer.
2. Secure a "Caution Radioactive Materials" sticker to the outside of the container.
3. Use separate containers for short-lived waste (<90 days) and long-lived waste (>90 days).
4. Record the isotope and activity of the contents in the container and secure it to the outside of the container.
5. Do not fill the approve container greater than 75%of its capacity.
6. Store the containers within a secondary containment system and shielded if appropriate.
7. Completely fill out the Radioactive Waste Tracking Form.
8. Call the Chemical Control Centre to schedule a pick-up (ext. 3523). When calling, please inform the customer service representative that you require pick-up of a container of liquid radioactive waste.

For Mixed Liquids Only

1. Dispose of all "Mixed" radioactive liquid into a chemically compatible non-breakable container provided by the CCC.
2. Secure a "Caution Radioactive Materials" sticker to the outside of the approved container provided by the Chemical Control Centre.
3. Record the isotope and activity of the contents in the container and secure it to the outside of the container.
4. Do not fill the approve container greater than 75% capacity.
5. Store the containers within a secondary containment system and shielded if appropriate.
6. Completely fill out the Radioactive Waste Tracking Form.

7. Call the Chemical Control Centre to schedule a pick-up (ext. 3523). When calling, please inform the customer service representative that you require pick-up of a container of liquid radioactive waste.

2.15.6 Radioactive Solid Waste

Definition:
Solid waste consists of dry, radioactively contaminated materials (paper, plastic, microcentrifuge tubes, glassware, empty vials, gloves, etc.). Small amounts damp materials may be present, but solid waste may not contain any pourable liquids. Solid waste **must not** contain any metals, lead pigs, sealed sources, or sharps.

The University has two approaches for the disposal of solid radioactive materials comprised of (1) "delay-and-decay; and (2) radioisotope transfer.

Short-lived Solid Radioactive Waste (t ½ < 90 days): Solid radioactive wastes which contain short-lived radioisotopes are held in the Chemical Control Centre Radioisotope Facility (Essex Hall B32) for Decay-In-Storage (DIS) for a minimum of 10 half lives. A completed radioisotope tracking sheet must be completed and accompany each container that is held within the CCC's radioisotope facility.

Long-lived Solid Radioactive Waste (t ½ > 90 days): Long-lived solid radioactive waste should be placed within an approved container and transferred to the Radioisotope Facility for disposal by an approved waste management firm.

Segregation:
All solid radioactive waste must be segregated by isotope (Short-lived vs. Long-lived).

Packaging Instructions:
Solid Short-Lived Radioactive Waste (half life < 90 days):

Examples include: ^{32}P, ^{33}P, ^{35}S, ^{125}I, ^{45}Ca, ^{51}Cr, ^{67}Ga, ^{99}M, ^{133}Xe, and ^{192}Ir

1. The only accepted container for short-lived waste is a 15 gallon cardboard container provided by the Chemical Control Centre.
2. Each container must be shielded to reduce exposure to less than 2.5 uSv/hr.
3. Either a sticker or label must be attached to the exterior of the approved container that stipulates "Caution Radioactive Materials".

4. A completed radioactive waste tracking sheet must be completed for items which are to be held for Decay-In-Storage.
5. Each bag deposited into the container must be labeled with the date and isotope information.
6. Call the Chemical Control Centre to schedule a pick-up (ext. 3523). When calling, please inform the customer service representative that you require pick-up of a container of radioactive waste that is to be held for Decay-In-Storage.

Solid Long-Lived Radioactive Waste (half life > 90 days):
Examples include: ^{3}H, ^{14}C, ^{22}Na, ^{60}Co, ^{137}Cs

1. The only accepted container for short-lived waste is a 15 gallon radioactive materials storage drum which is provided (free of charge) by the Chemical Control Centre.
2. Each container must be shielded to reduce exposure to less than 1 Sv/hr.
3. Either a sticker or label must be attached to the exterior of the approved container that stipulates “Caution Radioactive Materials”.
4. A completed radioactive waste tracking sheet must be completed for items which are added to the drum. A copy of the radioactive waste tracking sheet must be located within the immediate proximity of the storage drum.
5. Each bag deposited into the container must be labeled with the date and isotope information.
6. A wipe test of the drum must be completed and the results attached to the copy of the radioisotope tracking sheet.
7. Call the Chemical Control Centre to schedule a pick-up (ext. 3523). When calling, please inform the customer service representative that you require pick-up of a drum of solid radioactive waste that is to be sent for disposal.

3. EMERGENCY RESPONSE

3.1 Radioactive Material Spill and Decontamination Procedures:

In the event that a spill occurs from an open source of radioactive material, one of two procedures should be followed, depending on the size and extent of the spill. First, as a General Precaution, inform persons in the area that a spill has occurred. Keep all personnel away from the area that a spill has occurred and cordon off the area with tape and signs. Cover the spill with absorbent paper to prevent the spread of contamination.

Minor Spills

Defined as, less than 100 exemption quantities (EQ) of a nuclear substance; for example, ^{32}P has an exemption quantity of 0.1 MBq. Therefore, 100 EQ of 32P is equal to 10 MBq or 270 µCi. Refer to the determination of exemption quantities specific to radioisotope in appendix 1.

A minor spill does not include contamination of personnel or the release of volatile material to the environment.

Procedure for clean-up of a minor spill:

1. Wash hands and monitor clothing and hands to determine if contamination occurred during accident.
2. Ensure that you are wearing the appropriate protective clothing (i.e. lab coat and safety glasses) and two pairs of fresh disposable gloves prior to cleaning spill zone.
3. If the radioactive material is wet, clean up the spill using absorbent materials and transfer to a plastic bag. Place contaminated absorbent materials within radioisotope specific labeled waste container.
4. If the radioactive material is dry, moisten the material with water and clean spill as outlined in step # 2.
5. Decontaminate the spill zone using an appropriate complexing agent (decontamination solution – Radiacwash (CCC Part Number: BASE0093). Avoid spreading contamination to surrounding area by work from the outside of the spill towards the Centre. Allow the complexing agent to absorb the contamination by allowing it to sit for up-to 30 minutes.

6. Perform wipe test or survey for residual contamination, as appropriate. Repeat decontamination, if necessary, until contamination monitoring results meets the University's licence criteria for Nuclear Substances and Radiation Devices.
7. Adjust inventory records to reflect loss of radioactive material due to spillage. In addition, record wipe(s) test results and decontamination procedure within Permit Holder's Radioisotope Inventory Record log-book.
8. Prior to leaving the spill zone, utilize a contamination monitor to determine contamination level of personnel (hands) and clothing, including shoes.
9. Report the spill and cleanup to the person-in-charge (Permit Holder) and to the Radiation Safety Officer (RSO).

Major Spills

Defined as, spills involving more than 100 exemption quantities (EQ), or contamination of personnel or release of volatile material. See appendix 1 for exemption quantities.

Procedure for clean-up of a major spill:

1. Clear the area. Persons not involved in the spill should leave the immediate area. Limit the movement of all personnel who may be contaminated until they are monitored.
2. If the spill occurs in a laboratory, leave the fume hood running to minimize the release of volatile nuclear substances to adjacent rooms and hallways.
3. Close off and secure the spill area to prevent entry. Post warning signs indicating "Radioactive Hazard".
4. From a safe area, initiate the University of Windsor's Emergency Response Plan by contacting Campus Police at ext. 911. Inform dispatcher of the following: your name, phone number, location of spill (room # & building), and that the incident involves radioactive material.
5. Inform Permit Holder of spill including notification of Campus Police.
6. Campus Police will coordinate with both the RSO and Person-In-Charge (Permit Holder) of the laboratory pertaining to decontamination procedures in the order of: personnel, laboratory, and equipment.
7. Decontamination of personnel is completed by removing contaminated clothing and flushing contaminated skin with lukewarm water and mild soap.
8. Record the names of all persons involved in the spill. Note the details of any personal contamination.
9. The RSO will arrange for any necessary bioassay measurements.

10. The RSO will notify CNSC immediately of the incident, followed by preparation of a written report which must be submitted to the CNSC within 21 days of the incident.

3.2 First-Aid Response Involving Radioisotopes:

Injuries:

In case of a serious injury involving a radioactive material, the treatment of the injury takes precedence over any other consideration, including property and/or equipment. Provide immediate assistance to injured personnel regardless of the radioactive contamination.

Steps:

1. Initiate the University of Windsor's Emergency Response Plan by contacting Campus Police (ext. 911), requesting Emergency Medical Assistance involving a Radioactive Incident including amount and chemical form of material and any other relevant information.
2. Arrange to have someone escort medical response and/or Campus Police Officers to area.
3. Advise emergency personnel of radioactive material, amount of contamination, nature of injuries, and any other relevant information.
4. Ensure that the injured person is not further contaminated by radioactive material. Identify spill zone to emergency personal and take necessary steps to reduce possibility of contamination to responders.
5. Inform the Permit Holder of incident. University of Windsor Campus Police will notify the RSO.

Minor Wounds (NOT requiring hospitalization):

Steps:

1. Treat minor wound immediately at or near the location of the incident.
2. Using a sterile swab, clean the affect area. Attempt to remove contaminated material by running wound under warm water. If possible, encourage minor bleeding. If the wound occurs on the face, protect the eyes, mouth, and nose from contamination. Internal contamination can only be treated by decay and can lead to significant tissue damage.
3. Wash wound with warm water and soap. Repeat if necessary.
4. Once decontamination is completed, apply a first aid dressing appropriate to the wound.
5. Notify both the Permit Holder and the RSO.

Epidermal Contamination:

1. Immediately flush contaminated area with large amounts of warm water. Using your hands, apply a mild soap or detergent to skin and wash for at least five (5) minutes.
2. Monitor the effectiveness of the decontamination/removal process by utilizing the appropriate survey technique.
3. Repeat the steps listed above, if necessary.
4. If continuous washing does not remove the contamination, contact the RSO.

Internal Contamination:

If there is even the slightest possibility of internal contamination the Radiation Safety Officer should be contacted immediately.

If the ingested material is chemically toxic/reactive medical treatment associated with the chemical toxicity should be completed first. Prompt medical attention is required. Contact Campus Police, ext. 911.

3.3 Fire Emergency Procedures:

All radioactive material must be stored within the prescribed packaging provided by the manufacture when held for storage. For example, a vial of ^{32}P is shipped within a plastic lined leg pig. These protective devices shield individuals from radioactivity while also protecting the contents in case of a fire.

In the case of a fire or explosion where radioactive material is known or suspected to be present the RSO must be notified immediately. RSO in collaboration with Campus Police will provide the RSO and or emergency responders with detailed information pertaining to the location, amount, and type of radioisotopes present. In addition, Permit Holders, End-Users, staff, faculty, and students who have specific information regarding radiation hazards in the area of interest should make themselves available for consultation with the RSO and or emergency responders.

After a major incident, the radioactive storage units must be left closed or locked until the authorized laboratory faculty member or Radiation Safety Officer is present to open and inspect the radioactive source.

For sealed radioactive sources that are contained in instruments such as gas chromatographs or liquid scintillation counters and subjected to a laboratory fire, the instrument should be quarantined until it can be leak tested. The Radiation Safety

Officer will conduct a leak test as outlined in the University of Windsor's Leak Testing Program. If the sealed source is damaged it will be removed by a qualified technician.

In case of Fire – Pull Fire Alarm

From a safe area, contact University of Windsor Campus Police
Emergency Line: ext. 911
Inform of fire involving radioactive materials

3.4 Security of Nuclear Substances and Radiation Devices:

The University of Windsor's Radiation Protection Program includes numerous provisions to prevent the unauthorized use of radioactive materials, or deliberate or accidental access to such materials. For example, radiation safety procedures only permit authorized persons to access radioactive materials in accordance with complementary physical and administrative arrangements that secure, and restrict the use of, such materials.

Access: Access to nuclear substances and radiation devices must be restricted to those who have been authorized to work with the material through the Permit Holder. Laboratories possessing open source radioactive material and counting facilities must be kept locked when left unattended. It is the joint responsibility of the permit holder and Department to provide updated access lists to the RSO for all licenced locations every time access is either granted or revoked.

Storage: All radioactive materials, when unattended by authorized persons, must be stored in locked containers to discourage theft, unauthorized use or inadvertent exposures to radiation. Storage may be within a locked refrigerator, or freezer or lockable container within these devices, or storage cabinet within a secure room.

Inventory Verification: Regular inventory checks of nuclear substances and radiation devices should be carried out to ensure that the licensee is alerted if there has been any unauthorized removal of the radioactive material. The theft of radioactive material is a serious federal offence and must be reported to the RSO immediately. This applies regardless of whether the incident was reported to the Police. If significant quantities of radioactive materials are involved the RSO will oversee a full investigation and submission a detailed report to the CNSC

Audit: The RSO will complete a security audit including reviewing the access list for all licenced areas on an annual basis.

Loss, Theft or Unauthorized Use: Losses, thefts or any unauthorized use of any nuclear substances, prescribed equipment or prescribed information must be reported immediately to the Radiation Safety Officer. Contact Campus Police at ext. 911 after hours.

3.5. Record Keeping & Reporting

All records and reports must be available for inspection at the site. All records and reports required under the regulations will be completed, maintained and kept in accordance with the CNSC regulations and provided to the CNSC upon request. The CNSC will be notified 90 days prior to the disposal of any documents kept for the licence.

3.6. Lost or Stolen Nuclear Substances

In the event that a nuclear substance is lost, stolen or no longer in control of the person required to have it, the individual will;

- Notify the Radiation Safety Officer immediately
- The RSO will notify the CNSC immediately of the incident.
- The RSO will prepare a written report which must be submitted to the CNSC within 21 days of the incident.

Appendix 1: Radioisotope specific regulatory information pertaining to laboratory classification, contamination thresholds, and allowable disposal levels. This table is for reference purposes only. Please refer to information contained on your permit for permit specific limits and designations.

Radionuclide	Regulatory Amounts		Laboratory Classifications			Contamination Threshold		Allowable Release to Environment		
	EQ (MBq)	**ALI estimate (ingest)** (MBq/yr)	**Basic Level** (MBq)	**Intermediate Level** (MBq)	**High Level** (MBq)	**Wipes Controlled Area** (Bq/cm2)	**Wipes Public area** (Bq/cm2)	**Garbage** (MBq/kg)	**Sewer** (MBq/yr)	**Air** (kBq/m3)
Am-241	0.001	0.1	0.5	50	500	300	30			
C-14	100	34	170	1700	17000	300	30	3.7	10000	
H-3	1000	1000	5000	50000	500000	300	30	37	1000000	37
I-123	10	95	475	4750	47500	300	30	3.7	1000	3
I-125	1	1.3	6.5	65	650	300	30	0.037	100	0.03
I-131	0.01	0.9	4.5	45	450	30	3	0.037	10	0.175
P-32	0.1	8.3	41.5	415	4150	300	30	0.37	1	
P-33	1	80	400	4000	40000	300	30	1	10	
S-35	100	11	110	1100	11000	300	30	0.37	1000	

Appendix 2: The University of Windsor's Nuclear Substances and Radiation Device Licence outlines the allowable limit of radioactivity which can be detected within licenced laboratories (wipe controlled areas) and non-licenced areas.

Radionuclide	Contamination Threshold	
	Wipes Controlled Area (Bq/cm2)	**Wipes Public area** (Bq/cm2)
Br-82	30	3
C-14	300	30
Co-57	300	30
Co-58	30	3
Co-60	3	0.3
Cr-51	300	30
F-18	30	3
Fe-59	30	3
Ga-67	30	3
H-3	300	30
I-123	300	30
I-125	300	30
I-131	30	3
In-111	30	3
Na-22	3	0.3
P-32	300	30
P-33	300	30
Ra-226	3	0.3
S-35	300	30
Sb-124	3	0.3
Sr-85	30	3
Tc-99m	300	30
Tl-201	300	30
Xe-133	300	30