UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY

RADIATION SAFETY MANUAL

R9: September, 2016

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1.0 INTRODUCTION

Ionizing radiation and radioactive materials are used at the University of Ontario Institute of Technology as part of its research and teaching programs. The University is committed to ensuring that the use of radiation and radioactive materials is carried out in a safe manner with due regard for the safety and protection of employees, students, the public and the environment.

As part of the legal requirements for using radioisotopes, the University, as a corporation, holds a Consolidated Radioisotope Licence issued by the Canadian Nuclear Safety Commission (CNSC). In addition to this license, the University also holds a separate licence for a Class II Nuclear Facility housing an accelerator/neutron generator. The University is responsible to the CNSC for establishing and maintaining a radiation safety program, which will ensure compliance with the regulations while permitting the appropriate use of radioisotopes within the context of research and teaching. The University also has an obligation under the Ontario Occupational Health and Safety Act to put in place programs and procedures to protect the health and safety of employees from hazards arising in and out of the course of its activities.

This radiation safety manual documents the processes and procedures by which the University will fulfill its obligations under the CNSC regulations and the terms and conditions of its Nuclear Substances and Radiation Devices Licence, Class II Nuclear Facilities and Prescribed Equipment Licence, and the Ontario Occupational Health and Safety Act and its regulations. All users of radioisotopes and radiation emitting devices must be familiar with and comply fully with the policies and procedures in this manual. The failure of any single radioisotope user to comply could adversely affect the health and safety of faculty, staff, students and the public and place in jeopardy the appropriate licence and the work of other radioisotope users. Any failure to comply with the provisions of this manual will be subject to appropriate disciplinary action up to and including the restriction or loss of access to radioactive materials.

Where the term “radiation” appears in this manual, it refers to “ionizing radiation” only. This manual applies to all uses of radiation or radioactive materials within the University. This encompasses activities undertaken pursuant to the University’s Nuclear Substances and Radiation Devices Licence and Class II Nuclear Facilities Licence, as well as the use of X-ray generating devices and industrial radiography undertaken on University premises. Although X-ray machines are not regulated under the CNSC licence, they are regulated under the Ontario Occupational Health and Safety Act and the X-Ray Safety regulation and this manual applies to them also. This manual does not apply to an X-ray machine which is intended for the irradiation of humans and which is subject to the Healing Arts Radiation Protection Act.

For all matters associated with the Consolidated Radioisotope Licence and the Class II Nuclear Facilities Licence:

- The Vice President Research, Innovation and International is the “Applicant Authority” for the University and is responsible for identifying the “Signing Authority” for the University.
- The Radiation Safety Officer is the “Signing Authority” for the University and the primary contact person for the University;

The Radiation Safety Officer is responsible for maintaining the radiation safety manual and the associated required documentation, performing inspections and audits of the internal permit holders and making recommendations to the Committee regarding actions required to maintain the integrity of the radiation safety program.

Questions regarding the application or interpretation of this manual should be directed to the Radiation Safety Officer.

2.0 POLICY

2.1 Health and Safety Policy

The University of Ontario Institute of Technology is committed to providing and maintaining a safe and healthy work and learning environment. This commitment is expressed in its health and safety policy, which is reproduced in Figure 2.1

FIGURE 2.1

UOIT POLICY ON HEALTH AND SAFETY

The University of Ontario Institute of Technology (UOIT) has a vital interest in the health and safety of its employees, students, visitors and contractors. The prevention of occupational illness or injury is a major continuing objective and UOIT will make every reasonable effort to provide and maintain a safe and healthy work and learning environment. As a minimum standard, the university shall comply with all statutory requirements, including the Ontario Occupational Health and Safety Act, the Environmental Protection Act and other applicable federal, provincial and local statutes and bylaws.

The university is responsible for establishing, maintaining and communicating a safety program to implement this policy. Specific safety policies, regulations and procedures shall be developed, documented and implemented in order to ensure that employees and students are aware of their rights and responsibilities and to facilitate the maintenance of safe working conditions.

Every employee and student has a responsibility to work safely in accordance with both the statutory requirements and the university safety policies and procedures and to report any unsafe or unhealthy conditions.

Employees in a supervisory position have an additional responsibility to ensure that persons under their supervision are made aware of any hazards in the workplace and that these individuals comply with all applicable safety policies and procedures. Supervisors are responsible for ensuring that any hazards or safety violations in workplaces under their control are investigated and corrected promptly.

Contractors and sub-contractors performing work for the university must, as part of their contract, comply with all relevant workplace and environmental health and safety statutes and to meet or exceed the university's safety program requirements.

It is the intent of the university that a commitment to health and safety form an integral part of the culture of the institution and all its activities.

The Health and Safety Policy was approved by the Board of Governors on November 12, 2003.

2.2 Radiation Safety Policy

With a view to establishing and maintaining a safety culture within the institution, the University adopts the ALARA principle of the International Commission on Radiological Protection as the basic philosophy governing the use of radiation and radioactive materials within the University.

AS LOW AS REASONABLY ACHIEVABLE (ALARA)

All doses of ionizing radiation shall be kept as low as reasonably achievable, social and economic factors being taken into consideration.

No practice involving exposure to ionizing radiation shall take place unless there is a benefit as a result of carrying out the practice. Radiation exposures shall be kept below the statutory limit regardless of the practice. Persons using radiation or radioactive material shall endeavour to keep all radiation exposures as far below the statutory limit as is reasonably achievable.

The policies and procedures outlined in this manual have been developed to meet the regulatory requirements and to create a framework for achieving ALARA. The University believes that ALARA is not a particular numerical target to be achieved, but rather a **process** and a way of thinking that involves organization, planning, training, controlling, monitoring, documenting, reviewing, analyzing and revising.

It is the responsibility of all persons who supervise or perform work with radiation or radioactive materials to be familiar with and to follow the procedures outlined in this manual. Failure to do so will result in appropriate disciplinary action up to and including restriction or loss of access to work with radiation or radioactive materials.

3.0 ORGANIZATION AND RESPONSIBILITIES

3.1 General

This section details the overall organization of the radiation safety program and the specific responsibilities of individuals within the program. The organization is based on the principle of the responsibility of the line of management and supervision to appropriately organize, monitor and resource the radiation safety program.

The basic instrument for control of the use of radiation and radioisotopes is the internal permit system. Any person intending to use radiation or radioactive materials must apply for and obtain a permit from the Radiation Safety Committee. Likewise, any person purchasing and using an x-ray machine must obtain a permit from the Radiation Safety Committee.

Permit holders will be subject to routine and random inspections by the Radiation Safety Officer or their designate and may be subject to disciplinary actions in the case of non-compliance with the permit conditions.

3.2 The Vice President Research, Innovation and International

The Vice President Research, Innovation and International is the senior academic officer of the University with overall responsibility for oversight of research programs. The Vice President Research, Innovation and International is the designated “Applicant Authority” for the University who will certify the name and authority of the “Signing Authority”. The Vice President Research, Innovation and International has the following specific responsibilities:

- To appoint the members of the Radiation Safety Committee,
- To appoint the Chair of the Radiation Safety Committee,
- To certify to the CNSC, as the license “Applicant Authority” the name and authority of the “Signing Authority”
- To provide the resources necessary for the proper operation of the radiation safety program.

3.3 Radiation Safety Committee

The Radiation Safety Committee is a specialist regulatory committee within the management structure of the University of Ontario Institute of Technology (“university”) with charge over radiation protection on campus. Its primary responsibility is to ensure the effectiveness of radiation safety programs and the integrity of any licenses, certifications or registrations issued to the university from regulators under federal or provincial legislation.

The Radiation Safety Committee is vested with the ultimate authority and necessary executive power delegated to it by the Vice President Research, Innovation and International to determine radiation safety policies and procedures for use within the university and to enforce and maintain the required standards of radiation protection necessary for a teaching and research institution. The programs are founded on Federal and Provincial regulations and guidelines issued by the Canadian Nuclear Safety Commission (CNSC), the Radiation Protection Bureau of Health Canada and the Ministries of Health and Labour, Government of Ontario. These regulations and guidelines mandate the provisions on all matters pertaining to the possession, handling, storage and disposal of radioactive materials and the acquisition, installation, development, operation and/or exposure to any equipment or sources producing ionizing or non-ionizing radiation.

The Radiation Safety Committee has the authority to review and approve all ionizing and non-ionizing radiation activities at the university. Further, the committee has the authority and responsibility to grant or withhold an internal radiation or laser permit, and to impose conditions on that permit as a means of enforcing compliance with the University Radiation and Laser Safety

Programs, with the regulations and terms of the CNSC Consolidated License and Class II Nuclear Facilities and Prescribed Equipment Licence, X-ray Safety regulations and the ANSI Standard on the Safe Use of Lasers. The committee also has the authority to set standards for limiting exposure to electromagnetic fields (EMFs) and enforce compliance with the EMF Safety Program. The Terms of Reference of the Committee are given in Figure 3.

3.4 Chair and Vice Chair of the Radiation Safety Committee

The Chair of the Radiation Safety Committee carries out the executive functions of the Committee and acts on behalf of the Committee on a day-to-day basis. The Chair is appointed by and is accountable to the Vice President Research, Innovation and International. The Chair shall normally be a member of the faculty of the University with expertise in the hazards and uses of ionizing radiation. The Chair will normally be, but need not be, the holder of a radioisotope permit under the Consolidated License.

The Chair is appointed for a three-year term which is renewable.

The Committee shall select a vice-chair who will act as Chair in the absence of the Chair or in the event of a conflict of interest of the Chair. The Chair would be deemed to have a conflict of interest in matters relating to any permit held by the Chair.

The duties of the Chair of the Committee are given in Figure 3.2.2

3.5 Radiation Safety Officer

The Radiation Safety Officer acts as a consultant to the Committee and its Chair on matters pertaining to legislation and radiation safety practices and procedures. The Radiation Safety Officer is responsible for the day-to-day administration of the radiation safety program and as such has the authority to monitor and enforce the provisions of the university radiation safety program and the conditions of the internal permits.

The Radiation Safety Officer works closely with the Chair of the Radiation Safety Committee to implement and monitor the radiation safety program. The Radiation Safety Officer reports to both the Vice President Research, Innovation and International through the Chair of the Radiation Safety Committee and the Manager, Research Services and to the Vice-President, Human Resources and Services.

Specific duties of the Radiation Safety Officer are given in Figure 3.2.4

FIGURE 3

TERMS OF REFERENCE OF THE RADIATION SAFETY COMMITTEE

3.1 Radiation Safety Committee

The university has established and shall maintain a radiation safety committee comprising of members of the university community and stakeholders knowledgeable in radiation protection. The responsibility of the committee includes all sources of ionizing radiation and non-ionizing radiation, for all uses (materials and equipment), on properties owned or controlled by the university. The committee also has responsibility to users of ionizing or non-ionizing radiation that perform work off campus for university related business. The committee shall report to the Vice-President Research, Innovation and International.

The Radiation Safety Committee is authorized to:

- review the need for and recommend the development of safety programs related to uses of ionizing and non-ionizing radiation within the University;
- oversee the operation of the Radiation, Laser and EMF Safety Programs on behalf of the University;
- provide direction to the Radiation Safety Officer on matters pertaining to policy and enforcement of the Radiation, Laser and EMF Safety Programs;
- provide advice and direction on all matters pertaining to radiation safety to users and to University management;
- approve all uses of radiation, radioisotopes or radiation emitting devices;
- establish policies and procedures on all matters relating to radiation safety and the use of radioactive materials, radiation emitting devices or exposure to radiation sources;
- take appropriate steps to ensure the safe use of ionizing and non-ionizing radiation within the university in conformance with legislative requirements and accepted national and international standards;
- assess the adequacy and effectiveness of the university's training programs related to uses of and exposure to ionizing and non-ionizing radiation;
- review and approve all Safety Manuals related to uses of and exposure to ionizing and non-ionizing radiation;
- review all permits issued pursuant to the university Radiation and Laser Safety Programs;
- report annually to the Vice-President Research, Innovation and International on the activities of the Radiation Safety Committee;
- monitor activities taking place pursuant to any permit and review all instances of non-compliance with the Radiation and Laser Safety programs and permit conditions;
- review and approve any issuance of, withdrawal of, or changes to a radiation permit(s) or laser operating permit(s) as a means of dealing with non-compliance with the provisions of the Radiation and Laser Safety Manuals or the permits;
- notify and recommend to the Vice President Research, Innovation, International any additional disciplinary measures to deal with continued non-compliance with the radiation and laser safety policies and procedures.

3.2 Radiation Safety Committee Membership and Terms

The composition of the Radiation Safety Committee is based primarily on technical expertise in radiation protection and the use of radioisotopes, ionizing or non-ionizing radiation. It may have a minority of members who are not experts in radiation protection and not involved in using radiation in order to provide a broader perspective in decision making. The Committee is appointed by and reports to the Vice-President Research, Innovation and International (VP RII).

1. Committee members are appointed for a nominal term of three years. Members may be reappointed for additional terms.
2. The number of appointed voting members of the Radiation Safety Committee shall not be less than 3 including the chair and vice chair. At least 2 members, including the Chair, will have expertise in radiation protection and who are preferably radiation permit holders or individuals directly responsible for the radioactive work performed by laboratory personnel.
3. At least 1 member will have expertise in laser safety and use, when matters of laser safety are discussed. This person can be an ad hoc member.
4. At least 1 member will have knowledge or expertise in EMF safety, when matters of EMF safety are discussed. This person can be an ad hoc member.
5. At least 1 member will be chosen from the academic community at large.
6. The following are ex-officio members of the Committee

    - Radiation Safety Officer
    - Director of Research Services

    Ex-officio members have no fixed term, but serve by virtue of their position within the University. Ex-officio members will have voting privileges on this committee.

7. The committee shall meet as necessary to fulfill its mandate, with a minimum of two meetings per year.
8. The Committee shall maintain minutes of its meetings with copies to the joint health and safety committee and VP RII.
9. The required minimum quorum for committee meetings will be 50% of the members, inclusive of the Radiation Safety Officer and the Chair.
10. The Committee shall endeavour to reach decisions by consensus. Where no consensus is achieved a simple majority shall suffice and this shall be noted in the minutes.

3.2.1 Chair and Vice Chair

The Chair of the Radiation Safety Committee carries out the executive functions of the Committee and acts on behalf of the Committee on a day-to-day basis. The Chair is appointed by and is accountable to the VP RII. The Chair shall normally be a member of the faculty of the University with expertise in the hazards and uses of ionizing radiation. The Chair will normally be, but need not be, the holder of a radioisotope permit under the Consolidated License.

The Chair is appointed for a three-year term which is renewable.

The Committee shall select a vice-chair who will act as Chair in the absence of the

Chair or in the event of a conflict of interest of the Chair. The Chair would be deemed to have a conflict of interest in matters relating to any permit held by the Chair.

3.2.2 Duties of the Chair

1. To act as the "Signing Authority" for the University for all matters encompassed by the Consolidated Radioisotope Licence or Class II Nuclear Facilities and Prescribed Equipment Licence in the absence of the Radiation Safety Officer;
2. To review and sign all permits. Permits issued to the Chair shall be countersigned by the Vice-Chair;
3. To review the annual report on the operation and effectiveness of the Radiation Safety Programs;
4. To review and sign all reports to the Canadian Nuclear Safety Commission, as required;
5. To declare a conflict of interest to the Committee on all matters relating to a permit held by the Chair.

3.2.3 Administrative support

The Office of Research Services, in partnership with the Radiation Safety Officer, shall provide administrative support to the committee and provide the following:

- Maintain records for the radiation safety committee;
- Record minutes of meetings, for correspondence arising;
- Organize committee meetings;
- And other support as needed.

3.2.4 Duties of the Radiation Safety Officer

1. Act as the "Signing Authority" for the University for all matters encompassed by the Consolidated Radioisotope Licence and Class II Nuclear Facilities and Prescribed Equipment Licence; Act as the signing authority for all matters governed by the Ontario Ministry of Labour with respects to x-ray equipment, lasers and EMFs;
2. Act as a consultant to the Radiation Safety Committee in the development, implementation and maintenance of safety programs related to uses of and exposure to ionizing and non-ionizing radiation and procedures to ensure radiation protection and compliance with regulatory requirements;
3. Maintain the UOIT Radiation, Laser and EMF Safety Program and manuals, reviewing and assisting in their update on a regular basis;
4. Monitor existing and proposed uses of radioisotopes and radiation devices, including x-ray and laser systems and prepare appropriate control procedures and applications for amendments to the consolidated license or Ministry of Labour registrations as necessary;
5. Conduct inspections of designated radiation and laser laboratories to determine compliance with the University's radiation and laser safety programs and any license conditions;
6. Conduct inspections related to concerns with EMF exposure to determine compliance with the University's EMF safety program;
7. Verify that radiation monitoring devices or equipment are appropriate for their intended use and properly calibrated according to the regulatory requirements;
8. Verify the operability and adequacy of engineering controls (e.g. interlocks) in accordance with University policy and regulatory requirements;

9. Development and deliver internal training programs to ensure that persons who use, handle or may be exposed to radioactive materials, sources or radiation emitting devices are adequately trained in radiation safety/laser safety and compliant with the University's radiation and laser safety programs and procedures;
10. Participate as a member of the Radiation Safety Committee in overseeing and auditing the operation and effectiveness of the radiation safety programs;
11. Review all applications for internal permits under the consolidated or class II license, recommend appropriate permit conditions and prepare permits for approval by the Committee;
12. Review requests to purchase, receive or use radioactive materials and radiation emitting devices to ensure that the proposed uses comply with applicable regulations and the University's safety programs related to uses of and exposure to ionizing and non-ionizing radiation;
13. Assist in the investigation of accidents or incidents involving radiation or radioactive materials and in the preparation of reports to the regulatory authority according to legislation and license conditions;
14. Maintain records of the current status of all designated laboratories, radiation emitting devices and radioactive materials. Ensure that all records and reports that are required by legislation and licenses are prepared, maintained, submitted and kept as required;
15. Monitor radiation exposures received by persons to ensure that all doses are ALARA and make recommendations, where appropriate, to reduce exposures;
16. Prepare an annual report to the Vice-President, Research, Innovation and International on the operation and effectiveness of the radiation safety programs;
17. Carry out other duties as requested by the Radiation Safety Committee.

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3.6 Permit Holders

Permit holders are responsible for:

- Being knowledgeable of and following the policies and procedures in the Radiation Safety Manual;
- Conforming with the terms and conditions of their Radiation Permit;
- Cooperating with the Radiation Safety Officer in the performance of his/her duties;
- Promptly correcting any identified deficiencies;
- Identifying to the Radiation Safety Officer any persons working with or exposed to radiation sources under their control;
- Ensuring that no person works with radiation sources under their control until that person has received appropriate training according to the requirements of the Radiation Safety Manual;
- Maintaining an up-to-date inventory of all radiation sources under their control;
- Providing and maintaining any radiation monitoring equipment prescribed on their permit;
- Ensuring that all required contamination monitoring has been performed as required and that all necessary records are maintained;
- Purchasing, receiving and disposing of radiation sources according to the procedures in the Radiation Safety Manual;
- Notifying the Radiation Safety Officer when they are absent for an extended period of time and unable to supervise and identifying an alternate permit holder who has accepted the responsibility as the temporary supervisor;
- Making every effort to maintain radiation doses as low as reasonably achievable.

3.7 Users

All users of radiation emitting devices or radioactive materials must:

- Follow the procedures provided in the Radiation Safety Manual;
- Follow the procedures specified by their supervisor;
- Not work with radiation or radioactive materials until they have received appropriate training from the Radiation Safety Officer.
- Report to the permit holder or to the Radiation Safety Officer any defective equipment, violation or any situation which may endanger themselves or another person or create an unauthorized release of radioactive materials to the environment;
- Not create or participate in any activity which may endanger themselves or another person or create the potential for an unauthorized release of radioactive material to the environment.

4.0 CONTROL OF RADIATION SOURCES

4.1 Radioisotope Permits

Internal permits are required for the purchase, possession and use of sealed and open source radioactive material and nuclear substances such as deuterium. No person may purchase, possess or use any radioactive material without a valid internal radioisotope permit. Permits are required for sources both above and below the CNSC exemption quantities. Permits are required for all acquisitions of radioactive material, whether purchased, transferred or donated. Permits are also required for sources which are used as an integral part of a device such as a liquid scintillation counter or gas chromatograph detector.

Prospective radioisotope users must apply to the Radiation Safety Committee for a permit using the form in Appendix 1.

The Radiation Safety Committee will only issue permits to individuals whom the Committee deems qualified by training and/or experience to safely possess and use the materials covered by the permit. The Committee may attach any restrictions and conditions to the permit as the Committee deems appropriate.

Permits will normally be issued for a fixed period of time with the expiry date indicated on the permit. The Committee reserves the right to cancel or modify a permit at any time where the Committee feels such action is necessary to maintain the integrity of the radiation safety program and the Consolidated License.

A permit is granted on the grounds that the permit holder is aware of and responsible for the activities specified on the permit. The permit holder is responsible for overseeing all activities taking place under the permit and for providing appropriate supervision to other individuals working under the permit. If a permit holder is taking an extended leave such as a sabbatical where he/she will be unable to carry out this responsibility, arrangements must be made prior to taking such leave to either suspend the permit or to transfer the responsibility to another individual approved by the Radiation Safety Committee. Such arrangements will involve an amendment to the permit.
Permit applications require the approval and signature of the Dean of the Faculty.

All laboratories where the use of radioactive materials is proposed must be approved by the Radiation Safety Committee. Such approval will be preceded by an inspection by the Radiation Safety Officer or designate and corrective actions may be required before the use of radioactive materials is permitted.

Once a permit has been issued, there may be no changes to the facilities, isotopes and quantities specified on the permit without the approval of the Radiation Safety Committee. Changes to the permit are to be initiated by the permit holder using the form in Appendix 1.

Permitted locations will be subject to random inspections by the Radiation Safety Officer or designate. Infractions will be dealt with according to the Radiation Safety Committee procedure on enforcement (see section 7.1).

A copy of the permit must be posted by the permit holder in each room listed on the permit.

The permit will contain the following information in the format shown in Figure 4.1:

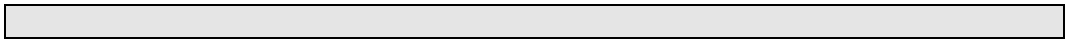

FIGURE 4.1

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY
RADIOISOTOPE PERMIT

SECTION 1

- Permit number
- Revision number of the permit
- Name and position of the responsible permit holder
- School or Faculty
- Building and room numbers covered by the permit
- Period for which the permit is valid

SECTION 2

- Listing of the sealed sources and their activities and/or a listing of unsealed sources and the maximum quantities permitted in the laboratory and/or the maximum quantity per purchase and the permitted frequency of purchase.

- Listing of each radiation device and their activity

SECTION 3

- Brief description of the manner in which the sources will be used

SECTION 4

- Permit conditions specific to the permit
- Personal dosimetry requirements (if any)

SECTION 5

- The names of individuals authorized to work with the radioactive materials

SECTION 6

- Signature of Radiation Safety Officer
- Signature of Chair of Radiation Safety Committee
- Signature of Permit Holder
- Date of issuance of permit

4.1.1 Special Projects

In some instances, special projects may be proposed which fall outside the scope of the Consolidated License. All special projects should be submitted to the Radiation Safety Committee for a full review. No internal permit will be approved before the written approval by the CNSC..

4.2 X-Ray Permits

Permits are required for the acquisition and operation of X-Ray machines. The applicable policies and procedures are given in Section 8 of this Manual.

4.3 Industrial Radiography Permits

On occasion it may be necessary for Industrial Radiography to be conducted in University buildings. Any such undertaking will require a permit from the Radiation Safety Officer. The purpose of this permit is to allow the Radiation Safety Officer to review the procedures to ensure that any doses meet the ALARA principle and to ensure that occupants of the building involved are aware of the work and of the precautions being taken to ensure their safety and that of their research assets where appropriate.

An application for an industrial radiography permit is to be made to the Radiation Safety Officer using the form in Appendix 3. The completed form will constitute the permit.

No permit will be issued until the persons who may potentially be affected by the beam have been notified and any concerns addressed.

The permit will be posted prominently in and provided to persons working in areas which may potentially receive radiation doses from the radiography.

4.4 Radioisotope Laboratory Approval

All rooms intended to be used for the storage, handling, use or disposal of radioactive material must be approved by the Radiation Safety Committee and will appear as authorized locations on the internal permit. Radioactive material must not be stored, used or handled in any location other than those specified on the permit.

Radiation laboratories will be classified according to criteria set by the Canadian Nuclear Safety Commission. When dealing with unsealed or open sources, the laboratory is classified as Basic Level, Intermediate Level, High-Level or Containment Level depending on the isotope used and the amount of radioactive material handled.

The designation of any room as a radioisotope laboratory will require an inspection by the Radiation Safety officer to ensure compliance with the design requirements. A standard chemical laboratory will under most circumstances meet the requirements for a Basic Level radioisotope laboratory. The laboratory design compliance checklist is given in Appendix 6.

The Radiation Safety Committee may designate Basic Laboratories. Designation of Intermediate, High and Containment Level require the approval of the CNSC.

4.5 Procurement of Radioactive Materials

The CNSC requires the University to maintain a record of all radioactive materials received and held under the Consolidated License and to limit the isotopes and quantities to those specified on the license. All quantities of radioisotopes ordered and in possession are reported to the CNSC in an annual report and must also be available for inspection by the CNSC at any time.

No radioactive materials may be purchased, or otherwise brought onto the University campus without a valid radioisotope permit and without the prior authorization of the Radiation Safety Officer for each purchase or acquisition.

A request for purchase or acquisition of radioactive material must be submitted to the Radiation Safety Officer for authorization. Only after the approval of the RSO is received may a purchase order be placed for the material.

In some cases radioactive material may be obtained from external institutions or companies as gifts or loans. Any such acquisition must be approved by the Radiation Safety Officer before receipt of the material. The same form should be used to request such acquisitions. Purchases and acquisitions will be allowed only if they fall within the conditions of the Consolidated License.

Requests to purchase or otherwise obtain radioactive material must be submitted to the Radiation Safety Officer on the form in Appendix 4.

4.6 Procurement of Radiation Emitting Devices

Prospective purchasers of radiation emitting devices such as an x-ray machine must contact the Radiation Safety Officer well in advance of the proposed purchase date. The Radiation Safety Officer will review the proposed facility with the purchaser to determine appropriate shielding requirements, engineered controls, operating procedures, training, dosimetry and any other requirements.

The purchaser will be responsible for preparing an operating manual and procedures for approval by the RSO and the Radiation Safety Committee. Upon approval of the manual and procedures an x-ray permit will be issued to permit the purchase and installation of the machine.

Commissioning of the device will be done in conjunction with the radiation safety officer who will verify the radiation doses during operation. Following commissioning an operating permit will be issued.

4.7 Inventory

CNSC regulations require that an inventory be maintained of all radioactive material and prescribed substances held under the Consolidated License. The Radiation Safety Committee requires all permit holders to maintain an accurate, current inventory of all such material in their possession. Records must be kept up to date and available for inspection by the Radiation Safety Officer and the CNSC.

Failure to maintain an accurate inventory will be considered an infraction and subject to Radiation Safety Committee disciplinary procedures.

4.7.1 Sealed Sources

Sealed sources are any radioactive materials where the radioisotope is encapsulated to prevent direct manipulation of the material. They are usually small sources used for instrument calibration or incorporated into a device such as a liquid scintillation counter, gas chromatograph or other such laboratory equipment.

An inventory of sealed sources held under an internal permit is appended to the permit itself. This constitutes the inventory record of sealed sources. It is the responsibility of the permit holder to ensure that the record of sealed sources on the permit is accurate.

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

Permit holders are responsible for maintaining the integrity of these records. Permit holders must notify the RSO prior to the receipt, transfer or disposal of any sealed source or device containing a sealed source. The RSO will make arrangements for the disposal or transfer of any sealed source.

The RSO must be immediately notified of the loss of any sealed source or device containing a sealed source.

The RSO will maintain a central inventory consisting of all the sealed sources maintained by all permit holders.

The records of permit holders will be checked at least annually by the RSO and verified against the records of the RSO.

4.7.2 Unsealed Sources

Unsealed or open sources are those where direct manipulation of the radioisotope or labeled compound is possible.

All permit holders are required to maintain at all times an accurate and current inventory of all open source material in their possession. The record must show the order number, isotope, chemical form, total activity, date received, details of usage and final disposal. The inventory form to be used is given in Appendix 8.

Where the initial radioisotope order is diluted into a number of stock solutions this must be indicated on the primary record and a separate record maintained for each stock solution. The stock solutions must be uniquely identified.

All radioisotope inventory records must be kept for three years following final disposal of the material. These records must be kept up to date and available for inspection at any time by the Radiation Safety Officer or the Canadian Nuclear Safety Commission.

4.8 Storage of Radioisotopes

All radioisotopes, including wastes, must be stored in a secure location to prevent unauthorized access.

All radioactive labeled chemicals must be kept in storage cabinets, refrigerators or freezers that have been designated for this purpose. All cabinets, refrigerators or freezers used for storage must be clearly marked with a radiation warning sign on the outside.

Storage cabinets, refrigerators or freezers must either have a lock to prevent unauthorized access or they must be in a separate secure room which is not accessible in the absence of the persons who are authorized to use the material.

Each radioisotope container must be labeled with the isotope, the activity and the radiation warning symbol.

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.

Radioisotopes must be stored with adequate shielding. In some cases of low energy pure beta emitters (e.g. H-3, C-14) the container itself provides adequate shielding. High energy beta emitters (e.g. P-32) or gamma emitters must be kept in suitably shielded containers.

4.9 Labels and Warning Signs

1. The standard radiation warning sign consists of the radiation warning symbol (the “trefoil”) and the words “RAYONNEMENT – DANGER – RADIATION”.

2. CNSC regulations require that a warning sign be posted at every access point to a room if:

   (a) there are more than 100 exemption quantities of a radioactive material in the room, or

   (b) there is a reasonable probability that a person in the room will be exposed to a dose rate greater than 25 µSv per hour.

3. All containers which contain radioactive material shall be labeled with a warning sign and the name, quantity, date of measurement and form of the substance in the container.

4. Where radioactive material is used or stored there shall be posted a legible sign indicating the name or job title and telephone number of a person who can be contacted 24 hours per day with respect to any accident or incident involving the radioactive material.

5. All laboratories designated for the use of unsealed radioactive sources shall be posted with the appropriate poster (e.g. Basic or Intermediate Level) produced by the CNSC.

6. A radiation warning sign shall not be frivolously posted where radiation or radioactive material is not present.

4.10 Waste Handling and Disposal

Permit holders may not dispose of any sealed sources on their permit. Requests for disposal of any sealed source shall be directed to the RSO. The RSO shall take possession of the source and arrange appropriate disposal or place the source in secure storage.

Radioactive waste arising from the use of open sources is to be segregated in the laboratory and disposed of by one of the following methods.

(1) Direct disposal of solid wastes to landfill where the activity is below the limits specified in the license;

(2) Direct disposal of liquids to the municipal sewer system there the activity is below the limits specified in the license and the material contains no other chemicals which would preclude its release;

(3) Storage of material until the activity has decayed to levels where the waste can be released as non-radioactive waste by either method 1 or 2;

(4) Packaging and shipment to an approved radioactive waste management site (e.g., Chalk River).

Specific procedures will be put in place for each laboratory to minimize the amount of waste generated and detail the specific release criteria for each isotope used. No waste will be released either to landfill or to the municipal sewer without the authorization of the Radiation Safety Officer.

Section 7.8 of this manual gives the detailed radioactive waste management procedures.

4.11 Inspections

The Radiation Safety Officer shall have access to all permitted locations at all times.

The Radiation Safety Officer shall conduct regular and unannounced inspections of all permitted locations. The frequency of such inspections shall be commensurate with the types and magnitude of the radioisotope sources and the compliance record of the permit holder, however, under no circumstances shall the inspections be less frequent than once per year.

Results of inspection shall be documented, placed in the permit holder's file and be reported to the Radiation Safety Committee at its next scheduled meeting.

5.0 FACILITIES AND EQUIPMENT

5.1 Laboratory Design

There are no special design requirements for laboratories where sealed sources <50MBq are stored and handled.

Laboratories or other facilities where radiation emitting devices, such as an x-ray machine, are used have special design requirements relating to shielding of the beam. Such facilities shall be designed such that the dose rate to any person external to the room where the equipment is operated shall be less than 0.5 µSv per hour measured at a distance of 1 m from the wall.

The Radiation Safety Officer shall inspect all proposed locations where radioactive material or radiation emitting devices are stored or handled and shall approve such locations before issuing an internal permit.

The Radiation Safety Officer may issue a permit for sealed sources which are less than the exemption quantity to be stored in a secure office, where such storage is necessary to ensure the security of the sources.

When dealing with unsealed or open sources, the laboratory is classified as Basic Level, Intermediate Level, High-Level or Containment Level depending on the amount of radioactive material handled. The designation of a laboratory for use with open sources must be specifically approved by the Radiation Safety Committee based on criteria established by the Canadian Nuclear Safety Commission. This will require an inspection by the Radiation Safety Officer to ensure compliance with the design requirements. The laboratory design compliance checklist is given in Appendix 6. A standard design chemical laboratory will normally meet the requirements for a Basic Level Lab. The designation of a laboratory as Intermediate, High or Containment Level requires the approval of the CNSC.

The designation of a laboratory will depend upon the isotopes used, the quantities of these isotopes, and the particular experimental manipulations being performed. Any changes to these parameters will require a re-inspection by the Radiation Safety Officer to confirm or change the designation.

5.2 Access Control and Security

Access to radioactive materials or radiation devices is restricted to responsible persons. When radioactive material is not in use it will be kept in locked rooms and, if possible, within locked cabinets in these rooms. The permit holder is responsible for maintaining the security of all radioactive sources and radiation emitting devices under his/her control. Distribution of room keys or prox cards will be controlled by centralized facilities staff following authorization from the permit holder granting permission for use of his/her room. The only persons with access to radioactive materials or nuclear substances are the permit holder, individuals designated by the permit holder as authorized users and listed on the internal permit and the Radiation Safety Officer.

Sources may only be stored and used in the locations listed on the internal permit.

The internal permit will be posted in all rooms listed on the permit and will serve as an inventory of all sources present in that location.

Rooms where only sealed sources are used are not designated as radiation laboratories under the CNSC regulations. As such, signs will not normally need to be placed on entrance doors. Signs will be placed on the door as per Section 21 of the Radiation Protection Regulations where there are greater than 100 exemption quantities of a nuclear substance or where there is a

reasonable probability that a person may be exposed to an effective dose rate in excess of 25 µSv per hour.

Each sealed source must bear the radiation warning sign and the container in which the sources are placed will bear the radiation warning sign.

When the sources are in use, a responsible person listed on the permit must be present at all times. If this is not practical, then the room door must be locked.

Any loss of or damage to a sealed source shall be reported to the Radiation Safety Officer immediately.

5.3 Decommissioning

There are no particular decommissioning requirements for a room where sealed sources have been used, provided the sources are intact.

Where sources have been damaged such that the integrity of the source is breached, the Radiation Safety Officer shall be notified. Swipe testing shall be performed and any necessary decontamination performed according to the monitoring procedure and standards for surface contamination.

When any sealed source or any equipment containing sealed sources is decommissioned or disposed of, the RSO shall be contacted to arrange removal and disposal of the source prior to disposal of the equipment

When any laboratory using unsealed sources is to be decommissioned it will be the responsibility of the permit holder to ensure that the room is decontaminated to the levels specified by the CNSC in the license and reproduced below in Table 5.1.

TABLE 5.1

CONTAMINATION CRITERIA FOR UNRESTRICTED USE

Radionuclides	CNSC Contamination Limit ($Bq.cm^{-2}$)
H-3, C-14, P-32, P-33, S-35, Ni-63	**30**
Sr-90, Ba-133	**3**
Co-60, Cs-137 **All alpha emitters**	**0.3**
All other radionuclides	**Consult RSO**

The Radiation Safety Officer will verify that all sources and signs have been removed and that the above contamination criteria have been met before releasing the laboratory for other uses.

5.4 Radiation Monitoring Equipment

All users of radiation or radioactive materials will be required to have suitable dose or contamination monitoring instrumentation available. Such instrumentation shall be approved by the Radiation Safety Officer for the intended use.

A number of radiation detection instruments (contamination and survey) are available at UOIT as part of the teaching and research programs. A representative selection of these is detailed in Appendix 11.

Procedures and instrumentation used to perform leak testing of sealed sources shall be able to detect a leakage of 200 Bq or less of the nuclear substance.

Procedures and instrumentation used to perform contamination monitoring shall be able to detect the action levels listed in Table 7.1

Any radiation survey meter used to measure radiation dose rates for purposes related to the license shall be calibrated at least every 12 months according to the requirements set by the CNSC. [See CNSC document "*Regulatory Expectations for Calibration of Survey Meters*" dated February 7, 2011]

Portable contamination meters shall be checked for constancy on a regular basis before and after every use and recalibrated as necessary.

Appendix 11 details the principles which will form part of the operating procedures for radiation detection instruments.

6.0 PERSONNEL

6.1 Education and Training

All staff and students working with radioactive materials will receive appropriate training to enable them to work safely with radiation and radioactive materials. The training applicable to each identified group will be developed in accordance with the principles in 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.* No person will work with or around a radiation source or radioisotopes without having received appropriate training prior to beginning work.

Categories of workers requiring training and the extent of that training will be defined according to the principles of G-313 and documented in a Radiation Safety Training Manual. Specific categories of worker will include:

- Management
- Permit holders
- Nuclear Energy Workers
- Laboratory staff (non nuclear energy workers)
- Purchasing and receiving workers
- Security staff
- Cleaning and maintenance staff

All radioisotope permit holders will receive appropriate training prior to their being issued a license. This training will be guided by the recommendations of G-313 with emphasis on the policies and procedures outlined in the Radiation Safety Manual.

All training courses for persons working with radioisotopes shall cover the appropriate modules of CNSC, G-313 and where appropriate include hands-on use of some radiation survey instrumentation. The UOIT Radiation Safety Training course is mandatory for all persons planning to work with radioactive materials or radiation devices. This training is required prior to working with radioisotopes, and involves testing (pass/fail). In the event that an applicant fails the administered test, the applicant will be referred to self-study and re-tested.

A record of all personnel trained will be maintained by the UOIT Radiation Safety Officer for the duration of the employment of the worker, and for five (5) years post UOIT employment.

Ancillary personnel (clerical, janitorial, maintenance, security) that are not designated workers but may come into contact with laboratories containing radioactive material will receive abbreviated training. The training will concentrate on personal safety (ALARA principles/ shielding, distance and time/ difference between sealed and loose sources, etc), security and incident reporting. Personnel purchasing or receiving radioactive materials will receive specific training on the packaging and transport of Class 7 shipments and receiving class 7 packages.

The modules for both the worker training and the ancillary personnel training will be included in the UOIT Radiation Safety Training Manual.

Recurrent training for all radioisotope user permit holders and actively designated workers will be scheduled for every three (3) years, and may be conducted either via web-based training and testing, self-study and testing, or attending the UOIT Radiation Safety Training Course.

6.2 Designation of Nuclear Energy Workers

A “Nuclear Energy Worker” is defined in the *Nuclear Safety and Control Act* as a person who, in the course of his/her 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).

The Radiation Safety Committee shall designate an individual as a nuclear energy worker based on an analysis of the likelihood of that individual receiving an effective dose in excess of 1 mSv per year or a dose to any organ or tissue in excess of the public dose limit.

For the typical sealed sources in quantities likely to be used in an undergraduate laboratory the external gamma dose for an annual exposure of 2000 hours is of the order of a few μSv per year. (See Table 6.1).

In the worst, case scenario, a ^{60}Co source of 50 MBq would give a dose rate of about 20 μSv per hour at 1 m, or an annual dose of 40 mSv for an exposure time of 2000 hours per year.

Therefore, under the normal usage anticipated in undergraduate laboratories it is extremely unlikely that any person would receive an annual dose in excess of 1 mSv per year. Therefore, undergraduate students will not normally be designated as nuclear energy workers.

TABLE 6.1

DOSE RATES FROM SELECTED SEALED SOURCES

ISOTOPE	HALF-LIFE	EXEMPTION QUANTITY (Bq)	SOURCE QUANTITY (uCi)	SOURCE QUANTITY (Bq)	GAMMA DOSE CONSTANT (mSv/h per MBq)	GAMMA DOSE RATE @ 1 m (mSv/h)	ANNUAL DOSE FOR 2000 h (mSv)
GAMMA							
Ba-133	10.4 y	1.00E+06	0.1	3.70E+03	1.23E-04	4.55E-07	9.11E-04
Cd-109	453 d	1.00E+06	0.1	3.70E+03	4.98E-05	1.84E-07	3.69E-04
Co-57	271 d	1.00E+06	0.1	3.70E+03	4.09E-05	1.51E-07	3.02E-04
Co-60	5.27 y	1.00E+05	0.1	3.70E+03	3.70E-04	1.37E-06	2.74E-03
Cs-137	30.1 y	1.00E+04	0.1	3.70E+03	1.03E-04	3.82E-07	7.64E-04
Mn-54	312 d	1.00E+06	0.1	3.70E+03	1.38E-04	5.11E-07	1.02E-03
Na-22	2.6 y	1.00E+06	0.1	3.70E+03	3.62E-04	1.34E-06	2.68E-03
BETA							
C-14	5730 y	1.00E+07	10	3.70E+05	0	0.00E+00	0.00E+00
Tc-99	2.1E+05 y	1.00E+07	10	3.70E+05	1.24E-10	4.60E-11	9.19E-08
Cl-36	3.0E+05 y	1.00E+04	10	3.70E+05	0	0.00E+00	0.00E+00
Bi-210 (Pb-210)	22 y (Pb)	1.00E+04	10	3.70E+05	6.80E-05	2.52E-05	5.03E-02
Sr-90(Y-90)	29 y (Sr)	1.00E+04	10	3.70E+05	0	0.00E+00	0.00E+00
ALPHA							
Am-241	433 y	1.00E+04	0.1	3.70E+03	8.48E-05	3.14E-07	6.27E-04
Th-228	1.9 y		0.1	3.70E+03	2.14E-05	7.93E-08	1.59E-04
Th-230	7.7E+04 y	1.00E+04	0.1	3.70E+03	1.86E-05	6.89E-08	1.38E-04
WORST CASE							
Co-60	5.27 y	1.00E+05		5.00E+07	3.70E-04	1.85E-02	3.70E+01

Employees and graduate students working with radioactive materials may be designated as Nuclear Energy Workers depending on the type and nature of their work**.**

All persons designated as Nuclear Energy Workers will be provided with the information required by Section 7 of the Radiation Protection regulations made under the Nuclear Safety and Control Act. The designated persons shall provide a written acknowledgement of this by signing the form given in Appendix 5.

6.3 Dose Limits

The Canadian Nuclear Safety Commission, in the Radiation Protection Regulations, sets dose limits for Nuclear Energy Workers and members of the general public. These limits are given in Table 6.2.

TABLE 6.2

DOSE LIMITS SET BY THE CNSC

Organ or Tissue	Period	Dose Limit (mSv) Nuclear Energy Worker (2)	Dose Limit (mSv) Member of the Public
Whole Body	One year	50	1
	Five years (1)	100	-
Lens of eye	One year	150	15
Skin	One year	500	50
Hands and Feet	One year	500	50

NOTES:
(1) In practice, the average limit on dose is 20 mSv per year when the dose is delivered at a uniform rate.
(2) For a pregnant NEW the limit is 4 mSv for the balance of the pregnancy.

The University has set action levels below these dose limits. These are outlined in Section 7.3.

6.4 External Dose Monitoring

Personal dose monitoring is required for nuclear energy workers where there is a reasonable probability that the effective radiation dose received will be greater than 5 mSv in a calendar year or if the dose to any organ will exceed the corresponding limit for members of the public. Hand dosimetry will be required when working with quantities of open sources of high energy beta emitters such as P-32 which exceed 50 MBq. All nuclear energy workers and designated x-ray workers will be provided with appropriate dosimetry.

Non-nuclear energy workers will not normally be provided with personal dosimeters. In exceptional circumstances requests by an individual for personal dosimetry will be considered by the Committee or the Committee may require dosimetry in order to evaluate and verify the effectiveness of protective measures being taken.

All dosimetry will be provided by a licensed dosimetry service.

6.5 Internal Dose Monitoring

A primary goal of the radiation protection program is to prevent workers from taking radioactive material into the body. Good work techniques and consistent and thorough monitoring of the workplace for radioactive contamination will serve to minimize the possibility of intakes of radioactive material,

In some circumstances, when working with very volatile compounds or with compounds which can readily be absorbed through the skin, some form of routine monitoring for internal contamination may be appropriate.

There are two primary bioassay techniques for monitoring radioactivity in the body. These are *in vitro* and *in vivo*. *In vitro* techniques involve taking a small sample of body fluid (usually urine) or tissue and analyzing for the radioactive content. This is normally used for pure beta emitting radionuclides such as tritium and carbon-14. The *in vitro* technique involves placing detectors on the surface of the body to detect gamma radiation being emitted. This technique is normally used for radioiodine in the thyroid or other gamma emitters in the lungs.

The decision as to whether to employ bioassay will depend on the radionuclide being used, the amounts being used, the chemical form of the labeled compound and the experimental techniques and operations being performed. Bioassays are typically performed after handling large quantities of tritium and radioiodine. The radioisotope permit will stipulate the conditions under which bioassay is required.

For the handling of sealed sources, the likelihood of an intake of radioactive material is essentially zero unless the source encapsulation is breached. In such a case this would be treated as a radiation emergency and the emergency procedures would apply. No routine internal dosimetry program is required for handling of sealed sources or x-ray machines.

7.0 RADIATION SAFETY POLICIES AND PROCEDURES

7.1 Enforcement

The ability of the University to maintain a consolidated license for the use of radioisotopes depends upon the strict adherence of all internal permit holders to the CNSC regulations, the Radiation Safety Manual and to the terms and conditions of individual radioisotope permits.

The Radiation Safety Committee acting for the University has been granted the authority to issue radioisotope permits to individuals, to set conditions on these permits and to enforce the terms and conditions of these permits. Permit holders are expected to adhere to the radiation safety manual and to the permit conditions and, further, to ensure that all staff and students working under their permit also comply with them. In the unlikely event that such is not the case, the Committee will apply the following approach to enforcement.

1. On the first occurrence of an infraction, the responsible permit holder will be notified in writing by the Radiation Safety Officer of the infraction, the need for the particular policy and the steps to be taken. The occurrence will be reported to the Chair of the Committee and to the Committee at its next scheduled meeting.

   The permit holder will be requested to respond, in writing, to the Radiation Safety Officer outlining the steps taken to comply.

2. On the second occurrence within a year, the Chair of the Committee will notify the permit holder, in writing, outlining the need for compliance and the duties of the permit holder in that regard. The letter will be copied to the Dean of the Faculty involved. The occurrence will be reported to the Committee at its next scheduled meeting.

   The permit holder will be requested to respond, in writing, to the Chair, outlining the steps taken to comply.

3. On a third occurrence within a year, the Chair of the Committee will arrange for the permit to be transferred to another permit holder or to the Radiation Safety Officer and the Dean of the Faculty will be notified of this action. Further work under this permit will be allowed only under the direct control of the individual to whom the permit is assigned. All purchase requisitions will require the approval of this individual.

4. If a fourth violation is noted, the Chair of the Committee will convene a meeting with the permit holder, the Dean of the Faculty, and the Radiation Safety Officer. The permit holder will be required to show cause as to why his/her permit should not be revoked.

   If, as an outcome of this meeting, the permit is revoked, the Radiation Safety Officer shall take charge of all radioactive materials held under the permit and transfer them to the care of another permit holder or place them in secure storage.

5. The permit holder may appeal the revocation of a permit to the whole Radiation Safety Committee at their next meeting.

6. Reinstatement of the permit will require the approval of the Committee.

7. If the nature of the violation is particularly serious, or the permit holder has shown a consistent and ongoing pattern of violations, however minor, the Committee reserves the right to bypass any of these steps.

Notwithstanding, the above enforcement procedure, if the Radiation Safety Officer is of the opinion that a serious and immediate risk to health, safety or security exists, the Radiation Safety Officer shall have the authority to suspend any operations or suspend a permit immediately.

The Radiation Safety Officer will immediately report this situation to the Chair of the Committee who will independently investigate the situation. Any disagreement between the Radiation Safety Officer and the Chair shall be considered by the full committee at a meeting which shall be convened as soon as possible.

7.2 Eating and Drinking in Laboratories

As a general policy, eating and drinking in any laboratory where there are hazardous chemical or biological agents or open source radioactive isotopes is strictly forbidden.

7.3 Action Levels

Action levels are specific quantifiable parameters which, if reached, may indicate a loss of control of part of the radiation protection program. Action levels are typically set in terms of radiation exposure or dose that an individual receives, a radiation level within a work area, or a level of contamination on surfaces. Action levels must also be based on parameters which are routinely measured.

7.3.1 Action Levels – Radiation Dose

Radiation doses are routinely measured only for those persons designated as Nuclear Energy Workers. In such cases the following effective dose limits would apply:

- Maximum external dose in any one year: 50 mSv
- Average annual dose over a 5-year period: 20 mSv per year
- For a pregnant nuclear energy worker: 4 mSv over the balance of the pregnancy

Data from the National Dose Registry (2003 Report on Occupational Radiation Exposures in Canada) indicate that for laboratory scientists and engineers the average annual doses over the 10 year-period from 1992 to 2001 was 0.075 mSv. 75% of the workers reported no measurable dose and 24.7 % of workers reported doses less than 5 mSv.

Based on this data, the University will endeavour to maintain doses to Nuclear Energy Workers below 5 mSv per year. To aid in monitoring and achieving this, the following action levels will be used:

Administrative Level:

A reported dose of greater than 0.3 mSv and less than 1 mSv in any three month dosimetry period.

A dose of 0.25 mSv in any three month period, would, if continued, lead to an annual dose equal to the dose limit for the public.

If the measurable dose is greater than 0.3 mSv and less than 1 mSv, the circumstances will be promptly investigated by the Radiation Safety Officer to determine the likely cause and the results of the investigation documented. The results of the investigation will be reported to the Radiation Safety Committee and the individual involved. Any appropriate actions or changes to protocols or procedures will be implemented to ensure that subsequent doses are not accumulated.

Action Level 1:

A reported dose of greater than 1 mSv and less than 4 mSv in any three month dosimetry period.

A dose of 1 mSv is the annual dose limit for a member of the public. A dose of this magnitude in a three month period would, if continued, lead to an annual dose of 4 mSv (20% of the annual limit for a nuclear energy worker and just below our annual target of less than 5 mSv per year). Four mSv corresponds to the maximum dose to a pregnant Nuclear Energy Worker for the balance of a declared pregnancy and would place the individual in the top dose group of the 25% of laboratory workers who received doses between the detection limit and 5mSv.

Upon receipt of the dosimetry results, the incident will be promptly reported to the Radiation Safety Committee and the CNSC. The Radiation Safety Officer will immediately conduct an investigation and the worker involved will stop radioactive work pending the results of the investigation.

The results of the investigation will be documented and reported to the Radiation Safety Committee, the CNSC and the worker involved. Any appropriate changes to the Radiation Safety Program will be promptly implemented.

Action Level 2:

A reported dose of greater than 4 mSv in any three month dosimetry period

Four mSv is the dose limit for the balance of pregnancy for a female nuclear energy worker. If continued, this would lead to an annual dose of 16 mSv which is 80% of the annual limit for a nuclear energy worker.

Upon receipt of the dosimetry results, the incident will be promptly reported to the Radiation Safety Committee and the CNSC. The worker involved will immediately cease all work with radioactive materials. The Radiation Safety Officer will immediately conduct an investigation which will involve both the activities of the worker and the activities of any other worker or any other processes which could have affected the dose to the worker.

The results of the investigation will be documented and reported to the Radiation Safety Committee, the CNSC and the worker involved. Any appropriate changes to the Radiation Safety Program will be promptly implemented.

The worker involved will not return to radioactive work until authorized by the Radiation Safety Committee. The Radiation Safety Committee may impose additional requirements on the worker (e.g. additional training, more frequent dose monitoring, etc.).

7.3.2 Action Levels – Surface Contamination

Action levels for removable surface contamination are given in Table 7.1. For isotopes commonly used in research these are:

TABLE 7.1

ACTION LEVELS FOR SURFACE CONTAMINATION IN PERMITTED RADIOISOTOPE LABORATORIES

Radionuclides	CNSC Contamination Limit ($Bq.cm^{-2}$)	UOIT Action Level ($Bq.cm^{-2}$)	Action Required
H-3, C-14, P-32, P-33, S-35, Ni-63	**300**	**30**	**Clean and report to RSO**
Sr-90, Ba-133	**30**	**3**	**Clean and report to RSO**
Co-60, Cs-137 All alpha emitters	**3**	**0.3**	**Clean and Report to RSO**
All other radionuclides	**Consult RSO**	**Consult RSO**	**Consult RSO**

7.4 Receipt of Radioactive Material

All radioactive materials must be properly checked upon receipt in order to minimize the possibility of contamination due to damaged or leaking containers. The following procedures should be used upon receipt of any radioactive material. For additional information see Appendix 12 - Radioactive Material Packaging and Labeling.

1. All radioactive material should be picked up from receiving by the permit holder or designate who has received appropriate radiation safety training and taken to the laboratory as soon as possible

2. The package should only be opened in a designated and permitted laboratory.

3. Wear appropriate protective clothing. For unsealed sources wear laboratory coat and gloves. Inspect the package for any signs of damage or leakage of the contents. If there is suspected leakage place the package in a plastic bag and notify the Radiation Safety Officer immediately.

4. Verify that the label on the package indicates the correct isotope, activity and labeled material.

5. Where a transport index is indicated on the package label, measure the dose rates and verify that they conform to the transport index.

    - White I: < 5 $\mu Sv.h^{-1}$ on contact with the package
    - Yellow II: > 5 $\mu Sv.h^{-1}$ and < 500 $\mu Sv.h^{-1}$ on contact
    - Yellow III: > 500 $\mu Sv.h^{-1}$ and < 2mSv.h-1

    If the dose rates exceed the prescribed limits contact the Radiation Safety Officer.

6. Carefully open the package and verify the isotope, activity and labeled compound against the order and the packing slip. If the contents are volatile open the package in a fume hood.

7. If there is any reason to suspect leakage of the material, swipe test the inner containers and notify the Radiation Safety Officer if any contamination is found.

8. Check gloves for any contamination.

9. Store the radioactive material according to the requirements of the manufacturer.

10. Remove gloves and wash hands after handling the material. Re-check hands and clothing for any contamination.

11. Log the appropriate source information in the laboratory inventory record.

12. Sign the Packing Slip acknowledging receipt and send a copy of the packing slip to the Radiation Safety Officer.

13. If no contamination is found on the packaging material, the warning labels must be removed or defaced to remove any reference to radioactive material. The packaging material may then be disposed of as regular waste. Contaminated packaging should be sealed in a plastic bag and the Radiation Safety Officer contacted for disposal.

14. 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, and contact the Radiation Safety Officer.

7.5 Shipping of Radioactive Material

Radioactive materials are classified as dangerous goods (Class 7) under the Transport of Dangerous Goods regulations. Shipments must meet the requirements of the TDG regulations as well as the CNSC Packaging and Transport of Nuclear Substances Regulations. Any person shipping or offering such materials for transport must have received TDG training. Permit holders are not authorized to ship or transport radioactive material and must contact the Radiation Safety Officer to arrange for shipment. For additional information see Appendix 12 - Radioactive Material Packaging and Labeling.

7.6 General Safety Procedures for Work with Unsealed Sources

Manipulations involving radioactive labeled compounds require consideration of both the chemical and radiological hazards of the material. Always consult the Material Safety Data Sheet for the specific compound for the non-radiological hazards.

7.6.1 Work Area

1. All radioisotope laboratories must be kept locked unless a person authorized to work with radioactive material is present.

2. A copy of the current permit must be posted prominently in all rooms listed on the permit. The permit will list the isotopes which may be used together with the conditions relating to their use. A list of authorized persons must be posted with the permit.

3. A copy of the appropriate poster (Basic Level or Intermediate Level) produced by the Canadian Nuclear Safety Commission must be posted in each room where radioactive material is handled.

4. Work must be confined to an area of the laboratory with minimal traffic. If possible, the handling of radioactive material should be in one area of the laboratory.

5. All radioisotope usage areas must be clearly labeled with radiation warning labels.

6. Radioactive waste must not be stored in the work area without adequate shielding and containment.

7. The work area must be covered with disposable absorbent materials which must be immediately discarded as solid radioactive waste in the event of a spillage of any kind. Disposable absorbent material should be replaced on a regular basis.

8. Radioisotope work areas must be kept free of materials that are not relevant to the work being carried out. Laboratory records and books should be kept away from possible sources of contamination.

9. Work should be carried out in a fume hood to the extent possible. In cases where radioactive material may be volatilized by dispersion of dust or by spraying or splattering the work must be done in a fume hood.

10. The fume hood must not be crowded with materials which may disrupt the air flow.

11. The fume hood must be supplied with a working, alarming flow monitoring device.

12. Appropriate dosimetry must be worn as specified on the permit.

13. Monitoring and contamination checks must be carried out regularly. Work areas must be checked immediately after performing manipulations and contaminated areas cleaned immediately and the cleaning verified by further contamination checks. Records must be maintained of all contamination monitoring and these will be subject to audit and verification by the Radiation Safety Officer.

14. Eating. Drinking, smoking, use of cosmetics or other material in contact with the skin is prohibited in the laboratory. Food or food containers must not be stored in a radioisotope laboratory or in a refrigerator used to store radioisotopes.

15. Any wound, puncture or break in the skin should be appropriately protected by a waterproof covering before putting on gloves to work with radioactive material.

16. All equipment and other items used during a radioisotope procedure must be labeled with appropriate radiation warning labels. Where feasible this equipment should be kept separate from other laboratory equipment. Equipment should also be regularly checked for contamination and decontaminated as necessary.

17. Radioactive solutions must be labeled with radiation warning signs which include pertinent information as to the compound, the radioisotope and its activity. All containers containing radioactive materials must be properly covered and labeled.

18. Where feasible, glassware should be designated for radioisotope work and washed separately. 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.

19. Where possible, one sink should be used for the washing of contaminated glassware and equipment. This sink should be clearly labeled with radiation warning signs.

20. Any spills of radioactive material should be immediately covered with absorbent material to prevent the spread of material. The spill area must be identified to warn other personnel of the location. Decontamination of the area must begin as soon as possible.

21. Usually, equipment may be cleaned by washing with a laboratory detergent. If necessary a complexing agent 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 Radiation Safety Officer for assistance.

22. Coat hooks should be installed near the exit door and laboratory staff should remove laboratory coats before leaving the lab. Laboratory clothing must not be worn to any cafeteria, eating area or office or other area outside the active laboratory.

23. Where maintenance work is to be carried out in the laboratory, the work area must be decontaminated and checked prior to the start of such work. Any equipment leaving the laboratory must be checked and decontaminated before removal.

24. Before leaving the laboratory all personnel must wash their hands thoroughly.

7.6.2 Protective Clothing

1. Direct contact with radioactive materials must be avoided by the proper use of protective clothing. As a minimum this consists of a laboratory coat, protective eyewear and disposable, impervious gloves. Disposable items, if contaminated, must be discarded as radioactive waste immediately after use.

2. Gloves should be checked frequently for any small punctures that may have developed. Disposable gloves for radioisotope work must be removed before leaving the laboratory. Gloves must be removed and discarded after use to prevent the spread of contamination, especially to telephones and refrigerator or door handles.

3. Double gloves are recommended where more than 37 MBq (1 mCi) of an isotope is handled.

4. Safety glasses or appropriate goggles must be used at all times when working with radioisotopes or with chemicals which could be splashed into the eyes.

7.6.3 Radioisotope Handling Precautions

1. Prior to conducting a new procedure involving radioisotopes, a test run using non-radioactive material should be carried out to test the procedure.

2. Use the minimum quantity of radioisotope necessary to satisfy the objective of the procedures.

3. Portable radiation monitors should be kept away from the radioisotope handling areas to prevent accidental contamination. Materials such as plastic wrap may be used to prevent contamination of the monitor from routine handling, however it must be recognized that any material placed over the detector will reduce its detection efficiency.

4. Due to the high dose rate encountered, work should never be carried out above an unshielded container of P-32 or other high energy beta emitter. A shield of at least 1 cm of plexiglass should be used for P-32.

5. Pipetting by mouth is prohibited under all circumstances.

6. If heating is necessary, a hotplate with a water bath should be used. Radioactive solutions should never be heated over an open flame. If it is necessary to look into a beaker containing radioactive material during a chemical procedure, safety glasses and/or face masks must be worn. Hands must be protected by appropriate gloves and by the use of forceps.

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

8. A radioactive solution should never be poured from one container into another. Transfer should be done with a pipette.

9. The work area should be monitored frequently during radioactive work to detect contamination. Particular attention should be paid to the floor below the radioisotope work area.

10. Upon completion of radioisotope work, all materials must be properly labeled. All material and equipment used during the procedure must be safety stored or prepared for disposal.

11. All radioisotope work areas must be monitored upon completion of work and records of monitoring and corrective actions must be maintained and available for inspection.

12. Hands must be thoroughly washed following completion of procedures involving radioactive material. Hands and clothing should be monitored to ensure that no contamination has occurred.

7.7 Contamination Control and Monitoring

Permit holders are responsible for ensuring that all radioisotope facilities on their permit are monitored regularly for contamination. Monitoring should be performed in the work area after every manipulation of radioisotopes. All monitoring results must be recorded in the Contamination Monitoring Log and made available for inspection by the RSO and the CNSC. Where open sources are in use in a laboratory there must be, as a minimum, weekly entries in the log. Where no radioactive sources are used during a week, the entry should state that no work was done that week. All monitoring results must be calculated in Bq/cm^2. The procedures and monitoring log are provided in Appendix 8.

Where only sealed sources are used spread of radioactive contamination should not be, under normal circumstances, a problem. Routine contamination monitoring is not required as long as the sealed sources are intact and in good condition. Where leak testing reveals that a sealed source has lost its integrity, contamination monitoring is required to delineate any spread of contamination. Such monitoring will be conducted by the RSO.

7.7.1. Contamination Criteria

Contamination monitoring criteria are established by the Canadian Nuclear Safety Commission. The University has established action levels which are less than the CNSC limits. These are given in Table 7.1 for common isotopes used in research.

For public areas and for purposes of decommissioning the limits are 1/10 of the CNSC limits for controlled areas, or are equal to the UOIT Action Levels for controlled areas.

The Limits and Action levels are averaged over a 100 cm^2 area.

7.7.2 Methods for Contamination Monitoring

The most effective means of monitoring for surface contamination is through the use of swipes followed by liquid scintillation counting. This is the only method acceptable for low energy beta emitters such as H-3, C-14, S-35 and Ni-63. The swipe is taken over an area of 100 cm^2 and measures removable surface contamination.

Portable instruments are also available that are capable of detecting a wide range of radionuclides in the form of surface contamination. These units are generally based on gas ionization and have detectors with large detection surfaces and thin mylar windows which allow beta particles and, in some cases, alpha particles to pass through into the detector. The detection efficiency of these detectors depends on the energy of the radiation. For low energy beta emitters such as H-3, C-14 and S-35 the detection efficiency is quite low (of the order of a few percent); for high energy beta particles such as those from P-32 the efficiency can be 30-40%. Gamma emitters are easily detected by portable instruments.

Portable surface contamination monitors can be influenced by sources of radiation in the vicinity and they measure total contamination on the surface – both removable and fixed.

The Radiation Safety Officer will maintain a list of appropriate instruments, and must approve the use of any particular instrument. The RSO will assess each instrument and document the efficiency and detection limits. The RSO will also reassess each instrument at least annually for proper function, calibration and detection limits.

7.7.3 Contamination Monitoring Procedures

All facilities where open sources of radioactive material are used must be regularly monitored for contamination. Monitoring must be carried out after completion of any manipulation of radioisotopes and the results entered into the contamination monitoring log (see Appendix 8).

As a minimum there must be a weekly entry into the log. If no radioisotopes have been used since the previous entry, a notation of the fact that no work has taken place should be made in the log.

Failure to maintain the log will be considered an infraction and subject to Radiation Safety Committee disciplinary procedures.

Detailed contamination monitoring procedures will depend on the isotope(s) being used and will be provided with the permit. They will also be discussed in the Radiation Safety Course. See also Appendix 8 of this manual.

7.8 Leak Testing of Sealed Sources

Routine leak testing is required for all sealed sources where the activity exceeds 50 MBq. Such testing must be able to detect a leakage of 200 Bq or less of the source material and shall follow the procedures specified in CNSC REGDOC-1.6.1 *Licence Application Guide: Nuclear Substances and Radiation Devices*, appendix AA.

Testing is required under the following conditions:

(a) The source shall be tested immediately upon receipt of the source and before placing it in service.
(b) Where the sealed source has been stored for 12 or more consecutive months, it shall be tested immediately before using it.
(c) Where the sealed source is in storage, it shall be tested every 24 months.
(d) Where an event occurs which may have damaged the source, it shall be tested immediately after the event.
(e) Where the sealed source is located in a radiation device, it shall be tested every 12 months.
(f) Where the sealed source is not located in a radiation device, it shall be tested every 6 months.

Two common types of sealed sources used in laboratories which may, depending on their activity, require leak testing are Electron Capture Detectors in Gas Chromatographs, and calibration sources in Liquid Scintillation Counters. These will normally fall under category (e) above and shall be tested annually.

Leak testing shall be performed using procedures approved by the CNSC and be done by suitably qualified persons approved by the Radiation 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 established by the CNSC [See CNSC document "*Regulatory Expectations for Leak Testing of Sealed Sources"*, dated February 7, 2011]. The Radiation Safety Officer shall maintain a list of sources requiring leak testing and shall coordinate the testing at the required frequency.

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

7.9 Waste Management

Radioactive wastes must be segregated in the laboratory. Because it is very expensive to dispose of radioactive waste, radioactive materials must not be mixed with non-radioactive waste. It is very important to minimize the production of radioactive waste.

Different isotopes should not be mixed in the same container. This will facilitate allowing the waste to decay to a level where the waste can be disposed of as non-radioactive waste.

Isotope users must follow these basic steps when preparing waste:

1. Keep all different isotopes segregated in separate containers. Do not mix different isotopes in the same container.
2. Do not mix solid and liquid waste.
3. Place solid wastes in the designated solid radioactive waste containers.
4. Liquid wastes are to be kept in liquid form in the designated liquid waste containers.
5. Complete the radioactive waste log after each addition of waste to the container.
6. Do not mix radioactive and non-radioactive waste. Do a careful segregation to minimize the amount of radioactive waste. Remove or deface any radioactive markings or symbols from non-radioactive waste.
7. Do not place lead pigs that hold isotope vials in the garbage. Lead can be recycled.
8. When the container is full, fill out the label completely and legibly and notify the Radiation Safety Officer.
9. If there are any problems or questions contact the Radiation Safety Officer

The CNSC, as part of the Consolidated Radioisotope License issued to the University has set limits on the amounts of radioactive material which can be disposed of to municipal garbage, sewer systems and the atmosphere. These are isotope dependent and their limits are given in Table 7.2 for those isotopes permitted by the terms of the Consolidated License.

TABLE 7.2

RADIONUCLIDE RELEASE LIMITS

Isotope	Solids to municipal garbage system (MBq/kg)	Liquids to Municipal Sewer Systems (MBq/year)	Gases to Atmosphere (kBq/m^3)
H-3	37	1,000,000	37
C-14	3.7	10,000	-
P-32	0.37	1	-
P-33	1	10	-
S-35	0.37	1000	-

The University release criteria are based on these limits and are given in the following sections for the various waste categories**.**

The procedures given below are of a general nature only, and specific procedures will be developed for each laboratory depending on the isotopes in use and the specific laboratory manipulations being performed. These specific procedures will form part of the internal permit requirements.

A radioactive waste log is to be kept for all containers of radioactive waste. The log shall contain the date of each addition of waste and an estimate of the total activity added on that date. A sample log form is given in Appendix 9.

7.9.1 Solid Waste

Solid radioactive waste will normally consist of such items as disposable pipette tips, absorbent paper and gloves.

- Carefully segregate radioactive and non-radioactive waste. Place radioactive waste only into the designated radioactive waste containers. Do not put non-radioactive waste in the radioactive waste containers. When in doubt monitor the waste for activity.
- Disposable pipette tips are likely to be the major type of solid waste generated in the laboratory and these will be kept stored separately in an appropriate container, normally a large wide-mouthed plastic bottle with a screw lid.
- Segregate any sharp waste (needles, blades, broken glass or plastic ware) into a separate container.
- Place paper and gloves into a separate container.
- Contaminated solid material (with the exception of paper) may be rinsed once and the washings placed into the liquid radioactive waste.
- Maintain a waste log for each container with an estimate of the total activity in the container.
- When the container is full, complete the waste label with the log and contact the Radiation Safety Officer for disposal.

- The Radiation Safety Officer will approve disposal as non-radioactive waste, or store the material for decay.

7.9.2 Aqueous Liquid Waste

This category includes all aqueous based liquids containing radioactive material with the exception of liquid scintillation counting vials (section 7.9.3) and very dilute solutions meeting the criteria in section 7.9.4.

- Radioactive liquid waste is segregated according to the isotope. A separate container is required for each isotope. The containers shall be unbreakable plastic or glass of no more than 4 L capacity and fitted with a screw cap.
- Liquid waste shall be kept in liquid form in the approved container.
- The container shall be kept in a fume hood with shielding suitable for the isotope.
- A waste log shall be kept for the container which details the date at which waste is added to the container and the estimated activity added.
- When the container is full, a sample shall be taken and the activity determined by liquid scintillation counting.
- A waste tag shall be completed for the container giving the isotope, the concentration, the total activity and the date.
- The Radiation Safety Officer shall be notified to take charge of the waste for disposal.
- If the measured activity meets the criteria in Table 7.3 the waste may be disposed of through the municipal sewer system. Note: The Radiation Safety Officer must approve the disposal of all waste.
- If the measured activity exceeds the criteria in Table 7.3 the waste (depending on the half-life) shall be stored until the activity has decayed below the release criteria, after which time it shall be disposed of through the municipal sewer system.
- Tritium and carbon-14 wastes which do not immediately meet the release criteria shall be solidified using a suitable absorbent and sent to a licensed radioactive waste management site.

TABLE 7.3

LIQUID WASTE DISPOSAL CRITERIA

ISOTOPE	CNSC RELEASE LIMIT (MBq/y)	DERIVED RELEASE LIMIT (MBq/week)	UOIT RELEASE CRITERIA (MBq/week)
H-3	1,000,000	19,000	1900
C-14	10,000	190	19
P-32	1	0.019	0.0019
P-33	10	0.19	0.019
S-35	1000	19	1.9

- Liquid waste which is disposed of to the municipal sewer system shall be released on a batch basis following a measurement of the activity in each container released, or an initial

measurement followed by the calculation of a release date at which the activity will have decayed to meet the release criteria.
- Batch releases shall be done only with the approval of the Radiation Safety Officer who shall maintain records of the amounts disposed of to ensure that the CNSC release limits are not exceeded.

7.9.3 Liquid Scintillation Vials

- Used liquid scintillation counting vials constitute a separate waste category and should not be mixed with other waste.
- Liquid scintillation vials may contain organic solvents which must be disposed of separately and not mixed with aqueous wastes or be disposed of through the municipal sewer. Newer cocktails are “environmental friendly” and have fewer restrictions on disposal.
- In most cases, the activity in liquid scintillation vials used in research activities is negligible and they can be considered to be non-radioactive. The criteria to be considered “non radioactive” are given in Table 7.4.
- Each LSC vial is individually measured for its activity and any vials which exceed the limits in Table 7.4 will be segregated to be either held to decay or sent for disposal at a licensed site.

TABLE 7.4

WASTE DISPOSAL CRITERIA FOR LIQUID SCINTILLATION VIALS

ISOTOPE	LIMIT FOR SOLIDS TO MUNICIPAL GARBAGE SYSTEM ($MBq.kg^{-1}$)	QUANTITY PER LSC VIAL FOR UNRESTRICTED RELEASE (kBq)*
H-3	37	370
C-14	3.7	37
P-32	0.37	3.7
P-33	1	10
S-35	0.37	3.7

***** Assuming 10g of solution per vial

7.9.4 Aqueous Washes

Some aqueous wastes (e.g. from washing of glassware or hands) may be of relatively high volume and contain only trace amounts of radioactivity. If these wastes meet the release criteria they can go directly down the laboratory drain.

NOTE: It is unacceptable to deliberately dilute solutions of high activity to meet the release criteria for aqueous wastes in this section.

7.9.5 Organic Liquid Waste

- Any radioactive liquid waste containing significant amounts of organic solvents must be kept separate from non-organic liquid waste. A separate bottle should be used for these wastes.

- Separate procedures for dealing with organic wastes will be developed depending on the nature of the research project, the particular solvent and isotope. These procedures will form part of the internal permit.

7.9.6 Waste Storage

- Small numbers of filled radioactive waste containers may be stored for decay in the generating laboratory in an appropriately shielded location. An inventory will be kept of such containers and they will be disposed of only by the Radiation Safety Officer at such time as they meet the release criteria in Section 7.9.2.
- If the volume of waste in storage exceeds that which can be safely stored in the generating laboratory, the University will maintain a separate, secure storage area for the decay of solid and liquid wastes removed from the laboratory. Access to this area will be restricted to authorized and trained personnel and the Radiation Safety Officer will oversee and approve all disposal of radioactive waste.

7.10 Emergency Procedures

7.10.1 Emergency Contacts

Radiation Safety Officer

Chair of Radiation Safety Committee

Campus Security

The names and contact numbers for each internal permit will be posted in the laboratory.

7.10.2 Basic Emergency Procedures

1. First aid and medical attention takes precedence over decontamination.

   In case of injuries involving medical attention or first aid, notify the medical personnel that radioactive materials are involved.

2. Alert everyone in the area

   Ensure that everyone in the vicinity of the accident has been alerted.

3. Confine the affected area

   Restrict access to the area involved in the emergency. Take steps to contain any spilled material. Mark the area with warning signs.

4. Clear the area of people not involved in the accident.

5. Summon aid.

7.10.3 Spill Kits

When working with unsealed sources, it is important to be prepared for the possibility of a spill of radioactive material. Users of such sources must maintain an appropriate spill kit in the laboratory. This kit should contain the following materials:

- Marker and tape – to mark the spill area
- Paper towels and absorbent pads - to contain and absorb liquids
- Box for sharps - to contain broken glass and needles
- Plastic bags – to contain contaminated non-sharp items and waste materials
- Tongs/forceps - safe handling of contaminated items
- Latex gloves – safe handling of contaminated items
- Decontamination solution – mild detergent or other solvent
- Scouring pad/scrub brush – for aggressive decontamination of surfaces

7.10.4 Fire or Explosion Involving Radioactive Material

In the event of a fire or explosion where radioactive material is known to be present, the Radiation Safety Officer must be notified immediately. Emergency personnel responding to the scene should be advised that radioactive materials may be present. Information on the location, amounts and any special precautions should be provided.

7.10.5 Loss or Disappearance of Radioactive Material

The loss or disappearance of any radioactive material must be immediately reported to the Radiation Safety Officer and license holder.

The Radiation Safety Officer will consult with the users and the permit holder to determine the exact amounts missing and conduct a preliminary investigation. The Radiation Safety Officer and the Chair of the Radiation Safety Committee will make the determination whether to report the incident to the police. Loss or theft of any quantity of radioactive material must be reported to the CNSC.

7.10.6 Significant Damage to a Sealed Source

If a sealed source is damaged to the extent that the encapsulation is compromised, the Radiation Safety Officer shall be notified immediately and the actions taken as detailed under radioactive spills (Section 7.10.7).

7.10.7 Spill of Radioactive Material

In the event of a spill of radioactive material it is important that immediate and proper steps be taken to prevent the spread of contamination.

Minor spills, which are contained within a fume hood or a small area, can usually be dealt with by laboratory personnel. Larger spills, particularly if radioactive material may become airborne may require assistance from the Radiation Safety Officer and/or other emergency personnel.

1. Do not panic. The most important immediate action is to notify others in the area that a spill has occurred and to prevent the spread of contamination without creating any additional hazards.

2. Isolate the area of the spill.

3. Wash hands in the event they were contaminated in the accident.

4. Use an appropriate detector to monitor hands and clothing. Remove and discard into radioactive waste any contaminated clothing.

5. Don a clean laboratory coat, properly buttoned up and 2 pairs of latex gloves before attempting cleanup.

6. Drop dry absorbent material on any wet spills.

7. Use water or an appropriate solvent to dampen dry materials.

8. Monitor and mark the extent of the contamination with tape and radiation warning signs.

9. Do not let anyone leave the contaminated area without checking hands, clothing and feet for radioactive contamination.

10. Begin decontamination procedures as soon as possible – any experiment or procedures in progress must be set aside until the contamination is cleaned up.

11. Collect sufficient spill cleanup materials and waste containers to properly clean the area in order to avoid leaving the area before the decontamination is completed.

12. Work inwards from the point of lowest contamination towards the highest contamination.

13. Remove and bag any absorbent material used to cleanup wet spills.

14. Gently wash the affected area with water and cleaning agent. Wash and rinse the affected area several times.

15. Treat all materials used for the decontamination as radioactive waste.

16. Monitor the area after each wash or rinse to check progress in decontamination. Monitoring can be done with a portable contamination meter, if it has sufficient sensitivity for the isotope spilled.

17. Continue washing and rinsing until contamination is removed or cannot be reduced any further.

18. After the decontamination has been completed, use a swipe test to check for the presence of any residual contamination. If the area is clean, record all results in the Contamination Monitoring Log for the room.

19. If the spill contained a gamma emitting radioisotope or a high energy beta emitter (e.g. P-32) survey the area for any residual fixed contamination with an appropriate survey meter.

20. If contamination remains in excess of the action levels, cover the area with an appropriate shielding material (e.g. Plexiglas), mark the area with radiation warning signs and notify the Radiation Safety Officer.

21. Notify the Radiation Safety Officer of the incident and the actions taken.

7.10.8 Radioactive Contamination of Clothing or Skin

If personnel are suspected of being contaminated with radioactive material:

1. Assess the location and extent of the contamination.

2. Use a survey meter appropriate for the isotope to locate the material and provide an assessment of the amount.

3. Remove any contaminated clothing and place in a plastic bag, labeled as to the contents and taped shut.

In Case of Serious Injury

1. The treatment of serious injuries takes precedence over any other consideration.

2. Provide assistance to injured person immediately, regardless of any radioactive contamination.

3. Contact Campus Security, requesting emergency medical assistance giving the location.

4. Advise Security of the radiation hazard, the isotope involved and any other pertinent information. Security will notify the Radiation Safety Officer.

5. Advise emergency response personnel of the radioactive material, the extent of the contamination, the chemical form of the material and other relevant information. Remain available for further consultation.

6. Notify the permit holder. Security will notify the Radiation Safety Officer.

In Case of Minor Wounds Requiring only First Aid

1. Treat immediately with first aid at or near the site of the accident.

2. Clean the affected area with swabs.

3. Wash the contaminated wound with warm water, encourage minor bleeding.

4. In the case of facial wounds, protect the mouth, eyes, ears and nose from contamination.

5. Wash wound with mild soap and water, repeating as necessary. Monitor for contamination with appropriate survey meter.

6. After decontamination, apply first aid dressing.

7. Notify the permit holder and the Radiation Safety Officer.

If the Skin is Intact

1. Flush contaminated skin area with copious amounts of warm water.

2. Wash any contaminated skin areas thoroughly with mild soap or detergent being careful not to abrade or damage the skin.

3. Wash for 2 to 3 minutes and rinse thoroughly, keeping rinse water confined to the contaminated area as much as possible.

4. Monitor effectiveness of removal with an appropriate contamination meter.

5. Continue washing and monitoring skin until contamination is removed.

6. If further washing does not remove the contamination, contact the Radiation Safety Officer.

7.10.9 Internal Contamination

If internal contamination is suspected, either through inhalation, ingestion, wounds, injection or absorption through intact skin treat for chemical toxicity first. Prompt medical attention should be sought.

If there is no serious injury, treat minor wounds with first aid, perform any decontamination of skin, and contact the Radiation Safety Officer and Campus Health Services.

7.10.10 Failure of an Interlock on a Radiation Emitting Device

Where a radiation emitting device requires an interlock the machine shall not be operated unless the interlock is functioning properly.

In any case of a failure of the interlocking device to operate properly, the machine shall not be operated and the Radiation Safety Officer shall be immediately notified.

The Radiation Safety Officer shall tag and lock out the machine so that it cannot be operated until the interlocking device is repaired by suitably qualified personnel.

Emergency procedures for specific radiation devices will be incorporated into the operating manuals and posted at the operating consoles for these devices.

7.11 Reports, Notifications and Records

The control of any hazard requires a system of monitoring, reporting and record-keeping. The radiation safety program therefore has built into it a system of routine and not-routine reporting and specifications for maintaining records.

When an event requires immediate reporting to the Canadian Nuclear Safety Commission, the University, through the Radiation Safety Officer or designate on the Radiation Safety Committee, has a requirement to immediately report such events to the CNSC Duty Officer.

Contact information for the CNSC Duty Officer: 613-995-0479

7.11.1 Annual Report to CNSC

Completion of an annual compliance report is a condition of the license issued by the Canadian Nuclear Safety Commission. The contents of this report are specified in the online forms for each license type on the CNSC website *Annual Compliance Reporting).*

The Radiation Safety Officer is responsible for maintaining the necessary records and preparing this annual report. The report will be reviewed by the Radiation Safety Committee and signed by the appropriate signing authorities before being sent to the CNSC.

7.11.2 Non-Routine Reports to the CNSC

A licensee is required to promptly report to the CNSC any of the following situations [*General Nuclear Safety and Control Regulations, Section 29*]:

- Any theft or loss of a nuclear substance, prescribed equipment or prescribed information;
- Any contravention of the Nuclear Safety and Control Act;
- The occurrence of an event that is likely to result in the exposure of persons to radiation in excess of the applicable radiation dose limits;
- A release, not authorized by the license, of a quantity of radioactive nuclear substance in the environment;
- A situation that requires the implementation of a contingency plan in accordance with the license;
- An attempted or actual breach of security or an attempted or actual act of sabotage at the site of the licensed activity;
- Information that reveals the incipient failure, abnormal degradation or weakening of any component or system at the site of the licensed activity, the failure of which could have a serious adverse effect on the environment or constitutes or is likely to constitute or contribute to a serious risk to the health and safety of persons or the maintenance of security;
- An actual, threatened or planned work disruption by workers;
- A serious illness or injury incurred or possibly incurred as a result of the licensed activity;
- The death of any person at a nuclear facility;

Reports are also required in the following circumstances:

- When an action level as specified in the radiation safety program and the license is exceeded [Radiation *Protection Regulations, Section 6*];
- When there is any change in the names and position titles of persons who are responsible for the management and control of the licensed activity; These individuals would include the “Signing Authority” and the Radiation Safety Officer. These individuals form part of the license and the CNSC must be notified of any change in personnel within 15 days.

The Radiation Safety Officer is responsible for preparing these reports for submission to the CNSC. Immediate reporting of these events is to the CNSC Duty Officer, 613-995-0479.

7.11.3 Records

The CNSC requires the following records be kept:

- A record of all information related to the license that is submitted to the CNSC [*General Regulations, Section 27*];
- A record of the name and job category of each “nuclear energy worker” [*Radiation Protection Regulations, Section 24*];
- A record of the external and internal radiation doses of each nuclear energy worker [*CNSC Act, Section 27; Radiation Protection Regulations, Section 5*].

For all nuclear substances the following records shall be kept [*Nuclear Substances and Devices Regulation, Section 36*]:

- The name, quantity, form and location of the nuclear substance;

- Where the substance is a sealed source, the model and serial number of the source;
- Where the substance is contained in a device, the model and serial number of the device;
- The quantity of the nuclear substance used;
- The manner in which the nuclear substance is used;
- A record of the name of each worker who uses or handles a nuclear substance;
- A record of the training received by each worker;
- A record of any inspection, measurement, test or servicing performed by the licensee in accordance with the Act, regulations made under the Act, or the license;
- A record of any transfer, receipt, disposal or abandonment of a nuclear substance; This record shall include the following:

    - The date of the transfer, receipt, disposal or abandonment;
    - The name and address of the supplier or recipient;
    - The number of the license of the recipient;
    - The name, quantity and form of the nuclear substance transferred, received, disposed of or abandoned;
    - Where the nuclear substance is a sealed source, the model and serial number of the source; and
    - Where the nuclear substance is contained in a device, the model and serial number of the device.

Training records shall be kept for at least three years after the termination of employment of the worker.

Records pertaining to the inspection, measurement, test or servicing performed in accordance with the Act, regulations and license shall be kept for at least three years after the expiry date of the last license.

Other records shall be kept for at least one year after the expiry of the license.

The CNSC must be notified of the date of disposal and the nature of the record at least 90 days before the date of the disposal.
[*Nuclear Substances and Devices Regulation, Section 36*]

The Radiation Safety Officer is responsible for maintaining these records.

8.0 X-RAY SAFETY

8.1 General Requirements

X-Ray machines are regulated by the province under the X-Ray Safety regulations under the Ontario Occupational Health and Safety Act. Enforcement is by the Ontario Ministry of Labour. Within the University, the use of X-Ray machines which fall under the X-Ray regulation, are subject to the authority and procedures of the Radiation Safety Committee.

The regulation applies to the following:

- an X-Ray machine
- an X-Ray source that is not licensable by the Canadian Nuclear Safety Commission and which is capable of producing an air kerma rate greater than 1.0 microgray per hour at any accessible point outside its surface.

The regulation does not apply to X-Ray sources licensed under the *Healing Arts Radiation Protection Act* which is used for the irradiation of humans.

X-ray machines must be registered with the Ministry of Labour and may not be installed or used in a permanent location until the Ministry has reviewed and approved the design of the facility. The University is responsible for ensuring that all X-Ray machines are registered and this registration process will be coordinated by the Radiation Safety Officer working in conjunction with the owner/user of the machine.

As a first step in this process, the owner/user shall apply for an X-Ray permit as outlined in Section 8.2.

The Radiation Safety Officer, in conjunction with the owner/user shall review the proposed installation and shall determine the appropriate regulatory requirements.

The Radiation Safety Officer shall coordinate the submission to the Ministry of Labour and upon the approval of the Ministry, the RSO shall issue an internal permit to operate the machine.

8.2 X-Ray Permits

An internal permit is required for the purchase, acquisition and use of an X-ray machine or an X-ray source which is not licensable under the Canadian Nuclear Safety and Control Act.

Prospective users must apply to the Radiation Safety Committee for a permit by completing the two Ministry of Labour forms (see Appendix 3):

Application for Registration
Application for Review of Permanent X-Ray Location

and forwarding them to the Radiation Safety Officer.

All rooms where X-ray devices are to be used must be approved by the Radiation Safety Committee. Such approval will be preceded by an inspection by the Radiation Safety Officer or designate to determine the appropriate shielding requirements and corrective actions may be required before the use of X-ray devices is permitted.

When the Committee has approved the application it will be forwarded to the Ministry of Labour for their approval.

Following Ministry of Labour approval, the Radiation Safety Committee will issue a permit and may attach any restrictions and conditions to the permit as the Committee deems appropriate. The Committee will also specify any training requirements for individuals having access to or operating the x-ray machine.

A permit is granted on the grounds that the permit holder is aware and responsible for the activities specified on the permit. The permit holder is responsible for overseeing all activities taking place under the permit and for providing appropriate supervision to other individuals working under the permit. If a permit holder is taking an extended leave such as a sabbatical where he/she will be unable to carry out this responsibility, arrangements must be made prior to taking such leave to either suspend the permit or to transfer the responsibility to another individual approved by the Radiation Safety Committee. Such arrangements will involve an amendment to the permit.

Once a permit has been issued, there may be no changes to the facilities and procedures specified on the permit without the approval of the Radiation Safety Committee. Changes to the permit are to be initiated by the permit holder using the form in Appendix 2.

Permitted locations will be subject to random inspections by the Radiation Safety Officer or designate. Infractions will be dealt with according to the Radiation Safety Committee procedure on enforcement.

A copy of the permit must be posted by the permit holder in each room listed on the permit.

The permit will contain the following information in the format shown in Figure 8.1

8.3 X-Ray Workers.

Within the University's Radiation Safety Program, an X-Ray worker is any person who may, as a result of their work, receive an effective dose in excess of 1 mSv per year.

The Radiation Safety Committee shall make the determination as to the designation of X-Ray workers based upon the design of each individual installation.

Where an individual is designated as X-Ray workers he/she shall:

- Be informed in writing that the individual is employed as an x-ray worker;
- Be informed of the appropriate dose limits, including those applicable to pregnant x-ray worker;
- Be given appropriate training in the risks of radiation, the protective measures to be taken and the procedures to be followed; and
- Be provided with an appropriate dosimeter.

The Radiation Safety Officer shall maintain a list of all x-ray workers.

‘

FIGURE 8.1

UNIVERSITY OF ONTARIO INSTUTUTE OF TECHNOLOGY
PERMIT FOR X-RAY MACHINE

SECTION 1

- Permit number
- Revision number of the permit
- Name and position of the responsible permit holder
- School or Faculty
- Building and room number covered by the permit
- Period for which the permit is valid

SECTION 2

- Listing of each x-ray machine in the room giving the manufacturer and serial number

SECTION 3

- Brief description of the purpose for which the machines will be used

SECTION 4

- Permit conditions specific to the permit
- Personal dosimetry requirements (if any)

SECTION 5

- The names of individuals authorized to operate the machine

SECTION 6

- Signature of Radiation Safety Officer
- Signature of Chair of Radiation Safety Committee
- Signature of Permit Holder
- Date of issuance of permit

8.4 System Design

All x-ray installations shall be designed and operated in accordance with the relevant provisions of Ontario regulation 861 – X-Ray Safety, made under the Occupational Health and Safety Act.

The design requirements shall be met before an x-ray permit is issued.

APPENDIX 1

APPLICATION FOR RADIOISOTOPE PERMIT

REQUEST FOR AMENDMENT TO RADIOISOTOPE PERMIT

INSTRUCTIONS FOR COMPLETING THE

RADIOISOTOPE PERMIT APPLICATION

Following these instructions when completing the application for an internal radioisotope permit will facilitate the review and approval of the application. Please type or print legibly. Missing, incomplete or illegible information will result in delays.

SECTION 1 – PERMIT HOLDER INFORMATION

Title or Position: Professor, Associate Professor, Assistant Professor, etc.

Laboratory Building and Room Number:

- Designate the building by its University name. E.g. Science Building (UA), ERC, etc.
- The room number(s) should be all rooms in which the radioactive sources will be stored and used. Radioactive materials may not be used or stored in rooms which do not appear on the permit.
- The Radiation Safety Officer needs to be able to contact the permit holder at all times. Please provide all possible contact numbers. This information will be held confidential; the only number which will appear on the permit is the University laboratory or room number where radioactive materials may be used or stored.

Please note that permits can only be issued for work within University buildings. If the source is to be transported or used outside the buildings, then special arrangements will need to be made. Please contact the Radiation Safety Officer well in advance of any such project.

SECTION 2 – RADIOISOTOPE WORK EXPERIENCE

- Please provide details of previous work locations and experience in working with radiation and/or radioisotopes.
- This information will be used by the Radiation Safety Committee to determine whether the applicant has the necessary knowledge and experience to hold an internal permit. It will also be used to determine the type and level of additional training which will be required.
- A CV may be attached to the application if the space on the application is insufficient.

SECTION 3 – SEALED SOURCES REQUIRED

- List each source requested separately, giving the activity of each source and a physical description of the source (e.g. 1” diameter disk).
- If the source is part of an instrument such as a liquid scintillation counter or a gas chromatograph give a description of the instrument – its manufacturer and model number – and the name and activity of the radioisotope used.

SECTION 4 – UNSEALED SOURCES REQUIRED

List the isotopes required, the normal activity which would be required in each order, and the anticipated rate of ordering sources (e.g. orders per month).

SECTION 5 – DESCRIPTION OF USAGE OF SOURCES

- Describe the usage of the sources, e.g. demonstration sources in undergraduate lab, check sources for instruments, calibration source in liquid scintillation counter, etc.

SECTION 6 – INSTRUMENTATION

List in this section the instrumentation available to measure the radiations from the source.

- Radiation survey meter means a portable instrument calibrated to measure radiation dose/dose rate. Any such instruments must, by law, be calibrated annually.
- Contamination meter means a portable instrument calibrated to read counts/minute for detecting surface contamination. Note here the probes available for the instrument for measuring different radiations (e.g. α, β, γ).
- If a liquid scintillation counter is available for measuring alpha and beta swipes, list it here giving the manufacturer and model number.
- List any other instrumentation available for measurement of radiations or contamination arising from the requested sources.

SECTION 7 – SIGNATURES

- The applicant must sign and date the application
- The Dean of the School or Faculty must sign the application

Forward the completed application to the Radiation Safety Officer.

RADIOISOTOPE PERMIT APPLICATION
UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY

1. PERMIT HOLDER INFORMATION

NAME: _____

TITLE/POSITION: _____

FACULTY: _____

LABORATORY BUILDING AND ROOM NUMBER: _____

OFFICE BUILDING AND ROOM NUMBER: _____

OFFICE TELEPHONE NUMBER: _____

EMAIL ADDRESS: _____

HOME TELEPHONE NUMBER: _____

OTHER TELEPHONE NUMBER(S): _____

_____

2. RADIOISOTOPE WORK EXPERIENCE

3. SEALED SOURCES REQUIRED

RADIOISOTOPE	SOURCE ACTIVITY	DESCRIPTION OF SOURCE OR DEVICE

4. UNSEALED SOURCES REQUIRED

RADOISOTOPE	SOURCE ACTIVITY	DELIVERY RATE (IF CONTINUING USE)

5. DESCRIPTION OF USAGE OF SOURCES/EXPERIMENTAL PROCEDURES

6. INSTRUMENTATION

SURVEY METER:

Manufacturer: _____

Model: _____

Serial Number: _____

CONTAMINATION METER:

Manufacturer: _____

Model: _____

Serial Number: _____

LIQUID SCINTILLATION COUNTER:

Manufacturer: _____

Model: _____

Serial Number: _____

OTHER RELEVANT INSTRUMENTATION

Type of Instrument: _____

Manufacturer: _____

Model: _____

Serial Number: _____

7. SIGNATURES

Applicant: _____

Date: _____

Dean of Faculty/School: _____
Print Name

_____
Signature

REQUEST FOR AMENDMENT TO A RADIOISOTOPE PERMIT
UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY

1. PERMIT HOLDER INFORMATION

Name of Permit Holder: _____

Faculty: _____

Permit Number: _____

Contact Telephone Number: _____

Contact Email Address: _____

2. NATURE OF CHANGE REQUESTED

Add Rooms ☐	**Delete Rooms** ☐
Add Radioisotopes ☐	**Remove Radioisotopes** ☐
Add new staff ☐	**Remove Staff** ☐

Other (describe)

_____

3. ADD/DELETE ROOMS

Rooms to be added to permit: _____
(Building and room numbers)

Usage of rooms: _____

Rooms to be deleted from permit: _____

Reason for deletion: _____

4. ADDITION OF NEW SEALED SOURCES

RADIOISOTOPE	SOURCE ACTIVITY	DESCRIPTION OF SOURCE OR DEVICE

DESCRIPTION OF USAGE OF SOURCES

5. REMOVAL OF EXISTING SOURCES

ISOTOPE	ACTIVITY	SOURCE ID #	REASON FOR REMOVAL

6. ADDITION OF NEW STAFF

NAME	TITLE/JOB FUNCTION	TELEPHONE/EMAIL

7. REMOVAL OF EXISTING STAFF

NAME	JOB TITLE/FUNCTION

8. OTHER CHANGES

LIST ANY OTHER CHANGES REQUESTED:

9. SIGNATURES

Permit Holder: _____

Date: _____

Dean of Faculty: _____
(Print Name)

_____
(Signature)

APPENDIX 2

APPLICATION FOR REGISTRATION OF AN X-RAY MACHINE

APPLICATION FOR REVIEW OF PERMANENT X-RAY LOCATION

Form 1 – Occupational Health and Safety Act

APPLICATION FOR REGISTRATION

Ontario Ministry of Lsbour	Radiation Protection Service	Registration No. …….

The undersigned, as employer ~ or as agent for the employer ~ applies for registration with the Radiation Protection Service of the Ministry of Labour.

A. The employer is:

Name …….. Telephone No …….

Business Address ……..

City ……. Postal Code ……

B. The person to whom correspondence should be addressed is as at "A" ~ ,
or is:

Name …… Telephone No ……..

Position or Title ……

Address ……

City …… Postal Code ……..

C. The general nature of he employer's business is (check one category only):

~ Industrial and Commercial
~ Veterinarian
~ Research and Development
~ Education and Training
~ Other (Please specify)…….

D. As of the date of this registration, the employer is in possession of the following X-ray sources at the locations indicated (for portable or mobile units indicate where normally stored):

MAKE	**MODEL**	**LOCATION (Room, Building, Street,City)**	**DATE INSTALLED**

Dated at ……, this …….. day of ……. 20…..

…… ……

Signature of Applicant Name (please type or print)

Form 2 – Occupational Health and Safety Act

APPLICATION FOR REVIEW OF PERMANENT X-RAY LOCATION

Ontario Ministry of Labour	Radiation Protection Service	Registration No. ……

PART A: GENERAL

The undersigned as: ☐ employer ☐ owner ☐ contractor ☐ architect ☐ engineer ☐ agent

applies for review of a permanent X-ray location. The application covers a total of ……. X-ray sources in …… rooms. It is accompanied by floor plans in duplicate and by one completed Part B for each X-ray source for which review is sought,

1. The name of the X-ray facility for which review is sought is

   ……

2. The employer is: ……...

   Name ……. Telephone No. ……..

   Number, Street ……..

   City …….. Postal Code …….

3 The employer's registration number is ……. OR The employer is not registered ~

4 This application is submitted for the following reason:

   ~ Opening of a new facility
   ~ Relocation of sources
   ~ Replacement of old sources in existing facilities
   ~ Additional sources
   ~ Acquisition of existing facility from:

   Previous owner's name …….. Registration No. …….

   ~ Change of shielding provisions, structure or safety devices
   ~ Compliance with inspector's direction

   Operation is expected to commence on the following date: ……. 20…..

5. The X-ray source(s) will be (or are at present) located as at 2 ~ , or at

   Number, Street ……

   City …… Postal Code ……

6. The person who exercises (or will exercise) direction over the safe use and operation of the X-ray source at the above location is the employer or is:

   Name …… Telephone No ……

   Position ……

   Relevant Qualifications ……

7. The drawings and specifications were prepared by:

   ~ employer ~ architect ~ other (specify) ……

   Name …….. Telephone No ……

   Number, Street ……

   City …… Postal Code …….

8. The information set out in this application and in each Part B accompanying this application is accurate to the best of my knowledge:
   Dated at ……., this …….. day of ……., 20…..

PART B: SPECIFIC

Please Note: one copy of Part B is required for each X-ray source for which review is sought.

1. This sheet refers to X-ray source number …… of ……

   X-ray sources located in the room designated as …… and so marked on the accompanying drawings.

2. This X-ray source is used for ……

   It is identified by:

   Make/Model …… Serial No. ……

   The following operating characteristics:

   (a) the maximum rated tube voltage is ……. kilovolts

   (b) the maximum rated tube current is ……. milliamperes

   (c) the anticipated maximum workload is ……milliampere-minutes per week

3. The composition of the boundaries of the room, including windows and doors, are (give material types and thicknesses):

   Floor ……

   Ceiling ……..

   Walls: North ……..

   East ……

   South ……

   West …….

Direction	Occupancy (See Note 1)		Usage Factor (see Note 2)
	Type	Percent	Percent
Down	……...	…….	…….
Up	…….	…….	…….
North	…….	…….	…….
East	…….	…….	…….
South	…….	…….	…….
West	…….	…….	…….

Note 1: Occupancy type is the nature of use of the area in the indicated direction relative to the X-ray source. (e.g. office, waiting room, parking lot, etc.). Occupancy percent is the fraction, expressed as a percentage, of the time the area will be occupied while the source is on (omit if unknown)

Note 2: The use factor is the fraction of the time the beam will be pointed in the direction indicated, as a percentage of the total time the source is on. For uncollimated, panoramic or multiple beams, the sum may exceed 100 percent.

The information given in this Part must correspond with that on the accompanying floor plans.

APPENDIX 3

APPLICATION TO CONDUCT INDUSTRIAL RADIOOGRAPHY

INSTRUCTIONS FOR COMPLETING THE PERMIT

Radiography sources of high energy and activity are used by contracted companies to estimate concrete thickness and imbedded piping prior to drilling in University buildings. The purpose of the internal radiography permit system is to identify the potential for exposure to radiation of staff and students, to ensure that appropriate safety measures are considered, to ensure that resultant doses are ALARA, and to ensure that staff and students are aware of the safe procedures to follow during such testing.

Furthermore, the internal permit system ensures that the radiography user and source are licensed or otherwise approved by the regulatory authorities.

This permit is valid only for the locations and time periods specified on the permit. This permit must be posted outside the space in which the radiography source is situated while the work is being conducted. If further testing is required outside the specified and approved time periods, a second permit for radiography must be requested and approval given.

Permits will be available from the University Radiation Safety Officer. The work must be authorized and approved by the Construction Project Manager or Building Property Manager. Following authorization by the project or property manager, the permit application must be signed by the radiographer and approved by the Radiation Safety Officer. All relevant documentation must be provided and attached to the permit. Copies of the permit must be kept on file for three years.

Any questions with respect to the radiography permit system or radiation safety should be directed to the University Radiation Safety Officer.

Outside working hours, the Radiation Safety Officer can be contacted through Campus Security at 905.721.8668 ext. 2400.

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY	**PERMIT TO CONDUCT RADIOGRAPHY**

This permit certifies that the radiography work has been reviewed and approved by the University Radiation Safety Officer and that appropriate precautions have been put in place to ensure the safety of staff and students.

This permit is valid only for the locations and times specified on the permit.

Any questions with respect to radiation safety should be directed to the University Radiation Safety Officer.

TO BE COMPLETED BY THE UNIVERSITY PROJECT MANAGER

Project Identifier: _____

Company performing Radiography: _____

Locations to be tested:

Building: _____

Rooms: _____

Date: _____

Time: _____

Relevant Staff and School/Faculty have been notified (circle): **YES** **NO**

Relevant Areas of Potential Exposure will be Closed: **YES** **NO**

Relevant Areas of Potential Exposure will be Posted: **YES** **NO**
(attach a copy of the warning sign)

Authorized by: _____
(Print name of project manager)

_____
(Signature of project manager)

Contact Telephone Number: _____

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY	**PERMIT TO CONDUCT RADIOGRAPHY**

TO BE COMPLETED BY THE RADIOGRAPHER

CNSC License Number: _____ **(attach a copy of the license)**

Radioactive Source: _____ **Activity:** _____

Collimated (circle one): **YES** **NO**

Direction of Beam (circle one): **UPWARDS** **DOWNWARDS** **OTHER**

If "OTHER" Identify: _____

Area (Rooms) of Potential Exposure: _____

Relevant Areas of Potential Exposure will be posted with warning signs: **YES** **NO**
(attach a copy of warning signs to be posted)

I have reviewed all information provided above and certify that it is correct:

Certified by:

Radiographer: _____
(print name)

_____
(signature)

TO BE COMPLETED BY THE RADIATION SAFETY OFFICER

Authorized by: _____
(Print Name)

_____
(Signature)

Date: _____

APPENDIX 4

PURCHASING PROCEDURES FOR RADIOACTIVE MATERIAL

PURCHASE REQUISITION FORM FOR RADIOACTIVE MATERIAL

PURCHASING PROCEDURES FOR RADIOACTIVE MATERIAL

Instructions for Permit Holders

1. All purchases of radioactive material must be made using a purchase order placed through the Faculty administrative assistant. University charge cards must not be used to purchase radioactive materials.
2. Only holders of a valid radioisotope permit issued by the University Radiation Safety Committee may purchase radioactive materials.
3. The permit holder must complete the form "Purchase Requisition for Radioactive Material" and submit it to the Radiation Safety Officer for Approval. The permit holder's signature must appear on the form.
4. When the form has been approved and signed by the Radiation Safety Officer, the permit holder may submit the form to the administrative assistant for processing along with any additional ordering information.
5. The permit holder will be notified by the Receiving Department when the material arrives and the permit holder shall pick up the material as soon as possible.
6. The permit holder shall notify the Radiation Safety Officer when the material is received.
7. The permit holder shall check the package for integrity and if damage to the source is suspected the radiation safety officer shall be immediately notified and he/she shall conduct such swipe testing as necessary to ensure that there has been no leakage.

Instructions for Administrative Staff

1. Administrative staff may not process the purchase order without a copy of the form "Purchase Requisition for Radioactive Material" signed by both the Radiation Safety Officer and the permit holder.
2. Administrative staff will enter the order into the Banner system with the "Ship to" address as follows:

   CONTROLLED SUBSTANCE
   DELIVER TO: UNIVERSITY OF ONTARIO INSTITUTE OF
   TECHNOLOGY **C/O PERMIT HOLDERS NAME**
   2000 SIMCOE STREET NORTH
   OSHAWA, ONTARIO
   RECEIVING DEPARTMENT

3. In the "Comments" section of the purchase order place the words

   RADIOACTIVE MATERIAL

4. Print and send a copy of the purchase order to the Radiation Safety Officer.

Instructions for Receiving Department

1. When a package containing radioactive material is received it should be immediately segregated and placed in a separate and secure location in a locked room or cabinet.
2. The purchaser should be immediately notified and requested to pick up the material.
3. If the package appears to be damaged, the purchaser shall be notified of this and requested to pick up the package immediately.
4. The purchaser must sign for receipt of the package.

PURCHASE REQUISITION FOR RADIOACTIVE MATERIAL

This form must be completed prior to each purchase of radioactive material. It must be reviewed and signed by the Radiation Safety Officer before any order is placed. It must also be completed for transfers of radioactive material from other institutions

Name of Purchaser: _____
(please print)

Radioisotope Permit Number: _____

Room Location in which sources will be stored and used:

_____

ISOTOPE	ACTIVITY (Bq)	PHYSICAL DESCRIPTION OF SOURCE	SUPPLIER

PERMIT HOLDER SIGNATURE

_____ _____
(signature) (date)

RADIATION SAFETY OFFICER AUTHORZATION

_____ _____
(signature) (date)

APPENDIX 5

NUCLEAR ENERGY WORKER NOTIFICATION AND DESIGNATION FORM

NOTIFICATION OF NUCLEAR ENERGY WORKER STATUS

In accordance with the *Nuclear Safety and Control Ac*t and *Regulations* this is to inform you that you are a NUCLEAR ENERGY WORKER within the meaning of the Nuclear Safety and Control Act.

The *Radiation Protection Regulations, section 10*, require that a Nuclear Energy Worker provide the following information to the holder of a license from the Canadian Nuclear Safety Commission:

(a) given names, surname and any previous surname;
(b) Social Insurance Number;
(c) sex;
(d) date, province, and country of birth; and
(e) dose record for the current one-year and five-year dosimetry periods.

This information is collected under the authority of the Nuclear Safety and Control Act and will be provided to the Canadian Nuclear Safety Commission, a licensed dosimetry service, and to the National Dose Registry.

Please provide the following information:

Name of Worker: _____ Sex: M □ F □

Previous Surname: (if applicable): _____ SIN Number: _____

Date of Birth: _____ Province and Country of Birth: _____

If you are currently being provided with a dose record in the current one-year or five-year dosimetry period from another facility or institution, please append a copy of your dose record to your Worker's Declaration.

NUCLEAR ENERGY WORKER (NEW) is defined in the Nuclear Safety and Control Act as a person who, is required, in the course of the person's business, or occupation in connection with a nuclear facility to perform duties in such circumstances that there is a reasonable probability that the person may receive a dose of radiation that is greater than the prescribed limit for the general public.

The radiation dose limits for Nuclear Energy Workers and the general public are specified in the *Radiation Protection Regulations, section 13, 14 and 15*. These limits are set outlined below.

Person	Period of Time	Effective Dose Limit[1] (mSv)
Nuclear Energy Worker, including a pregnant Nuclear Energy Worker	One year dosimetry period	50
	Five-year dosimetry periond	100
Pregnant Nuclear Energy Worker	The balance of the pregnancy	4
Any person who is not a Nuclear Energy Worker	One calendar year	1

Organ or Tissue	Person	Period of Time	Equivalent Dose Limit[1] (mSv)
Lens of an eye	Nuclear Energy Worker	One-year dosimetry period	150
	Any other person	One calendar year	15
Skin	Nuclear Energy Worker	One-year dosimetry period	500
	Any other person	One calendar year	50
Hands and Feet	Nuclear Energy Worker	One-year dosimetry period	500
	Any other person	One calendar year	50
[1] During the control of an emergency and the consequent immediate and urgent remedial work, the Effective and Equivalent Dose may exceed the limits prescribed above, but not exceeding an effective dose of 500 mSv and an equivalent dose of 5000 mSv received by the skin.			

The dose limits set out above are from all sources from which a dose record is maintained. Accordingly, if UOIT staff or students perform work at another institution, where that institution provides radiation dosimetry, the Nuclear Energy Worker shall so inform the UOIT Radiation Safety Officer, and provide a record of that dose to the Radiation Safety Officer. The Radiation Safety Officer at UOIT may if necessary, take steps, such as reducing the permitted dose limit at UOIT to ensure that the legal dose limits are not exceeded.

The *Radiation Protection Regulations* also require that any nuclear energy worker, who becomes aware that she is pregnant, immediately inform the holder of a license in writing. This notification is to be made to the immediate supervisor and to the Radiation Safety Officer. Upon such notification, the Radiation Safety Officer, the supervisor, and the worker shall review the work being performed and taken any necessary steps to ensure that the dose limits for the balance of the pregnancy are not exceeded.

NUCLEAR ENEREGY WORKER DECLARATION

As required by the *Radiation Protection Regulations*, I have been informed in writing of:

(a) the risks associated with radiation to which I may be exposed during the course of my work, including the risk associated with exposure of an embryo and foetus;
(b) the applicable dose limits as specified by the regulations;
(c) my expected radiation dose levels;
(d) for females, my rights and obligations should I become pregnant.

Further, if performing radiation work at both UOIT and another institution, I shall inform the UOIT Radiation Safety Officer, in writing of such work and provide to the Radiation Safety Officer a copy of the dose record from that institution.

I understand the risks, my obligations, and the radiation dose limits and levels that are associated with being designated a Nuclear Energy Worker.

Name of Worker: _____
(please print)

Signature of Worker: _____

Name of Radiation Safety Officer: _____

Signature of Radiation Safety Officer: _____

APPENDIX 6

LABORATORY DESIGN COMPLIANCE CHECKLIST

Date: _____

Permit Holder: _____

Permit Number: _____

Building/Room Number: _____

Laboratory Type: ☐ **Basic** ☐ **Intermediate**

Description of work to be carried out in the laboratory: _____

_____

_____

The following inspection items are based on CNSC Regulatory *Document R-52, Design Guide for Basic and Intermediate Level Radioisotope Laboratories (June 7, 1991) and* RD-52, *Design Guide for Nuclear Substance Laboratories and Nuclear Medicine Rooms* (May, 2010).

B = Required for Basic level laboratory
R = Recommended for Basic level laboratory; Required for Intermediate level laboratory
I = Required for Intermediate level laboratory
NR = not recommended

Ventilation				
	Designation	**Yes**	**No**	**Comments**
Radioactive aerosols or gases are likely to be produced in the laboratory	-			
Laboratory will be at negative pressure with respect to surrounding areas	**R**			
A glove box will be installed (if yes, submit details)	-			
A fume hood will be installed	-			

Fume Hood				
	Designation	**Yes**	**No**	**Comments**
All air from the laboratory will be vented through the fume hood	**R**			

Fume Hood				
	Designation	**Yes**	**No**	**Comments**
Air vented through the fume hood will be vented without recirculation	**B, I**			
The fume hood will be constructed of smooth, impervious, washable and chemical-resistant material	**B, I**			
Consideration has been given to the weight of shielding that must be supported by the working surface of the fume hood	**R**			
The working surface of the fume hood will have slightly raised edges	**R**			
The linear face velocity of the fume hood will be between 0.5 and 1.0 metres/second	**B, I**			
Before radioactive material is used in the fume hood, the fume hood will be tested to verify the flow rate and the absence of counter-currents	**B, I**			
The fume hood will be located near any entrance to the laboratory	**NR**			
A readily visible flow-measuring device will be included on the face of the fume hood	**R**			
There will be an automatic after-hours shutdown system. If yes, is there to be an override provision?	**-**			
The fume hood exhaust will be filtered. If yes, give details of filtration.	**-**			
Fume hood filters will be monitored for radioactive contamination before disposal	**B, I**			
The fume hood exhaust duct will be constructed of corrosion-resistant material	**B, I**			
All joints in the exhaust duct will be smoothly finished and sealed.	**B, I**			
The fume hood exhaust duct will connect with other exhaust systems. If yes provide details	**NR**			

Fume Hood				
	Designation	**Yes**	**No**	**Comments**
The fume hood exhaust duct will be marked at 3-metre intervals with radiation warning symbols.	**R**			
The fume hood exhaust duct will have horizontal sections. If yes, provide details.	**NR**			
The fume hood exhaust fan will be placed close to the discharge point.	**B, I**			
The fume hood fan motor will be mounted outside the exhaust duct.	**R**			
Exhaust stack height will ensure acceptable dilution, dispersion, and elimination of unacceptable re-entry through building openings.	**B, I**			
Exhaust ducts from fume hoods in radioisotope laboratories will be identified on plans supplied to maintenance personnel	**B, I**			

Finishing and Fixtures				
	Designation	**Yes**	**No**	**Comments**
Flooring will have an impervious surface with a strippable coating	**B, I**			
All joints in the flooring material will be sealed	**B, I**			
Walls and ceilings will have smooth, impervious and washable finishes.	**R**			
Counter surfaces will have a smooth, impervious, washable and chemical-resistant finish.	**B, I**			
All joints on counters will be sealed	**B, I**			
Cupboards and shelving will have smooth, impervious chemical-resistant and washable finishes.	**R**			
Light fixtures will be easy to clean.	**R**			
Light fixtures will be enclosed.	**R**			
Sinks will be made of a material that is readily decontaminated.	**B, I**			
Sinks will have overflow outlets.	**R**			

Finishing and Fixtures				
	Designation	**Yes**	**No**	**Comments**
Taps will be operable by means not requiring direct hand contact.	**R**			
An emergency eye-wash will be installed	**I**			
An emergency shower will be provided.	**R**			
Patient washrooms will be finished in materials that are easily decontaminated.	**B, I**			

Plumbing				
	Designation	**Yes**	**No**	**Comments**
Faucets with vacuum or cooling line attachments will have back-flow protection devices.	**R**			
The drain from the laboratory will go directly to the main building sewer.	**R**			
The drain will connect with drains other than the main building sewer. If yes, provide details.	-			
The drain line will be marked at 3-metre intervals with radiation warning symbols.	**R**			
Sink traps will be accessible for monitoring.	**R**			
Chemical resistance of the drains has been considered.	**B, I**			
Drains from radioisotope laboratories will be identified on plans supplied to maintenance personnel.	**B, I**			

Storage				
	Designation	**Yes**	**No**	**Comments**
Wastes will be stored in the laboratory.	**NR**			
An area to store waste outside the laboratory will be provided.	**R**			

Storage				
	Designation	**Yes**	**No**	**Comments**
Materials that may give rise to radioactive aerosols or gases will be stored in an appropriately vented area.	**B, I**			
Appropriate shielding will be provided for storage locations.	**B, I**			

Security				
	Designation	**Yes**	**No**	**Comments**
The basic laboratory will be provided with a lockable storage area or lockable doors.	**B**			
The intermediate laboratory will be provided with a good lock on each door.	**I**			
A lockable storage area will be provided in the intermediate laboratory.	**R**			
The laboratory windows on the ground floor will prevent access.	**B, I**			

Miscellaneous				
	Designation	**Yes**	**No**	**Comments**
Provisions will be made for hanging up potentially contaminated laboratory clothing within the laboratory	**R**			
Provision will be made for an appropriate radiation monitoring device to be installed in the laboratory.	**R**			
Food or beverage preparation facilities will be excluded from the laboratory.	**B, I**			
Desks and/or study facilities will be located in the laboratory.	**NR**			
Provision will be made for emergency lighting in the laboratory.	**R**			

Additional Comments: _____

_____

_____

_____

Internal Review and Approvals		
Approved as:	**With Fume Hood**	**Without Fume Hood**
Basic laboratory	~	~
Intermediate Laboratory	~	~

Name/Title	Signature	Date
Tanya Neretljak **Radiation Safety Officer**		
Facilities Management		
Chair, Radiation Safety Committee		

RADIOISOTOPE QUANTITY LIMITS FOR DESIGNATED LABORATORIES

CLASSIFICATION	RADIOISOTOPE QUANTITY LIMIT
Storage Room	• Storage of sealed or unsealed substances; quantity limit specified on license.
Basic Level	• Use of an unsealed nuclear substance greater than one “exemption quantity”. • The quantity of unsealed nuclear substance used at a single time does not exceed 5 times its corresponding annual limit on intake (ALI).
Intermediate Level	• The quantity of unsealed nuclear substance used at a single time does not exceed 50 times its • corresponding ALI.
High Level	• The quantity of unsealed nuclear substance used at a single time does not exceed 500 times its ALI.
Containment Level	• The quantity of unsealed nuclear substance used at a single time exceeds 500 times its corresponding ALI.

APPENDIX 7

OPEN SOURCE INVENTORY FORM

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY

OPEN SOURCE RADIOISOTOPE INVENTORY RECORD

Permit Number: _____

Requisition Number: _____ Lot Number: _____

Radioisotope: _____ Chemical Form: _____

Total Activity: _____ Total Volume: _____

Received by: _____ Date Received: _____

Checked on receipt? _____ Stored in Room No: _____

Date Used	Amount Used	Amount Remaining	User's Name

Final Date of Disposal: _____

Inventory records must be retained for 3 years following the disposal of the radioactive material.

APPENDIX 8

RADIOISOTOPE CONTAMINATION MONITORING PROCEDURES AND MONITORING LOG

The following procedures are applicable to the use of open or unsealed radioactive sources. All facilities using open sources must be monitored for contamination immediately after completion of any manipulation or use. A radioisotope monitoring log must be kept in the laboratory and an entry made in the log at least weekly. If no use of radioisotopes has occurred during a week then an entry must be made in the log to this effect.

The monitoring log must be kept in the laboratory such as to be accessible to all persons in the lab.

General procedure for maintaining the Contamination Log

1. Prepare a sketch of each room listed on the permit indicating the locations where radioactive material is stored or used. Refrigerators, active benches, sinks, fume hoods and equipment where radioactive material is stored or used should be indicated and numbered for reference purposes. Numbers should also be assigned to areas of the floor around the locations. There should be a minimum of four (4) monitoring locations including the floor in areas where radioactive material is handled on a bench top or in a fume hood. The RSO may be consulted in determining the locations.

2. Maintain the sketch and the monitoring log sheet in a log book which is stored in a location of the laboratory accessible to workers and to the RSO for inspection purposes.

Swipe Test Procedure

1. Swipe testing is the only acceptable method of contamination monitoring for low energy pure beta emitters such as H-3, C-14, S-35, P-33.

2. Swipe an area 10cm x 10cm and place the swipe in a liquid scintillation counting vial.

3. Add the appropriate LSC solvent, count in a liquid scintillation counter and record the results in the contamination log. Your printout will indicate the counts per sample. You must calculate the activity in Bq/cm^2 of the swiped sample and compare it to the action level. If the results are less than the action level, record the results as “no contamination found”. Keep the LSC printout in the log as a primary record.

Procedure using a survey meter

1. For high energy beta emitters and gamma emitters, monitoring may be done with a suitable calibrated contamination meter. The meter must be approved and calibrated by the Radiation Safety Officer. The calibration will provide an “action level” in counts per minute for the isotope(s) for which it is to be used. Otherwise, the activity must be calculated by converting the counts to activity in Bq/cm^2 and compared to the action levels indicated for surface contamination (section 7.3.2, Table 7.1).

2. Determine the background count rate at a surface that is known to be clean.

3. For surfaces where radioisotopes are known to have been used or contamination is suspected, place the probe as close to the surface as possible without touching the surface.

4. If the readings are less than the action level for contamination this finding is to be noted in the contamination control log as “no contamination found”.

5. If radioactivity is detected in the work area, it may be due to radiation sources and not due to contamination. If it is not feasible to remove the sources, then swipes must be taken.

6. Note that survey meters measure the sum of removable and fixed surface contamination. If readings are observed which exceed the action level, swipes may need to be taken to differentiate between removable and fixed contamination.

Procedure when action level exceeded

1. If the contamination result is greater than the action level, the area must be decontaminated.

2. If contamination is detected on the floor it must be cleaned immediately and the shoes of all persons in the laboratory checked for contamination.

3. If contamination is detected on the bench covering, remove it to the radioactive waste and monitor the surface under it for contamination. If contamination is still present, clean the area.

4. Clean all areas where contamination is detected until no contamination is detectable. If contamination remains, the contamination can be covered with a suitable shielding material, and marked with radiation warning signs. The contamination levels both before and after decontamination should be recorded in the log book. Post the contamination level at the location and inform the RSO.

Procedure for converting counts to activity

1. Measuring the counting efficiency of your detector
    a. Determine a background count rate at a surface known to be ‘clean’ or with no sources present
    b. Using a standard source with known activity, count the rate of the standard source for approximately 1 min
    c. Calculate the detector efficiency

$$\text{Detector Efficiency} = \frac{\text{Detector Count Rate} - \text{Background Count Rate}}{\text{Known activity of the standard source}}$$

2. Determining surface contamination
    a. For Direct monitoring using a meter, determine the activity of the contaminated area by calculating the quotient of your net counts over the efficiency of your detector, the time of measurement and the sample size
    b. For indirect monitoring, you must also take into account the swipe removal efficiency (typically 10% removal efficiency is used)

$$A\ (\text{Bq/sample}) = \frac{\text{Net counts (cpm)}}{\text{Detector Efficiency} * \text{sampling time (s)} * \text{sample size}}$$

PERMIT HOLDER: _____ **PERMIT #** _____ **BUILDING/ROOM** _____

INSTRUMENT USED: _____ **UNITS (circle one) cpm cps Bq.cm^{-2}**

Monitoring Locations: **1.** _____ **2.** _____ **3.** _____
4. _____ **5.** _____ **6.** _____
7. _____ **8.** _____ **9.** _____
10. _____ **11.** _____ **12.** _____

BG	1	2	3	4	5	6	7	8	9	10	11	12	DATE (M/D/Y)	SURVEYOR INITIALS

BG = Background

INSTRUMENT MDA: _____ **(from instrument calibration sticker)**

DATE OF CALIBRATION: _____ **(must be within the last 12 months; contact Radiation Safety Officer for calibration)**

APPENDIX 9

RADIOACTIVE WASTE LOG

UNIVERSITY OF ONTARIO INSTITUTE OF TECHNOLOGY

RADIOACTIVE WASTE INVENTORY RECORD

Container Number: _____ **Permit Number:** _____

Type of Waste _____ **Isotope:** _____

Date	Volume Added	Activity Added	Signature

Date Filled: _____ **Total Activity:** _____

Signature: _____ **RSO:** _____

APPENDIX 10

RADIATION DETECTION INSTRUMENTATION AVAILABLE AT UOIT

A representative set of the radiation detection instrumentation currently available at UOIT is given in the table below. Dose, dose rate, and α, β, and γ contamination can all be measured as well as there being instrument redundancy.

RADIATION DETECTION INSTRUMENTATION

Type	Model	Manufacturer	Energy Range	Dose rate Range	Particle
Survey & Contamination w/ FHZ731 probe	FH40G	Eberline	45 keV – 1.3 MeV	0.1 uSv/hr – 0.99 Sv/hr	γ
	FHZ731	Eberline	α,β DL < 0.5,0.05 Bq/cm^2		α,β,γ
Survey & Contamination	Model 5000	HP Instruments	> 6 keV γ	Background to 10 mSv/hr	α,β,γ
Survey (contamination with probes)	RDS-110	RADOS	50 keV – 1.25 MeV	0.05 uSv/hr – 100 mSv/hr	γ
Survey & Contamination	Rad Alert Inspector	SE International	10 keV – 1.25 MeV	0.01 uSv/hr to 1000 uSv/hr	α,β,γ
Contamination	LB-122	Berthold	Isotope dependant		α,β,γ
Survey w/ 42-41L probe	2363	Ludlum	thermal to 100 MeV		γ,n

A number of radiation detection instruments (contamination and survey) are available at UOIT. All instruments to be used for license-related radiation detection will be properly calibrated by an independent and licensed calibration facility, according to regulatory requirements. Survey meters will be calibrated annually. The calibration information (date & facility) will be posted on a sticker directly on the instrument. Instruments should be operated in accordance with the manufacturer instructions, and all manuals must be kept in a convenient location near the instruments.

All radiation detection instruments at UOIT are to undergo checks prior to use. The check ensures that each meter is working properly prior to determining background, detection limits and performing a survey. To perform a check on any survey meter, the meter is:

Turned on;

Battery level is checked, and
High Voltage is checked (if appropriate).

The instrument is then placed in the vicinity of an appropriate radioactive source in a reproducible manner (i.e. alpha emitter on contact to alpha probe, etc.). The instrument reading is recorded, and the instrument is considered to have passed the test if a reading above the ambient background is registered and consistent with other available results of checks for that instrument.

When applicable, daily checks are performed at the beginning and end of each work day, and whenever a user believes, for whatever reason, the meter may be working improperly. The results of placing the instrument near a fixed check source at the beginning and end of each day, to track the instrument response over time, must be recorded. This will allow the user to determine if an instrument is operating out of specification, and allow determination of instrument drift.

If an instrument fails the initial daily check, it will not be used for surveying until inspected further. Critical areas to check are typically the condition of the batteries, the probe surfaces, and the high voltage and signal cables. If the meter cannot be repaired in the field, it will be taken out of service and sent to a repair and calibration facility. The Permit Holder must be made aware that there has been an instrument failure. A replacement instrument must be provided, or radiation work discontinued until the instrument is replaced.

If an instrument fails the end of day check, some or all of the data taken with the instrument may have to be discarded, and re-surveying the affected areas must be performed. The Permit Holder must be made aware that there has been an instrument failure.

APPENDIX 11

EXEMPTION QUANTITIES

Exemption quantities of individual radioisotopes are defined by the CNSC in the *Nuclear Substances and Radiation Devices Regulations*. Exemption quantities of selected radioisotopes in common use are reproduced below. For isotopes not listed, consult the Radiation Safety Officer.

Isotope	EQ (Bq)	EQ (µCi)		Isotope	EQ (Bq)	EQ (µCi)
H-3	1×10^9	2.7×10^4		Sr-89 *	1×10^6	27
C-14 *	1×10^7	270		Sr-90	1×10^4	0.27
Na-22 *	1×10^6	27		Y-90 *	1×10^5	2.7
P-32 *	1×10^5	2.7		Zr-95 *	1×10^6	27
P-33 *	1×10^8	2700		Tc-99m	1×10^7	270
S-35	1×10^8	2700		Cd-109	1×10^6	27
Ca-45 *	1×10^7	270		Cs-137	1×10^4	0.27
Cr-51 *	1×10^7	270		Ba-133	1×10^5	2.7
Mn-54 *	1×10^6	27		Pm-147	1×10^7	270
Fe-55	1×10^6	27		Hg-203	1×10^5	2.7
Fe-59 *	1×10^6	27		Tl-204	1×10^4	0.27
Co-56	1×10^5	2.7		Po-210	1×10^4	0.27
Co-57 *	1×10^6	27		Ra-226	1×10^4	0.27
Co-60	1×10^5	2.7		Th-230 *	1×10^4	0.27
Ni-63 *	1×10^8	2700		Th-232 *	1×10^4	0.27
Zn-65	1×10^6	27		U (natural) *	1×10^3	0.027
Sr-85 *	1×10^6	27		U-238 *	1×10^4	0.27

ND = non-dispersable form
D = dispersable form

* Revised: July, 2014

APPENDIX 12

RADIOACTIVE MATERIAL PACKAGING AND LABELING

When an order is placed for radioactive material, the supplier is responsible for proper packaging of the material. Essentially all orders placed by and delivered to the University will be delivered as either an “Excepted Package” or a “Type A” package. These packages would normally consist of a sturdy cardboard box.

The type of package is determined by the activity inside the package, the label on the package is determined by the radiation hazard outside the package.

TYPES OF PACKAGE

1. Excepted Packages

Excepted packages contain very low levels of radioactive material and they are exempt from most of the requirements of the Transportation of Dangerous Goods regulations. The IAEA regulations provide detailed criteria for determining the type and amount of material that may be shipped as an excepted package.

Excepted packages need not be marked on the outside as containing radioactive material, they must, however, be accompanied by a shipping document which includes the shipping name and UN number of the radioactive materials.

For excepted packages there are only four (4) acceptable shipping names and UN Numbers.

UN 2910 – RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – LIMITED QUANTITY OF MATERIAL

UN 2911 – RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – INSTRUMENTS OR ARTICLES

UN 2909 – RADIOACTIVE MATERIAL, EXCEPTED PACKAGE - ARTICLES MANUFACTURED FROM NATURAL URANIUM or DEPLETED URANIUM or NATURAL THORIUM

UN 2908 – RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – EMPTY PACKAGING

The package must be marked on the outside with the following information

1. The name and address of the consignor or consignee or both
2. A UN number indicating the nature of the contents. (It may also have the shipping name but this is not mandatory)
3. The gross mass of the package if it exceeds 50 kg.

Excepted packages must have the marking “RADIOACTIVE” on an internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package.

2. Type A Packages

Type A packages contain higher levels of radioactive material than an excepted package. Limits on the amount of radioactive material that may be shipped in a Type A package are specified in the IAEA regulations.

PACKAGE LABELING

Labeling requirements are specified in the IAEA regulations. All packages with the exception of "excepted packages" must be labeled according to these regulations. Any package must bear two labels on opposite sides of the package exterior. The type of label depends on the radiation level outside the package.

The Transport Index relates to the radiation field at 1 m from the package and is derived by measuring the radiation field at 1 m from the package in units of μSv/hr and dividing that number by 10.

Category I – WHITE **Maximum radiation level at any point on the surface of the package ≤ 5 μSv/hr** **List isotope (s) and activity** **There is no transport index for this category**	

Category II - YELLOW **Maximum radiation field at any location on external surface of the package > 5 μSv/h and ≤ 500 μ Sv/h** **Transport index ≤ 1.0** **Radiation field at 1 m from the package is < 10 μSv/hr**	

Category III - YELLOW **Maximum radiation field at any location on the external surface of the package is > 500 µSv/hr and ≤ 2 mSv/hr** **Transport index > 1.0 and ≤ 10.0** **Radiation field at 1 m from the package < 100 µ Sv/hr**	

Procedures for Receiving Packages of Radioactive Material

1. All radioactive material should be picked up from receiving by the permit holder or designate who has received appropriate radiation safety training and taken to the laboratory as soon as possible

2. The package should only be opened in a designated and permitted laboratory.

3. Wear appropriate protective clothing. For unsealed sources wear laboratory coat and gloves. Inspect the package for any signs of damage or leakage of the contents. If there is suspected leakage place the package in a plastic bag and notify the Radiation Safety Officer immediately.

4. Verify that the label on the package indicates the correct isotope, activity and labeled material.

5. Where a transport index is indicated on the package label, measure the dose rates and verify that they conform to the transport index.

   - White I: < 5 $\mu Sv.h^{-1}$ on contact with the package
   - Yellow II: > 5 $\mu Sv.h^{-1}$ and < 500 $\mu Sv.h^{-1}$ on contact
   - Yellow III: > 500 $\mu Sv.h^{-1}$ and < 2mSv.h-1

   If the dose rates exceed the prescribed limits contact the Radiation Safety Officer.

6. Carefully open the package and verify the isotope, activity and labeled compound against the order and the packing slip. If the contents are volatile open the package in a fume hood.

7. If there is any reason to suspect leakage of the material, swipe test the inner containers and notify the Radiation Safety Officer if any contamination is found.

8. Check gloves for any contamination.

9. Store the radioactive material according to the requirements of the manufacturer.

10. Remove gloves and wash hands after handling the material. Re-check hands and clothing for any contamination.

11. Log the appropriate source information in the laboratory inventory record.

12. Sign the Packing Slip acknowledging receipt and send a copy of the packing slip to the Radiation Safety Officer.

13. If no contamination is found on the packaging material, the warning labels must be removed or defaced to remove any reference to radioactive material. The packaging material may then be disposed of as regular waste. Contaminated packaging should be sealed in a plastic bag and the Radiation Safety Officer contacted for disposal.

14. 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, and contact the Radiation Safety Officer.