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**TELEPHONE NUMBERS**

## I. RADIATION ACCIDENTS

**Radiation Safety Officer:**

Debra MacDonald 566-0835

**Deputy Radiation Safety Officer (VTH):**

Nancy Hogan 628 4383

## II. RADIATION POLICY, LICENSING INFORMATION

**Canadian Nuclear Safety Commission**

Ottawa Office Duty Office **1-844 879 0805**

## III. EMERGENCY NUMBERS

**Fire and Accidents/Injuries:**

UPEI Security 566-0384
911 9-911

## IV. HOUSEKEEPING 566-0471

## V. RADIATION SAFETY OFFICE

Room 2337N Atlantic Veterinary College

## INTRODUCTION

Basic policies and procedures are set forth in this manual for the safe use and handling of radioisotopes in the research, diagnostic and teaching activities of UPEI. They are intended to clarify but not to supplant the codes and regulations of the Canadian Nuclear Safety Commission (CNSC) or the recommendations of the International Commission on Radiological Protection (ICRP).

This manual covers only the use of radioisotopes, with limited reference to radiation-emitting devices.

## I. RADIATION SAFETY - ADMINISTRATION

### U.P.E.I. Radiation Safety Committee

The President of the University of Prince Edward Island is the administrative representative authorized to sign applications for licensing on behalf of the University.

The University Radiation Safety Officer is the contact person for licensing concerns.

The Committee is appointed by the President with authority to implement and enforce the radiation safety program encompassing the University's ordering, usage, handling, monitoring, storage, and disposal of radioactive materials.

Other members of the Committee include:

Radiation Safety Officer
Representative of each department using radioactive material
Union or staff representative

Responsibilities

(1) to ensure that all persons involved in the handling of radioisotopes have adequate training and experience to enable them to perform their duties safely and in accordance with the licensee's radiation safety program and CNSC requirements;

(2) to ensure that appropriate equipment and facilities exist and are in compliance with CNSC regulatory requirements;

(3) to ensure that there are sufficient resources allocated to the radiation safety program;

(4) to ensure that the doses of ionizing radiation received by any person involved with the use of radioisotopes do not exceed the limits specified in the *Nuclear Safety and Control Act* and be kept as low as reasonably achievable (ALARA principle).

(5) to grant approval for use of radioisotopes to users only if the use will comply with all regulatory, environmental and institutional requirements and ultimately deny the use of radioactive materials given sufficient cause.

Duties

The Radiation Safety Committee shall:

(1) establish and review the training and experience requirements for users of radioactive materials to ensure that they are able to perform their duties safely and in accordance with regulatory requirements;

(2) maintain a program to ensure that all persons, whose duties may require them to work in the vicinity of radioactive material, are properly instructed;

(3) designate any person to be considered as an atomic radiation worker under the *Nuclear Safety and Control Act;*

(4) be available for consultation on problems dealing with radioactive materials and radiation hazards;

(5) review and authorize, if appropriate, all requests for the use of radioactive material within the institution by issuing user permits;

(6) receive reports from the Radiation Safety Officer and recommend remedial action to correct any deficiencies;

(7) maintain written records of all meetings, actions, incidents or unusual occurrences, recommendations and decisions, and supply the CNSC with a copy of these, as well as an annual report as outlined in CNSC Regulatory Document R-80;

(8) advise the institution's administration of the resources necessary to set up and maintain an adequate radiation safety program which will incorporate the ALARA principle;

(9) approve designs for new laboratories in accordance with CNSC Regulatory Document R-52 (Revision 1);

(10) Meet at least once per year.

**Radiation Safety Officer (RSO)**

The Radiation Safety Officer is an officer of the University appointed by the University Radiation Safety Committee and administratively responsible to the Committee. The RSO shall have both theoretical and practical experience in radiation protection.

Responsibilities

The Radiation Safety Officer shall administer the consolidated licence issued to the University by the CNSC by overseeing and coordinating all aspects of radiation safety within the institution.

Duties with Respect to the University

The Radiation Safety Officer shall:

(1) act as the agent of the institution with respect to licensing matters;
(2) be available to radioisotope users effectively on a full-time basis;
(3) establish, implement and maintain a radiation safety control and assessment program in conjunction with the Radiation Safety Committee;
(4) systematically and periodically review survey programs for radiation and contamination levels in all areas where radioactive materials are used, stored or disposed of;
(5) implement a personnel monitoring program including bioassays, when applicable;
(6) ensure radiation safety instruments are available in sufficient number, and are calibrated and serviced as required;
(7) conduct a quarterly review of occupational radiation exposures and recommend ways of reducing exposures in the interest of the ALARA principle;
(8) supervise decontamination procedures;
(9) provide waste disposal procedures in accordance with conditions of the radioisotope licence;
(10) ensure necessary leak testing of sealed sources is performed;
(11) control the purchasing, use and disposal of radioactive materials via enforcement of conditions of user permits;
(12) provide appropriate radiation protection training on a regular basis as part of an ongoing "radiation protection awareness program" for all users and for those who occasionally come into contact with radioactive materials (i.e. cleaning staff, maintenance staff);
(13) maintain required records;
(14) ensure that each user permit is amended when necessitated by changes to facilities, equipment, policies, isotopes, conditions of use, procedures or personnel;
(15) coordinate the development of plans to be used in the case of an emergency involving radioactive materials;
(16) investigate all overexposures, accidents and losses of radioactive materials and report to the CNSC, when necessary; and
(17) act as liaison with radioisotope users to ensure that the doses of radiation are consistent with the ALARA principle.

Duties with Respect to the Radiation Safety Committee

The Radiation Safety Officer shall:

(1) function as the link between the Radiation Safety Committee and radioisotope users within the institution;
(2) prepare, or review in consultation with the Radiation Safety Committee, a comprehensive radiation safety manual;
(3) have a major input in matters pertaining to:
    (a) facility and equipment design;
    (b) work practices and procedures;
    (c) waste storage and disposal management;
    (d) evaluation, issuance and enforcement of user permits;
    (e) disciplinary action necessitated by non-compliance; and
    (f) radiation safety training.
(4) prepare, in consultation with the Radiation Safety Committee, an annual report to the CNSC as required by Regulatory Document R-80.

**Deputy Radiation Safety Officer**

The deputy RSO shall work in concert with and under the direct supervision of the RSO. In the absence of the RSO, the deputy RSO will be the acting RSO.

**Radioisotope User Permit Holders**

User Permit holders are those individuals issued an internal permit from the University Radiation Safety Committee for the purchase and possession of radioactive material.

Responsibilities

1. Ensuring that the conditions stated in the permit are fulfilled and that safe laboratory practices are followed.
2. Ensuring that all staff using radioactive materials have been authorized to use these radioactive materials.
3. Ensuring that all staff using radioisotopes have been issued, and wear, a thermoluminescent dosimeter and participate in bioassay programs, if required.
4. Designating specific work and storage areas for radioactive materials and ensuring that these areas are kept clean, are properly labelled, have adequate ventilation, and are adequately shielded.
5. Ensuring that all staff using radioactive materials have received adequate radiation protection training from the institution and have been informed of the risks associated with exposure to ionizing radiation. Further, permit holders are responsible for the provision of specific training in radioisotope handling that is necessary for the safe use of the radioisotopes in their laboratories.

6. Maintaining inventories of all radioactive materials as well as storage and disposal records.
7. Maintaining all area monitoring and/or wipe test records.
8. Reporting all radiation incidents to the Radiation Safety Officer.

**Radiation Users**

Radiation users are all persons whose work involves the use of radioisotopes or radiation-emitting devices, whether or not they are User Permit holders. Their familiarity with safe handling of radioisotopes and/or radiation-emitting devices is the direct responsibility of the User Permit holder for whom they are working. All users must attend a workshop on radiation safety before handling radioisotopes at UPEI. This workshop will be provided by the Radiation Safety Officer.

## II. RADIOISOTOPE LICENCE AND PERMITS

**U.P.E.I. Consolidated Licence**

A consolidated radioisotope licence is a single broad-scope radioisotope licence issued by the Canadian Nuclear safety commission (CNSC) to an institution having many users of radioactive materials who are primarily in one location. This document has been prepared by the Radioisotopes and Transportation Division of the CNSC to specify the requirements for a radiation safety program when a consolidated licence is issued.

The CNSC requires that the three following components be in place before a licence is issued:

1. Radiation Safety Committee;
2. Radiation Safety Officer;
3. Radiation Safety Manual.

**Design Compliance Form (DCF)**

The Design Compliance Form deals solely with laboratory features required to ensure radiological safety.

With the support of the Radiation Safety Committee, the Radiation Safety Officer shall have a major input on matters pertaining to facility design and layout.

Requirements for radioisotope laboratory facilities are outlined in the CNSC's Regulatory Document GD-52. The Radiation Safety Committee may approve plans for new laboratories that

meet the requirements of that document. Any proposed deviations from those requirements shall be discussed with the CNSC prior to approval. Design Compliance Forms (DCF) for laboratories approved by the Radiation Safety Committee shall be available for CNSC inspection.

Compliance with document GD-52 is mandatory for new or renovated. In addition, it is strongly recommended that all other existing facilities built before that date be upgraded to meet the requirements of that document.

**User Permit**

In order to purchase radioactive material the user must apply for and be granted a User Permit from the University Radiation Safety Committee. The application for a user permit will include such specifics as location of room(s) where radioisotopes will be used, the primary use of the isotope(s), possession limits, rate of use, monitoring equipment available, method of disposal, and names of all personnel who will be handling the radioactive material. An outline of intended lab procedures must be submitted and arrangements made with the Radiation safety Officer to attend a radiation safety course.

Application forms are available from the Radiation Safety Office. A sample form is included in *Appendix B.*

An annual accounting of all radioisotopes acquired against a User Permit will be reviewed by the Radiation Safety Officer at the end of each financial year, together with an inventory of radioisotopes on hand at the time. A suitable form for logging acquisitions and disposals is illustrated in *Appendix B*. Copies of this will serve for reporting purposes. Under no circumstances shall the inventory exceed the Possession Limits stated on the Radioisotope User Permit.

Any loss or theft of radioactive materials must be promptly reported to the Radiation Safety Office. Where such loss exceeds ten times the exemption quantity of any radioisotope the Radiation Safety Officer will make the loss known to local health authorities and to the Canadian Nuclear Safety Commission.

**Radioisotope Permit Amendments**

Permit holders desiring amendments will complete an Application for Radioisotope Permit Amendment form in *Appendix B*. The signed amendment form is to be submitted to the Radiation Safety Officer for review and passed on to the University Radiation Safety Committee for approval.

**Radioisotope Permit Renewal**

Renewal of an existing Radioisotope User Permit must be requested sufficiently in advance of its expiry to allow time for approval by the University Radiation Safety Committee and processing by the Radiation Safety Officer. Renewal form in *Appendix B.*

Internal permits are issued for one year.

**Termination of Permits**

User Permit Holders are responsible for notifying the RSO when a project is to be officially terminated. All radioactive materials acquired under the permit must be suitably accounted for and signed off by the RSO.

**POLICY FOR THE TERMINATION OF NUCLEAR SUBSTANCE USE:**

**RENOVATIONS, REMODELS, MOVES, TERMINATIONS**

**Introduction:**

A principal investigator (PI) is the individual in whose name a ***Nuclear Substance User Permit*** is issued for the use of nuclear substances or radiation emitting devices in their work. ***The principal investigator is responsible to the university for the safe use of such materials or devices by all persons under their supervision. Further, the principal investigator is responsible for the security of these materials from the time they enter the laboratory until they are safely and properly disposed of.***

It is the responsibility of the principal investigator to ensure that the Radiation Safety Office receives advance notification when:

- there is a planned move to new laboratory space

- there is expansion of current laboratory space (renovation)

- there are changes to current laboratory space (renovation/remodel)

- work with nuclear substances ceases

- the principal investigator leaves the university

**Procedures:**

Notify the Radiation Safety Office prior to any of the above listed changes or moves, giving the following information

- Principal Investigator, department, phone number

- Time and date of projected change or move

- Location of laboratory

Collect all radioactive waste and dispose of it in an appropriate manner as outlined in University of Prince Edward Island's Radiation Safety manual.

Consolidate all unwanted lead/plastic items (pigs, shields, etc.) into one area for removal by Radiation Safety Officer.

Nuclear substances not designated as waste must be disposed of in one of the following ways:

- An inventory ***transfer within the same department***
- An inventory ***transfer within the university***

****note: A transfer request must include the Transfer of Nuclear Substance/ Device form found in Appendix B***

- A wipe test survey must be done on all items that are in current use or had ***previously been used*** with nuclear substances. These results must be recorded in your Radiation Safety Manual. Items found to be contaminated must be cleaned and re-surveyed until removable contamination is as low as reasonably achievable. Wipe test results must also be submitted to the Radiation Safety Office.

A thorough lab survey ***must*** be conducted using both the direct survey method (if appropriate) and an indirect survey (wipe test). Areas surveyed ***must include,*** at the very least:

- Laboratory benches

- Sinks

- Floor areas

- Refrigerator/freezer (exterior and interior)

- Door knobs

- Telephone receivers

- On/off switches

Areas found to be contaminated must be cleaned and re-surveyed until removable contamination meets the following criteria, as specified in our Consolidated Uses of Nuclear Substances licence:

- non-fixed contamination in all areas, rooms or enclosures where unsealed nuclear substances are used or stored does not exceed:

3 bq/$cm^2$ for class A radionuclides

30 bq/$cm^2$ for class B radionuclides

300 bq/$cm^2$ for class C radionuclides

These results must be recorded in your ***Radiation Safety Manual***. Monitoring results must also be submitted to the Radiation Safety Office.

Once the monitoring results have been reviewed by the RSO, all radiation warning signs ***must be removed.*** This would include warning signs on doors, storage areas, sinks etc., The RSO will visit the lab to give final certification that the lab has been decommissioned. The lab will then be removed from the list of approved locations for work with nuclear substances

1. Any piece of heavy/bulky equipment transferred outside your laboratory must be certified ***"clear"*** by the RSO prior to removal by either Facilities Management or "outside" professional movers.

2. Be aware that the RSO must be consulted prior to the disposal of some pieces of equipment, such as liquid scintillation counters, as they often contain a radioactive source.

3. Plans to clean, paint or renovate a vacated or occupied lab must be submitted to the Radiation Safety Officer. Prior to any work beginning, the RSO must review the most current wipe test results for the area and grant official clearance for the work to begin.

## III. RADIOISOTOPE LABORATORIES

### Classification

The type of laboratory facility required for radioisotope work depends on the amount of radioactive material to be used, the type of operations to be performed, and the radiotoxicity of the radioisotopes.
Each room or area is classified if more than one exemption quantity is used at a single time.

Basic Level Room: if the largest quantity of an unsealed source in one container does not exceed 5 ALI (Annual Limit of Intake).

Intermediate Level Room: if the largest quantity of an unsealed source in one container does not exceed 50 ALI.

The dose rate of any occupied location outside the radioisotope laboratory shall not exceed 2.5 microsieverts per hour. Refer to *Regulatory Quantities for Typical Radionuclides Appendix A.*

### Design

The location of a radioisotope laboratory is such that the overall movement of radioactive materials is minimized and away from the general public.

Adequate room ventilation is essential. Fume hood construction for use with radioisotopes must be of smooth, easily cleaned materials with a linear velocity air flow of 0.5 - 1.0 metre per second. The exhaust at roof level must be so designed that exhausted air cannot re-enter any building.

Laboratory work surfaces must be smooth, impervious and easy to clean; also floors, walls and joints between surfaces must be sealed.

Plumbing must include an easily cleanable hand-washing sink fitted with an overflow outlet. It is recommended that drain pipes go directly to the main building sewer and that they are labelled. Drain traps should be accessible for periodic monitoring.

For the storage of both radioisotope stocks and wastes, it is essential that shielding be sufficient to reduce radiation dose rates to levels as low as reasonably achievable and at least adequate to reduce levels to less than 2.5 microsieverts per hour (0.25 millirem per hour).

It is recommended that the storage area be ventilated to prevent any possible buildup of radioactive, toxic or flammable vapours.

**Furniture**

It is recommended that laboratory furnishings be kept to a minimum and covered with materials that are easily cleaned.

**Security**

It is essential that all areas in which radioactive materials are used or stored be secured against unauthorized entry. For small quantities of radioactivity, good locks on doors and/or cabinets will suffice; more elaborate measures may be required in other circumstances

**Floor Area**

Radioisotope laboratories must have sufficient floor and counter top space to allow safe work practice. Requirements will depend upon type of work, traffic patterns and equipment used. At least 3 square metres of free floor area per person is adequate in a well-organized laboratory.

For details of the physical requirements for Basic and Intermediate Laboratories, refer to CNSC Regulatory Document R-52, "Design Guide for Basic and Intermediate Level Radioisotope Laboratories", on file in the Radiation Safety Office.

**Signs**

1. Laboratories in which radionuclides are present, or in which a person could receive a dose of ionizing radiation, at a rate in excess of 2.5 microsieverts per hour (0.25 mrem per hr), shall have posted at each entrance to that laboratory, a sign with the radiation waring symbol and the words *Caution - Radioactive Materials*, or *Caution - Radiation Area*", as appropriate.

2. CNSC Radioisotope Safety Posters *Rules for Working with Radioisotopes in a Basic Laboratory or Rules for Working with Radioisotopes in an Intermediate Laboratory* available from the Radiation Safety Officer must be posted in each such laboratory. Each poster must include the names and local and home telephone numbers of responsible persons to be contacted in an emergency, and any other special emergency instructions.

3. Cupboards, cabinets, refrigerators and other containers used to store radioactive materials must be identified with a radiation warning label and secured against unauthorized access.

4. Primary storage containers must be identified with a radiation warning symbol and information respecting the nature, form, quantity and date of measurement of the radionuclide contained within. Labelling is not required for containers such as beakers, flasks and test tubes used while the responsible individual is present, nor for containers

holding less than one exemption quantity of radioisotope.

5. Other radiation areas, including radiation zones, cold storage rooms, or enclosures where radiation fields may exceed 2.5 microsieverts/hour (0.25 mrem/h) must be posted with a "Radiation Area" warning sign and information concerning the nature of the radiation source. Appropriate radiation warning labels are required on all x-ray machines and other ionizing radiation-producing devices.

6. A current radioisotope user permit must be posted in each working laboratory.

## IV. RADIOISOTOPE PURCHASING, SHIPPING AND RECEIVING

**Purchase Procedure**

Transport of radioactive materials is regulated in detail by the CNSC. Transport Packaging of Radioactive Materials Regulations (SOR/83-740) is on file in the Radiation Safety Office.

In order to have radioisotopes or radiation-emitting devices shipped to a User Permit holder, the supplier must be provided with a copy of the licence. All requisitions for purchase by a User Permit holder must bear his/her signature and must also have the signature of the University Radiation Safety Officer before the University Purchasing Department can process the requisition. The Radiation Safety Officer must ensure that purchase levels are within limits specified in the Consolidated Licence and the internal User's Permit. Each requisition must include the CNSC Consolidated Licence number and the purchaser's User Permit number.

**Receiving Procedure**

Radioisotopes are delivered to the Central Shipping and Receiving Department. The User Permit Holder or a trained radioisotope worker will be notified of the delivery. This person should pick up the parcel as soon as possible and sign the log book located in Shipping and Receiving. Off hours delivery will be received by University security and transferred directly to the locked storage area. The shipment should be inspected immediately for visible damage and/or leaks..

If the package has a visible damage:

1. Wear a lab coat and disposable gloves while handling the package
2. Place package in leak-proof container.
3. Monitor area where package was held, and decontaminate if necessary
4. Transfer container holding package to a radioisotope laboratory.
5. Proceed to step 6 below.

If there is no visible damage

6. Wear lab coat and gloves
7. Transfer package to radioisotope laboratory
8. Place the package in a fume hood if possible.
9. Monitor the radiation field about the package and compare with the units stated on the package.

Packages containing radioactive materials are categorized by radiation level and display IAEA warning labels Radioactive I, II, and III. The transport index for a package is the number expressing the maximum exposure rate (mR/hr) at one meter from the surface of the package.

| Category I | Category II | Category III |
|---|---|---|
| Less than 0.5 mR/hr at the surface | Not exceeding 50 mR/hr at the surface nor 1.0 mR/hr at one meter from the surface | Not exceeding 200 mR/hr at the surface nor 10 mR/hr at one meter from the surface |

The transport index for a package is the number expressing the maximum exposure rate in millirems/hour at one meter from the surface of the package.

10. Open the outer package and check for possible damage to the contents as apparent by broken seals or by discolouration of packing materials. Wipe test the interior packaging.
11. Remove the inner package or primary container, monitor the radiation field, and wipe test the container.
12. Verify the radioisotope, the activity, and other details with the information on the packing slip and with your copy of the purchase order. Log the pertinent data in your inventory record.
13. Report any anomalies such as contamination, leakage, or wrong shipment immediately to the supplier.

**CONTROL OF NUCLEAR SUBSTANCES: UPEI/AVC**

In order to have radioisotopes or radiation-emitting devices shipped to a User Permit holder, the supplier must be provided with a copy of our Nuclear Substances and Radiation Devices licence. All requisitions for purchase by a User Permit holder must bear his/her signature and must also have the signature of the University Radiation Safety Officer before the University Purchasing Department can process the requisition. The Radiation Safety Officer must ensure that purchase levels are within limits specified in the Consolidated Licence and the internal User's Permit. Each requisition must include the CNSC Consolidated Licence number and the purchaser's User Permit number.

Once the User Permit holder has taken receipt of a package, they must immediately complete a Radioisotope Inventory form (Appendix D.12.1.a).

The separate Radioisotope Inventory form will be completed for each singular vial of radioactive material in their inventory.

The form contains all pertinent data for identifying the package including shipment date of arrival, radioisotope type, quantity, and form, as well as the company name and lot number.

All use and of the radioactive material will be logged on this form and it will be retained by the user as a part of the inventory of the respective Permit Holder.

This inventory record will be checked by the RSO as part of the internal audit process and all inventory records are to be made available to the CNSC upon request.

In order to purchase radioactive material the user must apply for and be granted a User Permit from the University Radiation Safety Committee.

The application for a user permit will include such specifics as location of room(s) where radioisotopes will be used, the primary use of the isotope(s), possession limits, rate of use, monitoring equipment available, method of disposal, and names of all personnel who will be handling the radioactive material. An outline of intended lab procedures must be submitted.

**To purchase radioisotopes at UPEI/AVC:**

1. Purchases can be made by Internal Permit holders only
2. The RSO **MUST** sign off on all purchase requisitions. IF a purchase requisition is received by our purchasing department, without the RSO signature, it will be returned to the individual, to seek proper approval
3. The RSO will verify and document the amount of radioactive material requewsted and confirm that the permit holder is working within the allowed limits, and that the purchase does not exceed permit and/or licence quantities.
4. The RSO will keep records of all purchases. Confirmation of receipt of shipment is to be made to the RSO upon arrival.
5. The RSO will check purchases against inventory forms for each permit holder during annual internal inspections.

## V. RADIOISOTOPES - RULES FOR WORKING SAFELY

The protection of individuals from external radiation is achieved by control of working time, working distance from sources, and the use of appropriate shielding materials.

Protection from internal radiation hazards is a matter of prevention of bodily contamination. Ingestion, inhalation, absorption through the skin, and entrance through wounds or abrasions are the principal routes for radioactive contamination to enter the body. Preventive measures require adequate ventilation and containment, the use of appropriate protective clothing and the practice of immaculate hygiene. With the exception of accidents, poor laboratory techniques and radiation hygiene are the chief causes of internal contamination among laboratory workers.

Some general rules for working with radioisotopes apply to all levels of laboratory licensing - Radiation Zones, Basic Laboratory and Intermediate Laboratory. Following these rules provides for the protection of personnel working with radioisotopes as well as avoiding contamination of other workers, adjacent work areas and sensitive equipment.

1. All persons working with radioactive materials must have basic training in radiation safety.
2. Do not eat, drink, or store food in areas where radioactive material is used.
3. Do not pipette radioactive solutions by mouth.
4. Do not work with radioactive materials if you have open cuts or abrasions.
5. Use gloves whenever there is a chance of contamination.
6. Wear laboratory coats when working with radioactive material. Leave in laboratory.
7. Wear dosimeter if required by licence. When it is not being worn, store it away from radioactive materials.
8. Use a fumehood for any work with dry powder or volatile substances.
9. Use disposable absorbent liners on trays or other work surfaces.
10. Glassware used for radioactive work must not be used for other purposes.
11. Monitor equipment and supplies before removing from laboratory.
12. On a weekly basis, and when work is completed, monitor and if necessary decontaminate equipment, trays, floor, and working surfaces.
13. Wash hands, and when appropriate, monitor thoroughly before leaving laboratory.

**University of Prince Edward Island**
**RADIATION SAFETY POLICY & PROCEDURE**

# A.L.A.R.A.

| | |
|---|---|
| **Title:** | ALARA Policy |
| **Date:** | May 2008 Revised: Jan 2016 |

**Introduction:**

***ALARA*** an acronym for **A**s **L**ow **A**s **R**easonably **A**chievable, means making every reasonable effort to maintain exposures as far below the regulated dose limits as practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

The current system of radiological protection reflected in the International Commission on Radiological Protection (ICRP) Publication 60 ***"1990 Recommendations of the International Commission on Radiological Protection"*** and the National Council on Radiological Protection (NCRP) Publication 116 ***"Limitation of Exposure to Ionizing Radiation"*** is based on three criteria.

I. ***Justification*** - the need to justify any activity which involves radiation exposure on the basis that the expected benefits to society exceed the overall societal detriments

II. ***Optimization*** - the need to ensure that the benefits of such justifiable activities or practices is maximized for the minimum associated societal detriment, economic and social factors being taken into account

III. ***Dose and Risk Limitation*** - the need to apply dose limits to ensure that individuals or groups of individuals do not exceed acceptable levels of risk

**Administration Commitment:**

a) The administration of UPEI is committed to the program described herein for keeping individual and collective doses as low as reasonably achievable. In accord with this commitment we hereby describe an administrative organization for radiation protection and will develop policies, procedures and instructions to foster the ***ALARA*** concept. The

organization will be comprised of a Radiation Safety Committee and a Radiation Safety Officer (RSO).

b) An annual review of the radiation safety program will be performed. This review will include operating procedures, past personnel dose records, inspections, training and consultation with the RSO.

**Obligations of Licensees**

a) Ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the ***Nuclear Safety and Control Act*** (the Act), the regulations made under the Act and the ***Nuclear Substances and Radiation Devices Licence***

b) Train workers to carry on the licensed activity in accordance with the Act and regulations

c) Take all reasonable precautions to protect the environment and the health and safety of persons and to maintain security

d) Provide the devices required by the Act and regulations and maintain them within the manufacturer's specifications

e) Require that every person at the site of the licensed activity uses equipment, devices, clothing and procedures in accordance with the Act and regulations

f) Take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity

g) Implement measures for alerting the licensee to the illegal use or removal of a nuclear substance, prescribed equipment or prescribed information, or the illegal use of a nuclear facility

h) Implement measures for alerting the licensee to acts of sabotage or attempted sabotage anywhere at the site of the licensed activity

i) Instruct the workers on the physical security program at the site of the licensed activity and to their obligations under that program

j) Keep a copy of the Act and the regulations made under the Act that apply to the licensed activity readily available for consultation by the workers

These obligations are tasked to the Radiation Safety Committee to be carried out by the Radiation Safety Officer.

**Obligations of Workers:**

a) Use equipment, devices, facilities and clothing for protecting the environment or the health and safety of persons, or for determining doses of radiation, dose rates or concentrations of radioactive nuclear substances, in a responsible manner and in accordance with the Act, the regulations made under the Act and the Nuclear Substance User Permit (permit)

b) Comply with the measures established by the licensee to protect the environment and the health and safety of persons, maintain security, control the levels and doses of radiation, and control releases of radioactive nuclear substances and hazardous substances into the environment

c) Promptly inform the licensee or the worker's supervisor of any situation in which the worker believes there may be

    a) A significant increase in the risk to the environment or the health and safety of persons

    b) A threat to the maintenance of security or a incident with respect to security

    c) A failure to comply with the Act, the regulations made under the Act or the permit

    d) An act of sabotage , theft, loss or illegal use or possession of a nuclear substance, prescribed information, or

    e) A release into the environment of a quantity of a radioactive nuclear substance or hazardous substance that has not been authorized by the licensee

    f) Observe and obey all notices and warning signs posted by the licensee in accordance with the ***Radiation Protection Regulations,*** and

    g) Take all reasonable precautions to ensure the worker's own safety, the safety of the other persons at the site of the licensed activity, the protection of the environment, the protection of the public and the maintenance of security.

**ALARA Procedures:**

The Radiation Safety Committee will delegate authority to the RSO for enforcement of these procedures. The Radiation Safety Committee will support the RSO when necessary in asserting his/her authority. If the Radiation Safety Committee overrules the RSO, it will record the basis for its action in the minutes of radiation safety committee meetings.

All occupationally exposed workers will be provided with a copy of the ALARA policy.

All new occupationally exposed workers will participate in the first available Radiation Safety Training course available after joining a research group

The RSO will thoroughly review the qualifications of each principal investigator with respect to the types and quantities of nuclear substance requested, methods of use, suitability of laboratory space, availability of required shielding, dosimetry, and monitoring equipment.

The RSO will thoroughly review all planned laboratory construction and renovation prior to submission of plans to the Canadian Nuclear Safety Commission (CNSC) to ensure that the requirements of CNSC's Regulatory Document R-52 ***"Design Guide for Basic and Intermediate Level Radioisotope Laboratories"*** are met.

The RSO will review the occupational radiation exposures of all monitored workers. An action level of one third the maximum limit in any quarter is set. If an action level is exceeded the RSO will conduct an investigation and decide if action is warranted. These limits apply to combined external and internal exposures.

| Item | Person | Period | Effective Dose (mSv) | Action Level (mSv/quarter) |
|---|---|---|---|---|
| 1 | a person who is not a NEW | 1 calendar year | 1 mSv | 0.3 mSv |
| 2 | a person who is not a NEW lens of an eye | 1 calendar year | 15 mSv | 5 mSv |
| 3 | a person who is not a NEW skin | 1 calendar year | 50 mSv | 16 mSv |
| 4 | a person who is not a NEW hands & feet | 1 calendar year | 50 mSv | 16 mSv |

Licence conditions require that removable contamination does not exceed nuclear substance-specific limits on accessible surfaces in occupational and public areas. Nuclear substances are assigned classifications as follows:

**Class A -** typically long lived and emit alpha radiation
**Class B -** typically long lived and emit beta or gamma
**Class C -** typically short lived and emit beta and gamma

At UPEI, only Class B & C nuclear substances are used. In keeping with an ALARA policy, contamination limits are set at regulatory limits, however every effort should be made to maintain contamination levels below the 2-3 times background “rule of thumb”. Contamination limits are based on activity per square centimetre.

| Class | Control Area Limit | Public Area/ Decommissioning Limit | UPEI Limit |
|---|---|---|---|
| A | 3 Bq/cm2 | 0.3 Bq/cm2 | 0.3 Bq/cm2 |
| B | 30 Bq/cm2 | 3 Bq/cm2 | 3 Bq/cm2 |
| C | 300 Bq/cm2 | 30 Bq/cm2 | 30 Bq/cm2 |

**RADIOACTIVE CONTAMINATION CONTROL**

Periodic surveys of radioisotope laboratories are important for the detection and cleanup of small amounts of contamination which may be present in spite of scrupulous care in technique and which otherwise might go unnoticed. Contamination of laboratory furnishings and equipment presents a potential health hazard to personnel. Monitoring for radioactive contamination can be done by indirect or direct method. The type of radioisotope will dictate whether a portable contamination meter or liquid scintillation counting of wipes is the method to be used.

**Direct Method**

A contamination meter will detect both ambient radioactivity and contamination adhered to surfaces. Most meters will detect the presence of gamma radiation $^{125}I$ and the more energetic beta emitters such as $^{32}P$. Indirect measurement (wipe testing) is necessary to detect contamination involving low energy emitters such as $^{3}H$, $^{14}C$ or $^{35}S$.

1. Select a contamination meter (calibrated annually). For beta particle counting, the end window covering must be removed.
2. hold the probe approximately 3 mm (1/8 inch) above the surface; increasing the distance will result in an underestimation or no detection of activity while decreasing the distance may result in probe contamination
3. pass it slowly over the area to be monitored (the sensitivity of detection is inversely proportional to the survey speed)
4. note the surveyed areas on a lab plan and report values as required.
5. Decontaminate and repeat if necessary, until all areas are a background levels.

Return the contamination meter(s) to the RSO if there is any question of proper functioning. Certain maintenance checks of the electronic circuitry will be performed.

**Indirect Method**

Wipe testing is the method of choice for the detection of loose, or removable, contamination on laboratory surfaces. Since the potential for internal exposure to personnel is a by-product of loose contamination, regulation wipe-testing is routine practice with all radioisotope work. Busy laboratories should wipe test weekly. When working in a temporary radiation zone or where isotope use is infrequent, wipe testing should be done at the conclusion of experiments.

Wipe Test Survey records must be maintained by all Radioisotope User Permit holders. Survey records must be kept up to date and will be inspected at regular intervals by the Radiation Safety Officer.

Wipe test surveys will be carried out by RSO in all labs on a monthly basis. If contamination is found, the user will clean the area and the permit holder is notified. Follow-up wipe tests should be done.

**Protocol for Wipe Test is as follows:**

1. Wipe test areas of radioisotope use. Locations chosen should include points such as door handles, telephone receivers, pipettor handles, and taps.
2. Use filter paper or cotton swabs lightly moistened with alcohol or water. Use one wipe per location and be sure to identify it.
3. Let the wipes dry in air.
4. Measure the radioactivity on each wipe using suitable detection devices for the isotopes used in the laboratory - Liquid Scintillation Counter or Gamma Counter.
5. Obtain background counts from a clean wipe or swab.
6. The amount of removable contamination permitted in occupational and public areas is regulated through the conditions of a CNSC licence.

A licence may require that removable contamination not exceed the following typical limits for all areas, averaged over not more than 100 $cm^2$.

- For controlled areas, not more than 300 $Bq/cm^2$ of Class C radionuclides, which are short-lived and emit beta or gamma radiation.
- For supervised public areas, and for decommissioning, 30 $Bq/cm^2$ of Class C radionuclides, which are short-lived and emit beta or gamma radiation.

<u>Formula For Determining Loose Contamination:</u>

$$\text{Removable activity} = \frac{\mathbf{N} - \mathbf{NB}}{\mathbf{E} \times \mathbf{A} \times \mathbf{F}}$$

N = net count rate measured directly or on the wipe in counts per second.
NB = normal background count rate (CPS)
$E_c$ = counting efficiency of gamma or scintillation counters. (see below)
A = area wiped in square centimetres (not to exceed 100 $cm^2$) or the area of the detector in $cm^2$ (for direct measurement)
F = the collection factor, or wipe efficiency, for the wipe (used only when calculating indirect wipe monitoring results). If F is not determined experimentally, a value of F=0.1 (ie. 10%) shall be used. A wipe efficiency of 10% is assumed, since only a fraction of contamination will be removed by this method.

7. If radioactivity is above background, the contaminated location should be cleaned with water or a commercial decontamination solution, taking care not to spread contamination over a larger area. Repeat wipe testing of the location and decontaminating until background levels are achieved.

8. Keep records of test results; such records shall be made available for inspection if so requested by the Radiation Safety Officer.
9. It should be noted that wipe tests will not detect fixed contamination. Where this is a possibility, the use of a survey meter in conjunction with the wipe test programme is necessary.

**Removable Surface Contamination Limits:**

For Control Areas: Removable surface-contamination limits, per area not exceeding 100cm$^2$, shall not exceed:

- 3.0 Bq/cm$^2$ for Class A radionuclides, which are typically long lived and emit alpha radiation.
- 30 Bq/cm$^2$ for Class B radionuclides, which are typically long lived and emit beta or gamma radiation.
- 300 Bq/cm$^2$ for Class C radionuclides, which are typically short lived and emit beta or gamma radiation.

For supervised public areas and for decommissioning: Removable surface-contamination limits, per area not exceeding 100cm$^2$, shall not exceed:

- 0.3 Bq/cm$^2$ for Class A radionuclides
- 3.0 Bq/cm$^2$ for Class B radionuclides
- 30 Bq/cm$^2$ for Class C radionuclides

## Calibrations and Efficiency:

In order for the results of a survey instrument to be meaningful, the instrument must be calibrated. Calibrations of survey instruments at UPEI are performed annually. Ion chambers are usually calibrated against Cs-137, Co-60, or an X-ray radiation field. GM counters are usually calibrated against a specified reference standard at a fixed distance from the detector (usually 1 centimeter) . Liquid scintillation counters and gamma well counters are checked regularly against a calibration standard of known count rate and calculated according to the following formula. Efficiencies for instruments expressing results in terms of counts rates can be calculated from the following formula:

$$\text{Efficiency} = \frac{\text{Observed Standard Count Rate (cpm)}}{\text{Known standard Disintegration Rate (dpm)}}$$

Divide the observed sample count rate by the detector efficiency to obtain the actual disintegration rate.

Example: A Carbon-14 standard has a disintegration rate of 85,000 dpm. Your GM counter measures a count rate of 4,500 cpm. If the background is 250 cpm, what is the efficiency of the counter?

$$\text{Efficiency} = \frac{4{,}500 \text{ cpm} - 250 \text{ cpm}}{85{,}000 \text{ dpm}} = 0.05 \text{ c/d} \times 100 = 5\%$$

## VII. Requirements for Leak Testing:

The CNSC requires that every licensee who possesses a sealed source containing 50 MBq or more of a nuclear substance, is required to perform annual leak testing on each source.

**The University of Prince Edward Island does not currently possess any sealed sources that meet this requirement.** In the event that we obtain a sealed source equal to or greater than 50MBq, we will follow the procedures as outlined below.

### Wipe Sampling Procedure Documentation

Before wiping any sealed source the licensee shall have available for inspection, a documented sampling procedure consisting of:

- a general description of the method of wipe sampling
- a list of all sealed sources to be leak tested, and their locations
- a step by step procedure of the method for wipe sampling each type of sealed source and each type of sealed source containment including:
- operating instructions for sealed source drives, shutter interlocks and safety features during sampling
- a description and reason for choice of physical configuration of the wipe, material of the wipe, and compatible solvent (if required)
- a description of the method of wiping
- a description of the location of wiping, which depending upon sealed source activity and sealed source accessibility may be from the exterior surface of the sealed source or the immediate environment of the sealed source device or holder
- a description of the types of wipe sample containers including:
- means of identifying the wipe sample or container or both the method of packaging and transporting to the person who will be conducting the measurement of the swipe.

Sampling must be performed by a person who:

- understands regulatory requirements and these expectations
- knows the type and activity of the sealed source and the sealed source containment
- can recognize and minimize the potential contamination and radiation hazards associated with:
    - the sealed source and its containment, including any sealed source windows
    - wipe sampling the sealed source or its immediate environment
    - the wipe sample
- has available sufficient wipe sampling materials and wipe sample containers
- follows all manufacturer's instructions for the safe operation of any radiation device for the purposes of leak testing
- follows all radiation and other safety precautions for working in the area in which the sealed source is located, including lock-out and personal protection requirements.

**Sampling Records**

Immediately following sealed source wipe sampling, the person conducting the sampling shall place the wipe sample in an identified container, recording the:

- name of the person conducting the sampling
- licensee name and CNSC licence number
- sealed source identification information (make, model, serial number and isotope)
- sample container identification number
- date that the sample was taken

All of the information in this record should be transferred with the sample container to the person who will be conducting the analysis of the swipe.

**Measuring Procedure Documentation**

Before measuring any sealed source leak test wipe samples, the person conducting the analysis of the swipe shall have available a documented sample measuring procedure consisting of:

- a general description of the method of measuring; and,
- a step by step procedure for measuring wipe samples with the measuring equipment including:
    - a description and identification of measuring equipment (make, model and serial #).
    - instructions, preferably including manufacturers' manuals, to set up, operate and measure samples
    - a description of the tests to be performed using check sources to demonstrate the capability to make reproducible measurements, and to detect 200 Bq or less of each isotope of interest.

**Sample Analysis**

Analysis of the swipe sample must be performed by a person who:

- knows the regulatory requirements and the expectations
- is familiar with the operation of the measuring equipment
- can recognize and minimize the potential radiation and contamination hazards associated with the wipe sample.
- has available and follows the documented sample measuring procedure.

**Leak Test Record Completion**

Immediately following the wipe sample measurement, the person conducting the analysis of the swipe sample shall complete the leak test record, retain a copy and send the original to the licensee. The person who analyzed the swipe sample shall immediately advise the licensee if a sealed source wipe sample has contamination which exceeds the leakage criterion of 200 Bq.

Licensees must notify the CNSC of any sealed source where leakage has been detected, in excess of 200 Bq.

**Maintenance of Records**

The licensee shall retain records of all leak testing as required, and shall retain those records for the period specified in the licence.

## VIII. CLEANING OF RADIOISOTOPE LABORATORIES

Basic laboratories may be cleaned on a regular basis by housecleaning staff without prior permission. It is the responsibility of laboratory personnel to keep floors and general use wastebaskets (areas and items routinely cleaned by housekeeping) free of radioactivity. Cleaning and monitoring of all laboratory benches, work surfaces, fume hoods, sinks and equipment is the responsibility of laboratory personnel. It is also the responsibility of laboratory personnel to segregate and contain in labelled containers all radioactive wastes. Laboratory personnel will be directly responsible for delivering such material to the Atlantic Veterinary College incinerator or for disposing of it through other approved routes. Anything not to be touched by University Housekeeping Staff should be clearly posted - such that there is no doubt that housekeeping will not handle it.

Intermediate laboratories are restricted areas which cannot be cleaned by housekeeping staff without prior authorization from the Radiation Safety Officer. The intermediate laboratories must be posted as off-limits to housekeeping. Since periodic care of floors will be needed, it will be necessary to have the Radiation Safety Officer contact the housekeeping staff periodically for such services. Prior to admitting housekeeping staff to the intermediate laboratories, the following steps must be carried out:

1. A radiation contamination survey will be conducted by the RSO. If unacceptable levels are found, laboratory personnel must decontaminate until levels are acceptable.
2. Laboratory personnel must clean the floor of all obstructions. If any other surfaces are to be cleaned, laboratory personnel must clean all equipment.
3. When the laboratories are considered safe for housekeeping staff, the RSO will make arrangements with the building supervisor.

Cleaning of any radioisotope area following a spill or incident will be the responsibility of laboratory personnel as directed by the Radiation Safety Officer. When the area is considered safe for further cleaning by housekeeping staff, they may be contacted, with the Radiation Safety Officer making arrangements via the building supervisor.

## IX. PERSONNEL SAFETY

### Permissible Doses to Personnel

The CNSC sets maximum permissible doses based on their definitions of Nuclear Energy Workers (NEWs) or any other worker, as defined in Schedule II of Nuclear Safety and Control Act. Since the definition is based on the dose of radiation a person is likely to receive, not the type of work done, most radioisotope workers are classed as non-atomic radiation workers and are considered as members of the public in terms of permissible doses. Specifically, the doses for whole body irradiation and for various organs are detailed in the table below:

| ORGAN | NUCLEAR ENERGY WORKER | ANY OTHER PERSON |
|---|---|---|
| Lens of eye | 150 mSv per one year dosimetry period | 15 mSv per one calendar year |
| Skin | 500 mSv per one year dosimetry period | 50 mSv per one calendar year |
| Hands and feet | 500 mSv per one year dosimetry period | 50 mSv per one calendar year |

### Personal Dose Monitoring

Personnel monitoring devices are worn to record the cumulative dose received from occupational exposure to external radiation. They are a simple means of providing employers with records of doses to personnel, as required by Nuclear Safety and Control Act. They provide assurance to radioisotope workers that their routine radiation exposure is low and may also provide valuable information in the unlikely event of an accidental exposure. Health Canada National Dosimetry Services provides Dosimetry Services and they recommend Thermoluminescent Dosimetry (TLD) as the monitoring service for most personnel monitoring requirements. The TLD is a clip on holder containing a luminescent material (lithium fluoride) which when exposed to radiation and subsequently heated (the developing or readout process) emits an amount of light proportional to the radiation exposure. The TLD is designed to monitor exposure to x-ray, gamma and some beta radiation. The range of detectable exposure is 0.03 mSv - 10 Sv. The policy for personnel who must wear a protective lead apron is that the personnel dosimeter "MUST be worn under the lead apron." Ring dosimeters are used by personnel handling $^{32}P$ and by the radiology department personnel ( as per guidelines outlined in table below ).

The Radiation Safety Officer will be responsible for distribution, instruction and wearing

schedules of TLD's. Individual records of accumulated doses for each wearer of a TLD will be maintained and available from the Radiation Safety Officer. TLDs are whole body dosimeters to be worn at the chest or waist position, and if applicable, under a lead apron. When a personal dosimeter is not needed for monitoring, it should be stored in the dark and out of range of exposure to any radiation.

1. Should an individual lose a dosimeter, the RSO must be notified immediately.
2. Cost of dosimeter will be incurred by the user after two losses per year.
3. Discipline code will be applied after three losses.

**Conditions for issuing a dosimeter:**
The most commonly used and conditions under which a dosimeter will be issued are as follows

1. Operation of Radiation emitting devices
2. Working with open sources of radioactive material as listed in table below. Only certain radioisotopes are considered external hazards: people working with these radioisotopes will be issued a dosimeter if they are working above a specific quantity of specific radioisotopes.

| **Radioisotope:** | **Conditions for issuing a dosimeter:** |
|---|---|
| Hydrogen 3 | not issued (not external hazard)* |
| Carbon 14 | not issued (not external hazard)* |
| Sulphur 35 | not issued (not external hazard)* |
| Phosphorus 32 | when working with quantities greater than 7.4 mBq (0.2 mCi) |
| Technetium 99m | always issued |
| Iodine 131 | when working with quantities greater than 7.4 mBq (0.2 mCi) |
| Iodine 125 | when working with quantities greater than 7.4 mBq (0.2 mCi) |

* wipe test monitoring is the appropriate method

**Requirements for obtaining a dosimeter:**

Dosaimeters are available upon request to, and dependant on the approval of, the RSO. If it is determined that an individual will be issued a dosimeter, then the following information is required:

- Given names (first, middle and last), as well as any previous surnames
- Social insurance number
- Sex
- Date, province, and country of birth
- Supervisor
- Department
- Job classification

All Nuclear Energy Workers are required to wear badge and ring dosimeters. The RSO reviews

dose reports quarterly and NEW's will receive an annual exposure report, in writing, from the office of Radiation Safety.

**Pregnant Workers Nuclear Energy**

Any female member of the UPEI community who works with radiation emitting devices, and /or open sources of radioactive material, who becomes pregnant, shall inform the radiation safety officer in writing.

Every NEW who becomes pregnant shall immediately inform the Radiation safety Officer in writing.

Dosimetry for the pregnant worker will be upgraded from a quarterly wearing period to a monthly/weekly wearing period.

The employee is required to accommodate this NEW, to insure that her responsibilities will keep her dose exposure under the limits set out in the chart above.

The regulations read as follows:

*Section 11* ***of the Radiation Protection Regulations requires the following***

- *(1) Every nuclear energy worker who becomes aware that she is pregnant shall immediately inform the licensee in writing.*
- *(2) On being informed by a nuclear energy worker that she is pregnant, the licensee shall, in order to comply with section 13, make any accommodation that will not occasion costs or business inconvenience constituting undue hardship to the licensee.*

**Action levels:**

The Radiation Safety Committee has the right to impose disciplinary measures on user permit holders who do not comply with the provisions of the Radiation Safety Manual or who are otherwise careless in their handling of radioisotopes. Infractions that might call for disciplinary action include, but are not necessarily limited to, the illegal importation to UPEI of radioisotopes, repeated contamination of laboratory facilities, and working with radioisotopes without a permit.

Generally, the response to a first infraction will be a meeting with the Chair of the RSC and the Radiation Safety Officer. For serious or repeated offenses, the Committee reserves the right to suspend the relevant user permit or, where no permit exists, to recommend alternative action to the Dean. In such cases, the offender will first be given the opportunity to appear before the Committee, along with his or her Department Chair and relevant technical staff, to offer any appropriate defense. Following such a meeting, the Committee will meet to decide whether a permit suspension is in order and what the term of the suspension should be; or whether other action should be recommended, which may include the placement of a formal letter in the faculty member's personal file.

Any disciplinary action taken by the Radiation Safety Committee may be appealed directly to the President of the University.

Action levels of one third the maximum dose is set.

| **Action levels:** | | | | |
|---|---|---|---|---|
| Item: | Person: | Period | Effective dose | Action level (per quarter) |
| 1 | Non NEW (whole body) | 1 calendar year | 1 mSv | 0.3 mSv |
| 2 | **NEW** (whole body) | 1 calendar year | 20 mSv | 2.0 mSv |
| 3. | **NEW** (hands) | 1 calendar year | 500 mSv | 50 mSv |
| 4. | Non-NEW (hands) | 1 calendar year | 50 mSv | 5 mSv |

Note: These action levels do not apply to workers using Iodine 125, or Iodine 131. For those workers, please refer to the UPEI Bioassay policy.

# University of Prince Edward Island
# I 131 Bioassay Policy and Procedures

The CNSC requires: **Under condition 2046-15 of our licence:** Every person who

**a)** Every person who, in any 24 hr period, uses a total quantity of iodine-125 or iodine-131 exceeding;

i) 2 MBq in an open room;
ii) 200 MBq in a fume hood;
iii) 20000 MBq in a glove box;
iv) any approved quantity in any room, area or enclosure authorized in writing by the CNSC shall undergo thyroid screening within a period more than 24 hours after the last use that resulted in any of the above limits being exceeded and less than 5 days after the limit was exceeded.

**b)** is involved in a spill of greater than 2 MBq of iodine-125 or iodine-131 shall undergo thyroid screening within a period more than 24 hours after the spill and less than 5 days after the spill

**c)** Every person on whom iodine-125 or iodine-131 external contamination is detected, shall undergo thyroid screening within a period more than 24 hours after the contamination and less than 5 days after the contamination.

**Under condition 2600-3 of our licence:**

Screening for internal iodine-125 and iodine-131 shall be performed using:

**a.** a direct measurement of the thyroid with an instrument that can detect 1 kBq of iodine- 125 or iodine-131; or
**b.** a bioassay procedure approved by the Commission or a person authorized by the Commission.

**Under condition 2601-6 of our licence**

If thyroid screening detects more than 10 kBq of iodine-125 or iodine-131 in the thyroid, the licensee shall immediately make a preliminary report to the Commission, or a person authorized by the commission and has bioassay performed within 24 hours by a person licensed by the Commission to provide internal dosimetry.

Only personnel authorized by the UPEI Radiation Safety Department will be permitted to work with I 131. A baseline bioassay ***must*** be performed before work with Radioiodine begins.

**Procedure:**

1. The Radiation Safety Office ***shall*** be notified 24 hours in advance of a radioiodination.

2. Personnel ***shall*** report to the Radiation Safety Office within 72 hours of the radio-iodination for routine thyroid screening.

3. If amounts of iodine-125 or iodine-131 meet or exceed those limits as referenced in condition 2601-6 of the university consolidated licence, a thyroid bioassay must be performed within 24 hours by a person licensed by the Commission to provide internal dosimetry.

4. The RSO will perform the thyroid bioassay on a calibrated thyroid uptake probe. This probe is located at the QEH nuclear medicine department. We have permission to utilize their equipment for this process. The RSO will escort the University staff to the QEH and perform the measurement. The reading will be documented and maintained in both the RSO office, as well as the radioiodine users records.

Prepared iodinated compounds such as radio-immunoassay kits are not considered to give rise to volatile iodine. However, personnel involved in performing radioiodination techniques for tracer labelling of proteins and polypeptides may handle sufficient quantities of $^{125}$I or $^{131}$I to create the need for bioassay monitoring. The purpose of a bioassay program is to detect internal contamination of radioactivity by a direct in vivo measurement of the thyroid gland with an appropriate detector. In some situations measurement of radioactivity in a biological sample such as blood or urine might be considered a bioassay program.

A copy of the CNSC Regulatory Guide R-58 *Bioassay Requirements for I-125 and I-131 in Medical Teaching and Research Institutions* is available upon request from the Radiation Safety Office. The Radiology Department at the Queen Elizabeth Hospital will perform bioassays on individuals upon request. Arrangements for the bioassays are the responsibility of the Radiation Safety Officer

## Emergencies

### Radioactive Contamination

Any work with unsealed nuclear substances involves the possibility of radioactive contamination, with consequent risk to personnel of subsequent ingestion and of interference with accurate measurements. Good operating methods as described in previous sections together with careful cleaning will normally keep contamination to an acceptably low level. However, regular monitoring of work and adjacent areas must be conducted on a minimum weekly basis. Procedures and supplies for dealing with an accidental spill must be provided. It is desirable that loose contamination be kept as near background levels as possible.

### Radioactive Spills

Spills are the most likely type of incident to occur in a laboratory operation involving the use of open source nuclear substances. Most of these spills will involve only minor quantities of radioactivity and can be dealt with at the time by laboratory personnel.

The Radiation Safety Office must be consulted for advice in any of the following situations:

i. a spill involving a nuclear substance of very high radiotoxicity
ii. a spill involving contamination of inaccessible areas
iii. a spill involving more than 100 exemption quantities (EQ's) of activity
iv. a spill involving the release of volatile material
v. a spill involving the contamination of personnel
vi. when reasonable efforts to decontaminate are not successful in reducing activity to less than twice background
vii. when there is any doubt concerning appropriate decontamination procedures

### Spill Clean-Up Procedure

The spill clean-up procedure, as outlined in CNSC poster "Spill Procedures", is listed below and is posted in all radioisotopes user labs. The poster can be found online at

http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/spill-procedures-eng.pdf

General Precautions

1. Inform persons in the area that a spill has occurred. Keep them away from the contaminated area.
2. Cover the spill with absorbent material to prevent the spread of contamination.

**Minor Spills** (Typically less than 100 exemption quantities of a nuclear substance)

1. Wearing protective clothing and disposable gloves, clean up the spill using absorbent paper and place it in a plastic bag for transfer to a labelled waste container.
2. Avoid spreading contamination. Work from the outside of the spill towards the centre.
3. Wipe test or survey for residual contamination as appropriate. Repeat decontamination, if necessary, until contamination monitoring results meet the Nuclear Substances and Radiation Devices licence criteria.
4. Check hands, clothing, and shoes for contamination.
5. Report the spill and cleanup to the person in charge and, if necessary, to the Radiation Safety Officer.
6. Record spill details and contamination monitoring results. Adjust inventory and waste records appropriately.

**Major Spills**
(Major spills involve more than 100 exemption quantities, or contamination of personnel, or release of volatile material)

1. Clear the area. Persons not involved in the spill should leave the immediate area. Limit the movement of
   all personnel who may be contaminated until they are monitored.
2. If the spill occurs in a laboratory, leave the fume hood running to minimize the release of volatile nuclear substances to adjacent rooms and hallways.
3. Close off and secure the spill area to prevent entry. Post warning sign(s).
4. Notify the Radiation Safety Officer or person in charge immediately.
5. The Radiation Safety Officer or person in charge will direct personnel decontamination and will decide about decay or cleanup operations.
6. In general, decontaminate personnel by removing contaminated clothing and flushing contaminated skin with lukewarm water and mild soap.
7. Follow the procedures for minor spills (if appropriate).
8. Record the names of all persons involved in the spill. Note the details of any personal contamination.
9. The Radiation Safety Officer or person in charge will arrange for any necessary bioassay measurements.
10. If required, submit a written report to the Radiation Safety Officer or person in charge.
11. The Radiation Safety Officer or person in charge must submit a report to the CNSC Immediately.

Major spill procedures should be implemented whenever minor spill procedures would be inadequate.

**If an exposure may have occurred that is in excess of applicable radiation dose limits, the CNSC shall be notified immediately as required by Section 16 of the Radiation Protection Regulations. CNSC telephone: 1-888-229-2672.**

**Decontamination of Personnel**

If contamination of personnel is suspected **contact the RSO immediately.** A colleague can assist in identifying contaminated areas of the body with a suitable contamination meter or other suitable detection method. By having a colleague perform the survey, contamination of the survey instrument is avoided. In the event of Personnel contamination, the RSO will measure and document the amount of contamination, the time of measurement, the efficacy of decontamination, etc, and, if necessary, file a report to the CNSC.

Reporting skin contamination events to the CNSC is required for the following circumstances:

1. If a nuclear energy worker (NEW) was calculated to have received an extremity (skin) dose above 50mSv.
2. IF a non-NEW was calculated to have received an extremity (skin) dose above 5mSv.

**In <u>ALL</u> instances of personnel contamination, the RSO is required to document, report and investigate every skin contamination event to ensure work practices are optimized and to minimize the probability of repeat occurrences.**

If skin is intact:

- Flush the area with copious amounts of tepid water
- Wet area and apply a mild soap
- Work up a good lather, keep lather wet
- Work lather into the contaminated area by rubbing gently to avoid damaging the intact skin. This process should be continued for three minutes, applying water frequently.
- Rinse thoroughly with tepid water
- Repeat above procedures, if contamination is still present.

If minor cuts, abrasions or open wounds which do not warrant treatment at the hospital is observed:

- Dry clean the affected area with suction and swabs
- Using wet swabs, work away from the area of open wounds taking care not to spread activity over the body or into the wound
- Obtain advice from the RSO

If ingestion of the nuclear substance has occurred, dial 0384 immediately. Security will notify the RSO.

**Fire**

In the event of fire, personnel must follow UPEI's fire procedures for the area. Laboratory personnel should see that the door to the radiation area is closed and take all reasonable steps to prevent the combustion of nuclear substances. Security should be contacted immediately at 0384 who will in turn notify the RSO.

**Any emergency responders should be notified of the presence of nuclear substances in the area.**

**Loss or Theft:**

Nuclear substances must be secured in such a manner that an individual with authorized access to the area, but who is not authorized to use or possess the materials, cannot gain control of the materials.

**The Authorized user must contact the RSO immediately in the event of any actual or suspected loss or theft of a nuclear substance.**

**Required Action:**

In the event of a loss or theft of nuclear substance, prescribed equipment, or prescribed information, a preliminary report must be made to the CNSC **immediately**. This is to be followed by a full written report within 21 days of the occurrence.

It is the responsibility of the RSO to make this report to the CNSC within the required time frame. The CNSC can be contacted by calling 1 844 879 0805.

## General Reporting Requirements for Emergency Situations :

*(Section 29: General Nuclear Safety and Control Regulations)*

Every licensee who becomes aware of any of the following situations shall immediately make a preliminary report to the Commission of the location and circumstances of the situation and of any action that the licensee has taken or proposes to take with respect to it:

- 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 prescribed by the *Radiation Protection Regulations*;
- a release, not authorized by the licence, of a quantity of radioactive nuclear substance into the environment;
- a situation or event that requires the implementation of a contingency plan in accordance with the licence;

- 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; or
- the occurrence of any of the following events:
    - (i) the making of an assignment by or in respect of the licensee under the *Bankruptcy and Insolvency Act*,
    - (ii) the making of a proposal by or in respect of the licensee under the *Bankruptcy and Insolvency Act*,
    - (iii) the filing of a notice of intention by the licensee under the *Bankruptcy and Insolvency Act*,
    - (iv) the filing of a petition for a receiving order against the licensee under the *Bankruptcy and Insolvency Act*,
    - (v) the enforcement by a secured creditor of a security on all or substantially all of the inventory, accounts receivable or other property of the licensee that was acquired for, or used in relation to, a business carried on by the licensee,
    - (vi) the filing in court by the licensee of an application to propose a compromise or an arrangement with its unsecured creditors or any class of them under section 4 of the *Companies' Creditors Arrangement Act*,
    - (vii) the filing in court by the licensee of an application to propose a compromise or an arrangement with its secured creditors or any class of them under section 5 of the *Companies' Creditors Arrangement Act*,
    - (viii) the making of an application for a winding-up order by or in respect of the licensee under the *Winding-up and Restructuring Act*,

- (ix) the making of a liquidation, bankruptcy, insolvency, reorganization or like order in respect of the licensee under provincial or foreign legislation, or
- (x) the making of a liquidation, bankruptcy, insolvency, reorganization or like order in respect of a body corporate that controls the licensee under provincial or foreign legislation.

Every licensee who becomes aware of a situation referred to in subsection (1) shall file a full report of the situation with the Commission within 21 days after becoming aware of it, unless some other period is specified in the licence, and the report shall contain the following information:

- the date, time and location of becoming aware of the situation;
- a description of the situation and the circumstances;
- the probable cause of the situation;
- the effects on the environment, the health and safety of persons and the maintenance of security that have resulted or may result from the situation;
- the effective dose and equivalent dose of radiation received by any person as a result of the situation; and
- the actions that the licensee has taken or proposes to take with respect to the situation.

**UPEI Radioactive Waste Disposal Guidelines:**

Proper handling of radioactive waste is a major concern in any facility licenced to possess radioisotopes. The disposal method must be determined based on level of activity and the physical and chemical form of the radioisotope(s), including association with hazardous properties of non-radioactive components of the waste. The main waste streams are:

1. Liquid aqueous waste (to sewer)
2. Direct Landfill Disposal
3. Radioactive Waste Held for Decay (solid or liquid)
4. Liquid Scintillation Waste
5. Radioactive Material Requiring Off-site Disposal

Another waste stream, Radioactive Carcass Waste, overlaps with Biomedical Waste Procedures and Animal Care and Veterinary Service Waste Procedures the requirements are detailed in a stand-alone procedure.
Regardless of the waste stream, specific sections of this procedure are applicable to all criteria: these include roles and responsibilities, packaging and labeling, records and storage requirements.

**ROLES AND RESPONSIBILITIES**

**Principal Investigators**
-Ensure relevant lab staff/students are following this procedure for the disposal of radioactive waste, and regulatory requirements are met.
-Ensure the lab is equipped with appropriate containers and labels.
-Ensure all documentation and inventory requirements are met.

**Users (students, technicians, visitors etc)**
-Practice due diligence and the principals of ALARA when handling radioactive waste to ensure compliances and minimize exposures.
-Follow this procedure for proper disposal of radioactive waste, and ensure regulatory requirements are met.
-Correctly and completely document all activities associated with waste management on the appropriate forms.

**Criteria associated with waste characteristics:**
-Solutions containing infectious agents must be disinfected by chemical or physical means prior to disposal.
-Aqueous solutions containing toxic material will have the disposal procedure decided upon based on the type of toxic material, its concentration and the radionuclide involved. The

Radiation Safety Officer must be contacted in order to determine an appropriate disposal procedure.

**Waste Disposal Streams**

Each 'Permit for Radioisotope Use', posted in the respective laboratories, outlines waste disposal limitations and allowances. Please refer to your permit to confirm the proper disposal method and quantity limitation per radioisotope, in your laboratory.

Maintain all records of waste disposal on the UPEI Radioisotope Inventory form and keep in the lab binder for inspections. Waste records must including the following:

- Name of Radioisotope
- quantity being disposed of
- method of disposal
- storage location if applicable
- date and initials

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***Note from CNSC: Licence Conditions 2160, Waste Disposal***
*Please note that the licence conditions governing disposal through the municipal sewage system, solid waste disposal and releases to atmosphere, are only for incidental releases associated with licensed activities or authorized activities. A typical release is the washing of contaminated glass ware or other similar inadvertent release.*
***The use of this condition for the deliberate disposal of surplus inventory of unsealed nuclear substances is not appropriate. Licensees must not use this method to dispose of unwanted stocks of material.***

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**Liquid Aqueous Waste**

Liquid aqueous waste often poses minimal risk due to the experimental procedures followed from which this waste is generated. For this reason CNSC has set limits on annual basis for each radioisotope, below these limits the material may be disposed
of to the municipal sewer. RCS monitors these levels to ensure limits are not exceeded. Lab personnel must also monitor the sink areas and associated pipes to ensure they are free of radioactive material. Should plumbing repairs be necessary, additional decontamination measures are required. The following procedures address the needs for in-house controls and compliance to external requirements.

1. Drains suspected of having plumbing problems should not be used. A periodic check beneath the sink is advised to ensure the absence of leaks and contamination.
2. Water should run for a minute or two prior to disposal to wet the surfaces

to minimize risk of material becoming adsorbed. A quick rinse of a detergent is also beneficial.
3. Liquids should be poured directly into the drain hole in order to minimize contact with the sink surfaces. Sink surfaces should be included in the weekly contamination monitoring program.
4. Water should run for two (2) minutes immediately after the disposal to clear the trap of any radioactive solution.
5. Ensure all documentation record requirements are met.

**Direct Landfill Disposal**

In recognition that some radionuclides pose minimal risk, the CNSC has set limits under which the material may be sent directly to landfill. These limits are outlined on the permit posted in the lab. Prior to disposal the following actions must be taken:

1. Deface all radioactive symbols and warnings.
2. Ensure all record documentation requirements are met.
3. Place in the waste in the regular garbage.

**Waste Held for Decay**

-Radioactive material held for decay is usually solid or liquid waste whose half-life is sufficiently short enough (< 3 month) to permit the waste to be held until it decays to an activity where it may be disposed of to landfill or municipal sewer. Liquid waste (aqueous or chemical) may be held in order for the radioactivity to decay below CNSC exemption limits; after which the waste will be disposed of according to its characteristics. In addition, should the waste be a liquid or solvents; the material will need to be stored in a climate control room with sufficient ventilation.

At UPEI, waste for decay must be stored for 10 half lives, in order to allow for the decay to reach background levels. **Prior to sending to regular garbage, all waste must be surveyed with a survey meter to insure activity level is at background levels.**

The following actions must be taken:

1. Deface all radioactive labeling on any items to be disposed. Remove both symbols and written warnings.
2. Store each different radioisotope in a separate storage container. DO not mix types.
3. When the storage container is full, seal the inner bag with tape, place the lid such that the waste will remain contained even if the container was tipped. Sharps containers should not be filled beyond ¾ capacity, then closed with its lid.
4. Use radioisotope tags (from RSO office) to label the sealed container. This tag must include the type of radioisotope, date and initials of users.
5. Ensure all records documentation requirements are met, including survey meter reading.

6. The container may either be held for decay in lab space managed by the permit holder or contact the RSO for storage in the radioisotope suite.
7. Once the contents have been decayed, it is the responsibility of the permit holder to dispose of the waste. The material can be disposed of as regular waste, unless other waste components prohibit disposal to landfill (i.e. chemical).

**Liquid Scintillation Waste**

Liquid Scintillation Waste is an organic based solvent which is used to enhance the detection efficiency of a sample (experimental or monitoring (swipe or leak test)). Biodegradable cocktails are also available; unfortunately they have not been approved for municipal sewer disposal. Non contaminated liquid scintillation fluid is to be disposed of through our chemical waste system, see RSO or contact Central Services for directions.

Prior to disposal the following procedures must be followed:

1. Deface all radioactive labeling on any items to be disposed.
2. Ensure the lid of each vial is securely tightened.
3. Multiple radioisotopes cannot be held in the same waste container.
4. When the container is full, seal the inner bag with tape or tie off, place the lid such that the waste will remain contained should the pail be tipped.
5. Ensure all record documentation requirements are met.
6. If storing for decay, please follow instructions indicated in that section above.
7. If storage for decay is not applicable, please consult with the RSO to facilitate disposal through approved means.

**Radioactive Material Requiring Off-site Disposal**

Depending upon the radionuclide involved and its associated activity, or due to the characteristics of the waste itself, the material may need to be sent off-site. An example of this are sealed sources that were purchased for experimental purposes or sources that were extracted from instruments (liquid scintillation counters, gas chromatographs) require off-site disposal. Ie. Cesium 137

The RSO must be informed when these circumstances arise. Each case must be treated independently in order to determine the needs for storage, documentation, and disposal.

Proper handling of radioactive waste is a major concern in any facility licenced to possess radioisotopes. The disposal method must be determined based on level of activity and the physical and chemical form of the radioisotope(s), including association with hazardous properties of non-radioactive components of the waste.

Radioactive waste may be disposed of to the environment if the level of radioactivity is low enough to satisfy the following criteria:

| COLUMN 1<br><br>Nuclear Substance | COLUMN 2(a)<br>LIMITS<br><br>solids to municipal garbage system (quantity per kilogram) | COLUMN 3(b)<br>LIMITS<br><br>liquids (water soluble) to municipal sewer system (quantity per year) | COLUMN 4(c)<br>LIMITS<br><br>gases to atmosphere (quantity per cubic meter) |
|---|---|---|---|
| Carbon 14 | 3.7 MBq | 10 000 MBq | |
| Chromium 51 | 3.7 MBq | 100 MBq | |
| Hydrogen 3 | 37 MBq | 1 000 000 MBq | 37 kBq |
| Iodine 125 | 0.037 MBq | 100 MBq | |
| Iodine 131 | 0.037 MBq | 10MBq | 0.175 kBq |
| Phosporus 32 | 0.37 MBq | 1 MBq | |
| Sulfur 35 | 0.37 MBq | 1000 MBq | |
| Technetium 99m | 3.7 MBq | 1000 MBq | |

**Safety Precautions with Incineration**

The AVC incinerator is designed with a secondary combustion chamber which allows for complete combustion and reduction of particulate emission. Burning of small amounts of radioactive waste in the University incinerator does not provide concern for atmospheric contamination as long as Scheduled Quantity guidelines are followed. Animal carcasses containing any radioactive residues should be incinerated. Scintillation fluors in plastic vials are safely handled by this method. However, care must be taken to avoid contamination of internal surfaces of the incinerator and anyone handling the ash produced. Incineration must include strict adherence to these precautions. The incinerator is a controlled access area for Authorized Personnel only.

. Notify the RSO before incineration is to occur.
. Wear proper protective clothing. Gloves are a necessity for loading the incinerator. For removal of ash, coveralls, gloves, and a dust mask must be worn.
. Wash thoroughly to avoid any possible transfer from hands.

. Safety monitoring by the RSO of the internal components of the incinerator such as refractory material and duct work must be done prior to work on the incinerator.

. Safety monitoring of workers loading and unloading the incinerator will be conducted by the Radiation Safety Officer at periodic intervals.
. Ash removed from the incinerator after a burn of radioactive materials must be placed in a sealed container, stored in a safe storage site, and monitored until it is safe to dispose of as ordinary trash. For radioisotopes with long half-lives (such as $^{3}H$ and $^{14}C$) dilution with non-contaminated ash may be used to bring the residue level to background levels and permit trash disposal.

**Exemption Quantity**

Exemption Quantity is the quantity of a given radioisotope, as specified in Nuclear Substances and Radiation Devices Regulations. The amount of each radioisotope in Bq required for a Exemption Quantity is found in Appendix A.

**Waste Disposal Records**

Waste disposal is a part of the complete inventory record for a given isotope. Choice of disposal and monitored disposal activity must be recorded for each vial radionuclide received. The Permit Holder is responsible for maintaining a complete Radioisotope Inventory and such records will be checked periodically by the RSO.
See Appendix B for a sample form.

**Waste disposal: Transfer and/or Disposal of Nuclear Substances and Radiation Devices**

Complete records must be maintained for all transfers and disposals of nuclear substances.

**On site disposal:**

All disposals must be recorded on the radioisotope inventory form, and must include the date, the type of radioactive material and physical form, the amount disposed of, the location and the name and/or initials of the person initiating the disposal. The requirements for on site disposal, ie: quantity and form, is outlined on each permit issued by the radiation safety office. Please refer to that permit or contact the RSO for further information.

**Transfer between UPEI permits holders:**

UPEI does allow transfer of radioactive materials/devices between permit holders ONLY. Transfer of radioactive substances to a non-permit holder is strictly forbidden. Any transfer of radioactive material must be accompanied by a UPEI radioisotope transfer form. **The RSO must sign off on any transfer.** The transfer must be documented on the Radioisotope Inventory Form. A new radioisotope inventory form must be filled out by the lab receiving the material, as if the shipment came from outside the university, and added to that laboratory's inventory records.

**Off site transfer/disposal requirements:**

The RSO will facilitate any off site transfers or disposals of nuclear substances/devices. Please contact the RSO at 566-0635 to initiate this process.

The disposal and transfer records must include the following:

- Name, quantity and form of nuclear substance
- Date received
- Name, address and license number of the supplier
- For radiation devices include model and serial number
- For sealed sources include model and serial number
- Activity associated with nuclear substances, radiation devices and/or sealed sources
- Date of transfer or disposal
- Recipient's name, address and CNSC license number
- Name and address of destination
- Verification of safe arrival
-

Anyone transporting radioactive substances at UPEI must complete UPEI Radiation Safety Training and Transport Canada's *Transportation of Dangerous Goods Regulation: Class 7* training. This training is available through the Office of Radiation Safety, and is in compliance with the *CNSC's Packaging and Transportation of Nuclear Substances Regulations*. Records of training must be kept by the RSO, the Employee and the Employer.

All transfers must be approved by the RSO, and the attached Transfer form must be filled out in its entirety.

**TABLE FROM GRAPHICS ON THIS PAGE**

## XI. ANIMALS AND RADIOISOTOPES

The following precautions must be taken when animals are injected with radioactive substances:

1. All patient and waste material monitoring is performed with a survey meter.

2. Live animals containing radioisotopes must be housed in isolation enclosures clearly marked with a radiation caution sign.

3. Patient excreta and bedding is treated as radioactive waste.

4. Radioactive animals should not be petted or groomed to avoid unnecessary exposure.

5. Avoid carrying animals.

6. Patients injected with Tc-99m may be returned to their regular areas or to their owners after 24 hours providing the exposure rate at 30 centimeters from the animal does not exceed 5 μSv/hour. Refer to consolidated licence.

7. The waste must be surveyed and stored in a controlled area (isolation enclosure) until the material reaches background (10 half-lives). At this time, the waste can be disposed of with regular waste and the radiation caution sign removed.

8. Cages must be monitored and decontaminated after use.

9. Animal carcasses must be incinerated and comply with environmental regulations (Table in Appendix A). They may need to be sealed in waste bags, labelled radioactive, and stored in a secure place until radioactivity levels subside. Arrangements for incineration should be made through the RSO.

## XII. TRAINING OF PERSONNEL

The UPEI Radiation Safety Committee requires personnel to receive appropriate training before working with radioisotopes.

ONLY WORKERS, WHO HAVE ATTENDED RADIATION SAFETY TRAINING, WILL BE PERMITTED TO USE NUCLEAR SUBSTANCES AND RADIATION DEVICES.

Personnel making incidental contact with radioactive materials should also receive basic training to enable them to recognize and deal with hazardous situations. These groups may include personnel in shipping/receiving, janitorial staff, secretarial and clerical workers, administrative and management staff, contractor and maintenance staff, security and emergency personnel, students and visits. They should be able to realize when they may be placing themselves at risk, whom to contact in the event of problems with radioactive materials, and what simple steps to take to protect themselves and others until radiation protection personnel arrive. For example, a member of the cleaning staff should be able to recognize a radiation warning symbol, should be familiar with the institution's radioactive waste handling policy and should know whom to call if there is a problem. A shipping/receiving clerk should know what steps should be taken if a leaking package of radioactive material is received.

The training is provided by the Radiation Safety Officer. Records are maintained of dates of the training courses, the course content, and the names of those who attended.

Refresher training for workers using radioactive materials is required every **3 years**.

The radiation safety course for occupationally exposed workers includes the following topics:

1. **Introduction**
   - ! Radiation
   - ! Man-made sources
   - ! Natural sources of radioactivity
2. **Regulations**
   - ! CNSC
   - ! UPEI
3. **Radiation fundamentals**
   - ! Radioactivity and radioactive decay law
   - ! Characteristics of ionizing radiation
   - ! Interaction of radiation with matter
   - ! Units of decay
4. **Personal and Survey Instruments**
   - ! Basic principles of detection instruments
   - ! Survey instrumentation -- calibration and limitation (practical session)

5. **Radiation Exposure**

- ! Biological effects of ionizing radiation
- ! Modes of exposure (internal,external)
- ! Special consideration to the exposure of women of reproductive capacity

**6. Radiation Protection**

- ! Basic principles of radiation protection: time, distance, shielding
- ! Radiation monitoring programs and procedures (bioassays, thermoluminescent dosimeters)

**7. Radiation Safety Program**

- ! Responsibilities of employees and of the institution
- ! Ordering radioactive material
- ! Procedure for receiving radioactive material
- ! Inventory control
- ! Radioactive waste management
- ! User permits

**Transportation of Dangerous Goods: Radioactives Class 7**

Any worker, at UPEI, who transports radioactive substances, to or from, the university, shall be trained in radiation safety as well as Transportation of Dangerous Goods Regulations, class 7. This training is to be conducted by an outside body and will cover the following topics:

* Review of radiation safety topics
* Units of radioactivity and radiation
* Basic radiation safety techniques
* Introduction to the regulation of Class 7 shipments: The TDG "Clear Language" regulations and the Packaging and Transport of Nuclear Substances Regulations
* Definition of TDG terms specific to Class 7 shipments
* Receipt of a Class 7 package
* Responsibilities of the Consignor
* Responsibilities of the Carrier
* Activity and Content Limits for packages
* Requirements for Packaging and Packages
* Requirements and Controls for Transport
* Marking, Labelling and Placards
* Shipper's Declaration of Dangerous Goods Document
* Accident reporting requirements

Upon completion of the course, participants will receive a course certificate and a *Certificate of Training* card which indicates they have taken Class 7 TDG training. A copy of this certificate is to be kept on file in the RSO office and maintained upon the person while transporting radioactive substances.

The training must be renewed every **three years**.

Policy for the Security of Nuclear Substances

Introduction:

Ensuring the security of nuclear substances consists of two components:

a) accountability
b) physical security

Your accountability program has important security ramifications as well as being both a CNSC licence condition as well as a University of Prince Edward Island "Nuclear Substance User Permit" condition. You must keep an accurate record of your inventory in order to know what is missing, should theft or loss occur. Physical security means ensuring that a mechanism is in place either by a locked laboratory door or a locked storage area to ensure that unauthorized removal of unattended nuclear substances does not occur.

The Canadian Nuclear Safety Commission requires, under its "Radioisotope Safety - Intermediate Laboratories" poster that:

a) General Safety -

1. Keep unauthorized persons out of this laboratory. Keep locked when unoccupied.

b) Usage, Storage and Disposal -

1. Store radioisotopes in a locked room or enclosure.
2. Supervise radioisotopes at all times when in use.
3. Maintain up-to-date inventory, usage and disposal records for all radioisotopes.

The Canadian Nuclear Safety Commission further requires under its "General Nuclear Safety and Control Regulations" that:

a) Section 12: Obligations of Licensees

1) implement measures for altering the licensee to the illegal use or removal of a nuclear substance, prescribed substance, prescribed equipment or prescribed information, or the illegal use of a nuclear facility

2) implement measures for alerting the licensee to acts of sabotage or attempted sabotage anywhere at the site of the licenced activity;

3 ) instruct workers on the physical security program at the site of the licenced activity and on their obligations under that program;

b) Section 17: Obligations of Workers

a) promptly inform the licensee or the worker's supervisor of any situation in which the worker believes there may be

- a threat to the maintenance of security or an incident with respect to security

- an act of sabotage, theft, loss or illegal use or possession of a nuclear substance, prescribed equipment or prescribed information,

Nuclear Substances In Use:

a) Constant surveillance and control must be maintained for nuclear substances in use. This means that an individual who has received training, as approved by Dalhousie University's Radiation Safety Committee, in the safe use of radioactive material must be present in the laboratory or the laboratory must be locked if the material is left unsecured in the laboratory.

Nuclear Substances In Storage:

a) All nuclear substances in storage such as stock or stock dilutions must be secured from unauthorized removal or access. The laboratory must be equipped with a lock as well as the storage container within the lab. The storage container must be equipped with a locking mechanism approved by the Radiation Safety Office.

b)When a room containing nuclear substances is unoccupied for periods such as lunch, evenings, meetings etc. the room must be locked. The nuclear substance must also be secured by placing the material in a locked storage container such as a refrigerator or a lock box within the refrigerator provided that it is secured within the unit.

c) The storage of nuclear substances in hallways is not permitted. Any exceptions to this policy must be approved by the Radiation Safety Committee.

d) Radioactive waste containers must be secure from unauthorized removal.

e) Counting rooms must be secured if nuclear substances are present.

Responsibilities:

a) It is the responsibility of the Permit Holder to secure nuclear substances in their possession that are in storage from unauthorized access or removal.

b) It is the responsibility of the Permit Holder or his/her designate to maintain surveillance over nuclear substances in their inventory that are not in storage.

c) If constant surveillance cannot be maintained, the materials must be secured.

d) Nuclear substances must be secured in such a manner that an individual with authorized access to the area, but who is not authorized to use or possess the materials, cannot gain control of the materials.

e) The Permit Holder or his/her designate must contact the RSO immediately if any actual or suspected loss or theft of a nuclear substance.

Required Action:

In the event of a loss or theft of nuclear substance, prescribed equipment, or prescribed information, a preliminary report must be made to the CNSC. This is to be followed by a full written report within 21 days of the occurrence.

It is the responsibility of the RSO to make this report to the CNSC within the required time frame. The CNSC can be contacted by calling 1 844 879 0805.

**ACCESS, CONTROL AND SECURITY**

The Atlantic Veterinary College and Duffy Science Building at UPEI, has key card access for authorized users only, after hours. These key cards are issued by the UPEI Security office after receipt of signed approval from the laboratory supervisor and department chair. Keys to access individual rooms are issued in the same manner. Only authorized users are issued key cards and room specific keys. A list of all key recipients is maintained at the security office.

It is essential that all areas in which radioactive materials are used or stored be secured against unauthorized entry. For small quantities of radioactivity, good locks on doors and/or cabinets will suffice; more elaborate measures may be required in other circumstances.

An annual accounting of all radioisotopes acquired against a User Permit will be reviewed by the Radiation Safety Officer at the end of each financial year, together with an inventory of radioisotopes on hand at the time. A suitable form for logging acquisitions and disposals is illustrated in Appendix E. Copies of this will serve for reporting purposes. Under no circumstances shall the inventory exceed the Possession Limits stated on the Radioisotope User Permit.

Any loss or theft of radioactive materials must be promptly reported to the Radiation Safety Office. The Radiation Safety Officer will make the loss known to local health authorities and to the Canadian Nuclear Safety Commission.

## XIII. DISCIPLINE

The Radiation Safety Committee has the right to impose disciplinary measures on user permit holders who do not comply with the provisions of the Radiation Safety Manual or are otherwise careless in their handling of radioisotopes. Infractions that might call for disciplinary action include, but are not necessarily limited to, the illegal importation to UPEI of radioisotopes, repeated contamination of laboratory facilities, and working with radioisotopes without a permit.

Generally, the response to a first infraction will be a meeting with the Chair of the Radiation Safety Committee and the Radiation Safety Officer. For serious or repeated offenses, the Committee reserves the right to suspend the relevant user permit or, where no permit exists, to recommend alternative action to the Dean. In such cases, the offender will first be given the opportunity to appear before the Committee, along with his or her Department Chair and relevant technical staff, to offer any appropriate defence. Following such a meeting, the Committee will meet to decide whether a permit suspension is in order and what the term of the suspension should be; or whether other action should be recommended, which may include the placement of a formal letter in the faculty member's personal file.

Any disciplinary action taken by the Radiation Safety Committee may be appealed directly to the President of the University.

## REFERENCES

CNSC, Requirements for a Radiation Safety Program for Consolidated Radioisotope Licences, Consultative Document C-121.
CNSC, Nuclear Safety and Control Act

**Appendix A**

Official Documents and Tables

**EXEMPTION QUANTITIES OF**
**RADIOACTIVE PRESCRIBED SUBSTANCES**

| Single Isotopes | MBq |
|---|---|
| Calcium- 45 | 1 |
| Carbon -14 | 100 |
| Cesium-137 | 0.01 |
| Chromium-51 | 1 |
| Cobalt-57 | 0.1 |
| Cobalt-58 | 0.1 |
| Cobalt-60 | 0.1 |
| Hydrogen-3 | 1000 |
| Iodine-125 | 1 |
| Iodine-131 | 0.1 |
| Phosphorus- 32 | 0.01 |
| Phosphorous-33 | 1 |
| Polonium-210 | 0.01 |
| Radium-226 | 0.01 |
| Rubidium-86 | 0.01 |
| Sodium-22 | 0.01 |
| Sulphur-35 | 100 |
| Technetium-99m | 10 |
| Thallium-204 | 0.01 |

**RELATIVE RADIOTOXICITY AND PHYSICAL HALF LIFE OF SOME RADIOISOTOPES**

1. Very High Radiotoxicity

| | | | |
|---|---|---|---|
| Actinium 227 | (21.2 years) | Plutonium 240 | (6760 years) |
| Americium 241 | (458 years) | Plutonium 241 | (13 years) |
| Americium 243 | (7650 years) | Plutonium 242 | ($3.8 \times 10^5$ years) |
| Californium 249 | (360 years) | Polonium 210 | (138 days) |
| Californium 250 | (10 years) | Protactinium 231 | ($3.2 \times 10^4$ years) |
| Californium 252 | (2.6 years) | Radium 223 | (11.7 days) |
| Curium 242 | (163 days) | Radium 226 | (1620 years) |
| Curium 243 | (32 years) | Radium 228 | (6.7 years) |
| Curium 244 | (17.6 years) | Thorium 227 | (18.2 days) |
| Curium 245 | (9320 years) | Thorium 228 | (1.9 years) |
| Curium 246 | (5480 years) | Thorium 230 | ($7.6 \times 10^4$ years) |
| Lead 210 | (21 years) | Uranium 230 | (20.8 days) |
| Neptunium 237 | ($2.1 \times 10^6$ years) | Uranium 232 | (73.6 years) |
| Plutonium 238 | (89 years) | Uranium 233 | ($1.6 \times 10^5$ years) |
| Plutonium 239 | ($2.4 \times 10^4$ years) | Uranium 234 | ($2.5 \times 10^5$ years) |

2. High Radiotoxicity

| | | | |
|---|---|---|---|
| Actinium 228 | (6.1 hours) | Iodine 131 | (8.0 days) |
| Antimony 124 | (60 days) | Iodine 133 | (21 hours) |
| Antimony 125 | (2.7 years) | Iridium 192 | (74 days) |
| Astatine 211 | (7.2 hours) | Lead 212 | (10.6 hours) |
| Barium 140 | (12.8 days) | Manganese 54 | (314 days) |
| Berkelium 249 | (314 days) | Proctactinium 230 | (17 days) |
| Bismuth 207 | (30 years) | Radium 224 | (3.6 days) |
| Bismuth 210 | (5.0 days) | Ruthenium 106 | (1.0 year) |
| Cadmium 115m | (43 days) | Scandium 46 | (84 days) |
| Calcium 45 | (165 days) | Silver 110m | (249 days) |
| Cerium 144 | (285 days) | Sodium 22 | (2.6 years) |
| Cesium 134 | (2.1 years) | Strontium 89 | (50 days) |
| Cesium 137 | (30 years) | Strontium 90 | (28 days) |
| Chlorine 36 | ($3 \times 10^5$ years) | Tantalum 182 | (115 days) |

| | | | |
|---|---|---|---|
| Cobalt 56 | (77 days) | Tellurium 127m | (105 days) |
| Cobalt 60 | (5.3 years) | Tellurium 129m | (33 days) |
| Europium 152 | (13 years) | Terbium 160 | (73 days) |
| Europium 154 | (16 years) | Thallium 204 | (3.8 years) |
| Hafnium 181 | (45 days) | Thorium 234 | (24.1 days) |
| Indium 114m | (50 days) | Thulium 170 | (127 days) |
| Iodine 124 | (4.2 days) | Uranium 236 | ($2.4 \times 10^7$ years) |
| Iodine 125 | (57 days) | Yttrium 91 | (59 days) |
| Iodine 126 | (13 days) | Zirconium 95 | (65 days) |

3. Moderate Radiotoxicity

| | | | |
|---|---|---|---|
| Antimony 122 | (2.8 days) | Iridium 194 | (19 hours) |
| Argon 41 | (1.8 hours) | Iron 52 | (8.3 hours) |
| Arsenic 73 | (76 days) | Iron 55 | (2.7 years) |
| Arsenic 74 | (18 days) | Iron 59 | (45 days) |
| Arsenic 76 | (26.5 hours) | Krypton 85m | (4.4 hours) |
| Arsenic 77 | (39 hours) | Krypton 87 | (78 minutes) |
| Barium 131 | (11.6 days) | Lanthanum 140 | (40.2 hours) |
| Beryllium 7 | (53 days) | Lead 203 | (52 hours) |
| Bismuth 206 | (6.2 days) | Lutetium 177 | (6.8 days) |
| Bismuth 212 | (60.6 minutes) | Manganese 52 | (5.7 days) |
| Cadmium 109 | (1.3 years) | Manganese 56 | (2.6 hours) |
| Cadmium 115 | (2.3 days) | Mercury 197m | (24 hours) |
| Calcium 47 | (4.5 days) | Mercury 197 | (65 hours) |
| Carbon 14 | (5730 years) | Mercury 203 | (47 days) |
| Cerium 143 | (33 hours) | Molybdenum 99 | (66 hours) |
| Cesium 131 | (9.7 days) | Neodymium 147 | (11.1 days) |
| Cesium 136 | (13 days) | Neodymium 149 | (1.8 hours) |
| Chlorine 38 | (37 minutes) | Neptunium 239 | (2.4 days) |
| Chromium 51 | (27.8 days) | Nickel 63 | (92 years) |
| Cobalt 57 | (267 days) | Nickel 65 | (2.6 hours) |
| Cobalt 58 | (71 days) | Niobium 93m | (3.7 years) |
| Copper 64 | (12.9 hours) | Niobium 95 | (35 days) |

| | | | |
|---|---|---|---|
| Dysprosium 165 | (2.3 hours) | Osmium 185 | (94 days) |
| Dysprosium 166 | (80 hours) | Osmium 191 | (15 days) |
| Erbium 169 | (9.4 days) | Osmium 193 | (32 hours) |
| Erbium 171 | (7.5 hours) | Palladium 103 | (17 days) |
| Europium 155 | (1.7 years) | Palladium 109 | (13.5 hours) |
| Europium 152m | (9.2 hours) | Phosphorus 32 | (14.3 days) |
| Gadolinium 153 | (200 day) | Platinum 191 | (3.0 days) |
| Gadolinium 159 | (18 hours) | Platinum 193 | (500 years) |
| Gallium 72 | (14.1 hours) | Platinum 197 | (2.0 hours) |
| Gold 196 | (6.2 days) | Potassium 42 | (12.4 hours) |
| Gold 198 | (64.8 hours) | Potassium 43 | (22 hours) |
| Gold 199 | (3.15 days) | Praseodymium 142 | (19.2 hours) |
| Holmium 166 | ($9 \times 10^4$ years) | Praseodymium 143 | (13.7 days) |
| Indium 115m | (4.4 hours) | Promethium 147 | (2.5 years) |
| Iodine 130 | (12.5 hours) | Promethium 149 | (53 hours) |
| Iodine 132 | (2.3 hours) | Protactinium 233 | (27.4 days) |
| Iodine 134 | (53 minutes) | Radon 220 | (56 seconds) |
| Iodine 135 | (6.7 hours) | Radon 222 | (3.8 days) |
| Iridium 190 | (12 days) | Rhenium 183 | (70 days) |

| | | | |
|---|---|---|---|
| Rhenium 186 | (90 hours) | Tellurium 127 | (9.3 hours) |
| Rhenium 188 | (17 hours) | Tellurium 129 | (67 minutes) |
| Rhodium 105 | (36 hours) | Tellurium 131m | (1.2 days) |
| Rubidium 86 | (18.7 days) | Tellurium 132 | (78 hours) |
| Ruthenium 97 | (2.9 days) | Thallium 200 | (26 hours) |
| Ruthenium 103 | (40 days) | Thallium 201 | (73 hours) |
| Ruthenium 105 | (4.4 hours) | Thallium 202 | (12 days) |
| Samarium 151 | (90 years) | Thorium 231 | (25.6 hours) |
| Samarium 153 | (46.7 hours) | Thulium 171 | (1.9 years) |
| Scandium 47 | (3.4 days) | Tin 113 | (118 days) |
| Scandium 48 | (44 hours) | Tin 125 | (9.4 days) |
| Selenium 75 | (120 days) | Tungsten 181 | (130 days) |
| Silicon 31 | (2.6 hours) | Tungsten 185 | (74 days) |
| Silver 105 | (40 days) | Tungsten 187 | (24 hours) |
| Silver 111 | (7.5 days) | Vanadium 48 | (16.1 days) |
| Sodium 24 | (15 hours) | Xenon 135 | (9.2 hours) |

| | | | |
|---|---|---|---|
| Strontium 85 | (64 days) | Ytterbium 175 | (4.2 days) |
| Strontium 91 | (9.7 hours) | Yttrium 90 | (64.2 hours) |
| Sulfur 35 | (87 days) | Yttrium 92 | (3.5 hours) |
| Technetium 96 | (4.3 days) | Yttrium 93 | (10.1 hours) |
| Technetium 97m | (91 days) | Zinc 65 | (245 days) |
| Technetium 97 | ($2.6 \times 10^6$ years) | Zinc 69m | (14 hours) |
| Technetium 99 | ($2.1 \times 10^5$ years) | Zirconium 97 | (17 hours) |
| Tellurium 125m | (58 days) | | |

4. <u>Slight Radiotoxicity</u>

| | | | |
|---|---|---|---|
| Argon 37 | (34.3 days) | Rhodium 103m | (57 minutes) |
| Cesium 134m | (2.9 hours) | Rubidium 87 | ($5 \times 10^{10}$ years) |
| Cesium 135 | ($2 \times 10^6$ years) | Samarium 147 | ($1.1 \times 10^{11}$ years) |
| Cobalt 58m | (9 hours) | Strontium 85m | (70 minutes) |
| Germanium 71 | (11 days) | Technetium 96m | (52 minutes) |
| Hydrogen 3 | (12.3 years) | Technetium 99m | (6.0 hours) |
| Indium 113m | (1.7 hours) | Thorium 232 | ($1.4 \times 10^{10}$ years) |
| Iodine 129 | ($1.6 \times 10^7$ hours) | Thorium (natural) | - |
| Krypton 85 | (10.4 years) | Uranium 235 | ($7 \times 10^8$ years) |
| Nickel 59 | ($8 \times 10^4$ years) | Uranium 238 | ($4.5 \times 10^9$ years) |
| Niobium 97 | (72 minutes) | Uranium (natural) | - |
| Osmium 191m | (14 hours) | Xenon 131m | (12 days) |
| Oxygen 15 | (2 minutes) | Xenon 133 | (5.3 days) |
| Platinum 193m | (4.4 days) | Yttrium 91m | (50 minutes) |
| Platinum 197m | (82 minutes) | Zinc 69 | (55 minutes) |
| Rhenium 187 | ($4 \times 10^{10}$ years) | | |

**RADIATION MEASUREMENT UNITS**

| | | |
|---|---|---|
| 1 kilocurie (kCi) | ~ | 37 terebecquerel (TBq) |
| 1 curie (Ci) | ~ | 37 gigabecquerel (GBq) |
| 1 millicurie (mCi) | ~ | 37 megabecquerel (MBq) |
| 1 microcurie (uCi) | ~ | 37 kilobecquerel (kBq) |
| 1 nanocurie (nCi) | ~ | 37 becquerel (Bq) |
| 1 picocurie (pCi) | ~ | 37 millibecquerel (mBq) |
| | | |
| 1 terebecquerel (TBq) | ~ | 27 curie (Ci) |
| 1 gigabecquerel (GBq) | ~ | 27 millicurie (mCi) |
| 1 megabecquerel (MBq) | ~ | 27 microcurie (uCi) |
| 1 kilobecquerel (kBq) | ~ | 27 nanocurie (nCi) |
| 1 becquerel (Bq) | ~ | 27 picocurie (pCi) |
| | | |
| 1 kilorad (krad) | = | 10 gray (Gy) |
| 1 rad (rad) | = | 10 milligray (mGy) |
| 1 millirad (mrad) | = | 10 microgray (uGy) |
| 1 microrad (urad) | = | 10 nanogray (nGy) |
| | | |
| 1 kiloroentgen (kR) | ~ | 258 millicoulomb/kg (mC/kg) |
| 1 roentgen (R) | ~ | 258 microcoulomb/kg (uC/kg) |
| 1 milliroentgen (mR) | ~ | 258 nanocoulomb/kg (nC/kg) |
| 1 microroentgen (uR) | ~ | 258 picocoulomb/kg (pC/kg) |
| | | |
| 1 kilorem (krem) | = | 10 sievert (Sv) |
| 1 rem (rem) | = | 10 millisievert (mSv) |
| 1 millirem (mrem) | = | 10 microsievert (uSv) |
| 1 microrem (urem) | = | 10 nanosievert (nSV) |
| | | |
| 1 gray (Gy) | = | 100 rad (rad) |
| 1 milligray (mGy) | = | 100 millirad (mrad) |
| 1 microgray (uGy) | = | 100 microrad (urad) |
| 1 nanogray (nGy) | = | 100 nanorad (nrad) |
| | | |
| 1 coulomb/kg (C/kg) | ~ | 3876 roentgen (R) |
| 1 millicoulomb/kg (mC/kg) | ~ | 3876 milliroentgen (mR) |
| 1 microcoulomb/kg (uC/kg) | ~ | 3876 microroentgen (uR) |
| 1 nanocoulomb/kg (nC/kg) | ~ | 3876 nanoroentgen (nR) |
| | | |
| 1 sievert (Sv) | = | 100 rem (rem) |
| 1 millisievert (mSv) | = | 100 millirem (mrem) |
| 1 microsievert (uSv) | = | 100 microrem (urem) |
| 1 nanosievert (nSv) | = | 100 nanorem (nrem) |

**SOME CHARACTERISTICS OF SELECTED RADIOISOTOPES**

| Isotope | Atomic Number | Principal Energies MeV (%) | | Half Lives | | Critical Organs | Personal Dosimeter Sensitive |
|---|---|---|---|---|---|---|---|
| | | Beta (Max.) | Gamma | Physical | Biological Total Body | | |
| $^{14}C$ | 6 | 0.156(100) | - | 5730 yrs. | 10 days | fat body | no |
| $^{45}Ca$ | 20 | 0.252(100) | - | 165 days | - | bone | yes |
| $^{51}Cr$ | 24 | - | 0.32(9) | 27.8 days | 616 days | total body, G.I. tract | yes |
| $^{137}Cs$ | 55 | 0.51(93) 1.18(7) | 0.66(85) | 30 yrs. | 70 days liver, spleen | total body, muscle | yes |
| $^{3}H$ | 1 | 0.018(100) | - | 12.3 yrs. | 12 days | total body | no |
| $^{125}I$ | 53 | - | 0.035(7) | 60 days | 138 days | thyroid | yes |
| $^{32}P$ | 15 | 1.71(100) | - | 14.3 days | 257 days | bone | yes |
| $^{35}S$ | 16 | 0.17(100) | - | 86.7 days | 90 days | skin, testis | no |

# UPEI Office of Radiation Safety
# Radioactive Device or Substance Transfer Form

**UPEI internal Permit #_____ Date:_____**

**Permit Holder Signature*:_____**

***by siging, the Permit holder is authorizing the transfer of the specified device/substance**

**Internal transfer** ☐ Complete Section A
**External transfer** ☐ Complete Section B

---

**Section A:**

Recipient Permit # _____ Room # _____

Recipient Permit Holder Signature*:_____

* by signing, the recipient permit holder is accepting responsibility for the radioactive substance/device and will document it as part of their inventory.

---

**Section B:**

Recipient CNSC license #_____

Name and Address of recipient:_____
_____
_____

Shipping Company and Tracking Number:_____
_____

Date shipped : _____
Verification of safe arrival*:_____

* verification of safe arrival must be signed off by UPEI permit holder responsible for the shipping. Attach tracking info if available.

---

RSO signature:_____ Date:_____

# University of Prince Edward Island

## Nuclear Energy Worker Designation

EMPLOYEE NAME: _____

In accordance with section 7 of the Radiation Protection regulations of The Nuclear Safety and Control Act, this is to inform you that you are designated as a Nuclear Energy Worker (NEW) within the meaning of the regulations.

Nuclear Energy Worker is defined as any person who, in the course of his/her work, business or occupation, is likely to receive a dose of ionizing radiation in excess of those specified for persons other than NEW's.

| **PERMISSABLE DOSES** | | | |
|---|---|---|---|
| **Person** | | **Period of Time** | **Effective Dose (mSv)** |
| Nuclear Energy Worker (NEW) Including pregnant NEW | | One year dosimetry | 50 |
| | | Five year dosimetry | 100 |
| Pregnant NEW | | Balance of Pregnancy | 4 |
| Any other person | | One calendar year | 1 |
| **Organ or Tissue** | Person | Period of Time | Equivalent Dose (mSv) |
| Lens of Eye | NEW | One year dosimetry | 150 |
| | Any other person | One year | 15 |
| Skin | NEW | One year dosimetry | 500 |
| | Any other person | One year | 50 |
| Hands and Feet | NEW | One year dosimetry | 500 |
| | Any other person | One year | 50 |

**EFFECTS OF EXPOSURE TO RADIATION**

Health effects caused by exposure to ionizing radiation can be grouped into two general categories: prompt and long term effects.

Prompt effects result when very large doses of radiation are absorbed over a short period of time and include radiation burns, radiation sickness, possible death and genetic defects in embryos and fetuses.

Long term effects are not readily apparent and are associated with absorbing lower levels of radiation over longer periods of time. Some examples of long term effects are anemia, leukemia, induction of malignant tumors, impaired fertility and gene tic defects in embryos and fetuses.

**Pregnant Nuclear Energy Workers**

Every NEW who becomes pregnant shall immediately inform the Radiation safety Officer in writing.

The employee is required to accommodate this NEW, to insure that her responsibilities will keep her dose exposure under the limits set out in the chart above.

The regulations read as follows:

*Section 11* ***of the Radiation Protection Regulations requires the following***

- *(1) Every nuclear energy worker who becomes aware that she is pregnant shall immediately inform the licensee in writing.*

- *(2) On being informed by a nuclear energy worker that she is pregnant, the licensee shall, in order to comply with section 13, make any accommodation that will not occasion costs or business inconvenience constituting undue hardship to the licensee.*

**SUMMARY OF RESPONSIBILITIES**

Radiation safety manuals and exposure device operating procedures and a copy of the operating license must be readily available.

Use a properly functioning survey meter which has been calibrated within the last 12 months.

Wear: TLD and Ring Extremity dosimeter

Take all reasonable and necessary precautions to ensure safety of the public, your own safety and the safety of your fellow employees.

**I have read and understood this information:**

SIGNATURE: _____ DATE: _____
Employee

SIGNATURE: _____ DATE: _____
Radiation Safety Officer

**University of Prince Edward Island**

**Office of Radiation Safety**

# POLICY FOR THE TERMINATION OF NUCLEAR SUBSTANCE USE - RENOVATIONS, REMODELS, MOVES, TERMINATIONS

## Introduction:

A principal investigator (PI) is the individual in whose name a ***Nuclear Substance User Permit*** is issued for the use of nuclear substances or radiation emitting devices in their work. ***The principal investigator is responsible to the university for the safe use of such materials or devices by all persons under their supervision. Further, the principal investigator is responsible for the security of these materials from the time they enter the laboratory until they are safely and properly disposed of.***
It is the responsibility of the principal investigator to ensure that the Radiation Safety Office receives advance notification when:

- there is a planned move to new laboratory space

- there is expansion of current laboratory space (renovation)

- there are changes to current laboratory space (renovation/remodel)

- work with nuclear substances ceases

- the principal investigator leaves the university

## Procedures:

Notify the Radiation Safety Office prior to any of the above listed changes or moves, giving the following information

- Principal Investigator, department, phone number

- Time and date of projected change or move

- Location of laboratory

Collect all radioactive waste and dispose of it in an appropriate manner as outlined in University of Prince Edward Island's Radiation Safety manual.

Consolidate all unwanted lead/plastic items (pigs, shields, etc.) into one area for removal by Radiation Safety Officer.

Nuclear substances not designated as waste must be disposed of in one of the following ways:
- An inventory ***transfer within the same department***
- An inventory ***transfer within the university***

- A wipe test survey must be done on all items that are in current use or had ***previously been used*** with nuclear substances. These results must be recorded in your Radiation Safety Manual. Items found to be contaminated must be cleaned and re-surveyed until removable

contamination is as low as reasonably achievable. Wipe test results must also be submitted to the Radiation Safety Office.

A thorough lab survey ***must*** be conducted using both the direct survey method (if appropriate) and an indirect survey (wipe test). Areas surveyed ***must include,*** at the very least:

- Laboratory benches

- Sinks

- Floor areas

- Refrigerator/freezer (exterior and interior)

- Door knobs

- Telephone receivers

- On/off switches

These results must be recorded in your ***Radiation Safety Manual***. Areas found to be contaminated must be cleaned and re-surveyed until removable contamination is as low as reasonably acheivable***.*** Monitoring results must also be submitted to the Radiation Safety Office.

Once the monitoring results have been reviewed by the RSO, all radiation warning signs ***must be removed.*** This would include warning signs on doors, storage areas, sinks etc., The RSO will visit the lab to give final certification that the lab has been decommissioned. The lab will then be removed from the list of approved locations for work with nuclear substances

4. Any piece of heavy/bulky equipment transferred outside your laboratory must be certified ***"clear"*** by the RSO prior to removal by either Facilities Management or "outside" professional movers.

5. Be aware that the RSO must be consulted prior to the disposal of some pieces of equipment, such as liquid scintillation counters, as they often contain a radioactive source.

6. Plans to clean, paint or renovate a vacated or occupied lab must be submitted to the Radiation Safety Officer. Prior to any work beginning, the RSO must review the most current wipe test results for the area and grant official clearance for the work to begin.

***The procedures listed above have been completed. The laboratory has been decommissioned and prepared for vacating/renovation.***

_____ _____

Principal Investigator Date

_____ _____

Department Head/Chair Date

_____ _____

Radiation Safety Officer Date

# University of Prince Edward Island

## APPLICATION FOR RADIOISOTOPE PERMIT AMENDMENT

With reference to Radioisotope User Permit:

NUMBER: _____ EXPIRING: _____

PROJECT DIRECTOR: _____ DEPARTMENT:_____

---

The following changes are requested:

Room(s) _____

User(s) _____

Radioisotope(s) _____

Possession Limits _____

Isotope Use _____

Date: _____ Signature: _____

---

Approved by _____ Date: _____

CHAIR

Radiation Safety Committee

Period of Renewal _____

---

Comments:

# University of Prince Edward Island

## APPLICATION FOR RENEWAL OF
## RADIOISOTOPE USER PERMIT

With reference to Radioisotope User Permit:

NUMBER: _____ EXPIRING: _____

PROJECT DIRECTOR: _____ DEPARTMENT:_____

---

Approval is requested for renewal of the attached permit:

ÉÍÍ»
ÈÍÍ¼ under the same conditions as specified.

OR

ÉÍÍ»
ÈÍÍ¼ changes as indicated.

Date: _____ Signature: _____

---

Approved by _____ Date: _____
CHAIR Radiation Safety Committee

Period of Renewal _____

---

Comments:

# UNIVERSITY OF PRINCE EDWARD ISLAND

## WIPE TEST SURVEY

PERMIT HOLDER _____ LOCATION _____

DATE _____ RADIOISOTOPE USED _____

| | | | |
|---|---|---|---|
| _____ | Centrifuge lid | _____ | Bench |
| _____ | Centrifuge inside | _____ | Bench |
| _____ | Door knob | _____ | Bench |
| _____ | Floor - near fume hood | _____ | Bench |
| _____ | Floor - near work bench | _____Other | _____ |
| _____ | Freezer handle | _____Other | _____ |
| _____ | Fume hood ledge | _____Other | _____ |
| _____ | Fume hood walls | _____Other | _____ |
| _____ | Fume hood work surface | _____Other | _____ |
| _____ | Incubator handle | _____Other | _____ |
| _____ | Incubator shelf | | |
| _____ | Phone handle | | |
| _____ | Refrigerator handle | | |
| _____ | Refrigerator shelf | | |
| _____ | Sink | | |
| _____ | Sink-cup | | |
| _____ | Waste storage container | | |
| _____ | Water bath | | |
| _____ | Vortex | | |

Number areas where wipes are requested.

Attach printout from counters to the back of Survey Sheet.

# UPEI RADIATION SAFETY OFFICE

## WIPE TEST MONITORING SCHEDULE

**Radioisotope_____Year_____Room_____**

| Month | Week 1 Date | Week 2 Date | Week 3 Date | Week 4 Date | Direct Method | Indirect Method |
|---|---|---|---|---|---|---|
| January | | | | | | |
| February | | | | | | |
| March | | | | | | |
| April | | | | | | |
| May | | | | | | |
| June | | | | | | |
| July | | | | | | |
| August | | | | | | |
| September | | | | | | |
| October | | | | | | |
| November | | | | | | |
| December | | | | | | |

RSO Signature_____

# RADIOISOTOPE USER PERMIT

ISSUED BY THE RADIATION SAFETY COMMITTEE
UNIVERSITY OF PRINCE EDWARD ISLAND
AUTHORIZED BY
THE CANADIAN NUCLEAR SAFETY COMMISSION RADIOISOTOPE LICENCE NUMBER **02172-1-03.0**

6. RADIOISOTOPE USER PERMIT NUMBER:
DATE OF ISSUE:
EXPIRY DATE:

7. PRINCIPAL RADIOISOTOPE USER:
8. DEPARTMENT:

9. APPROVED USE, LOCATION(S) & USER(S)

| Room(s) | User(s) | Radionuclide | Possession Limits | Use |
|---|---|---|---|---|
| | | | | |

AMENDMENTS:

10. METHODS OF DISPOSAL

| Radionuclide | Liquids to Sewer MBq per year | Solid to Garbage MBq per kilogram | Gas to Atmosphere kBq per cubic meter |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

11. INVENTORY RECORD LOCATION

12. UNIVERSAL CONDITIONS
- Post this permit in laboratory
- Post and enforce *Rules for Working in a Radioisotope Laboratory*
- Be familiar with and comply with contents of *UPEI Radiation Safety Manual*

CHAIR, RADIATION SAFETY COMMITTEE

## Appendix C

Definition of Terms

**Definition of Terms**

Activity - The number of nuclear transformations (decays or disintegrations) occurring in a given quantity of material per unit time.

Activity, Specific - The activity per unit of mass or volume of a given sample.

Alpha Particle - A charged particle emitted from the nucleus of an atom having mass and positive charge equal to those of a Helium nucleus, i.e. 2 protons and 2 neutrons.

Becquerel Bq - The SI unit of activity; one becquerel equals one nuclear disintegration per second.

Beta Particle - Charged particle emitted from the nucleus of an atom with mass and negative charge equal to those of the electron.

Bremsstrahlung - Photon radiation produced by deceleration of charged particles (usually electrons) passing through matter.

Calibration - Determination of variation from standard, or accuracy, of a measuring instrument to ascertain necessary correction factors.

Committed Dose Equivalent - The total dose equivalent averaged throughout an organ or tissue in the 50 years after intake of a radionuclide into the body.

Contamination, Radioactive - Deposition of radioactive material in any place where it is not desired.

Counter, Geiger-Muller - Highly sensitive, gas-filled radiation-measuring device. It operates at voltages sufficiently high to produce avalanche ionization.

Counter, Scintillation - The combination of scintillator, photomultiplier tube, and associated circuits for counting light emissions produced in the phosphors.

Curie (Ci) - The traditional unit of activity. One curie equals $3.7 \times 10^{10}$ nuclear transformations per second.

Decay, Radioactive - Disintegration of the nucleus of a radioactive atom by spontaneous emission of charged particles and/or photons.

Dose - A measure of the amount of radiation energy absorbed by matter per unit mass. Units are the Rad (traditional unit), Gray (SI unit).

Dose Equivalent - A measure of the biological effect of a dose of radiation. Units are the Rem

(traditional unit), Sievert (SI unit.)
Dose x quality factor (QF) = Dose Equivalent

Dosimeter - An instrument used to determine the radiation dose or dose equivalent received by a person or object.

Exemption Quantity - the quantity of a given radioisotope as specified in Nuclear Safety and Control Act section *Nuclear Substances and Radiation Devices Regulations* on the basis of its radioactive and radiotoxic properties. (See table Appendix A)

Exposure - The amount of electrical charge of one sign produced per unit mass of air by the passage of x-rays or gamma photons. Units are the Roentgen (traditional unit) or the Coulomb/kg (SI unit).

N.B. Exposure is only defined for photons passing through air.

Film Badge - A pack of photographic film that measures radiation exposure for personnel monitoring. The badge may contain two or three films of differing sensitivity and filters to shield parts of the film from certain types of radiation.

Film Ring - A film badge in the form of a finger ring.

Gamma Ray - Ionizing electromagnetic radiation frequently emitted from the nucleus of an atom during radioactive decay.

Gray (Gy) - The SI unit of absorbed dose equal to 1 Joule per kilogram in any medium.

Half-Life, Biological - The time required for the body to eliminate one-half of any substance taken up by an organism through regular process of elimination.

Half-Life, Effective - Time required for a radioactive element in an organism to be diminished by 50% as a result of the combined action of radioactive decay and biological elimination.

$$\text{Effective T } 1/2 = \frac{\text{Biological T } 1/2 \cdot \text{Radioactive T } 1/2}{\text{Biological T } 1/2 + \text{Radioactive T } 1/2}$$

Half-Life, Radioactive - Time required for a radioactive substance to lose 50% of its activity by radioactive decay.

Intake - The amount of radioactive material entering the body via nose, mouth or wound or absorbed through the skin.

Ionization - The process by which a neutral atom or molecule acquires a positive or negative charge through gain or loss of one or more electrons.

Ionizing Radiation - Means any atomic or sub-atomic particle or electromagnetic wave emitted or produced directly or indirectly by a prescribed substance or nuclear facility and having sufficient energy to produce ionization.

Isotopes - Atoms of the same chemical element which have the same number or protons but different nuclear masses.

Monitoring - Periodic or continuous determination of the amount of ionizing radiation or radioactive contamination present in a given region.

Open Source - A source from which radioactive material can readily be removed or escape.

Organ Burden - The amount of radioactive material in a specific organ.

Particle Accelerator - Means equipment that is capable of imparting high kinetic energy to charged particles through interaction with electric or magnetic fields and is primarily designed to produce or use in its operation atomic energy and prescribed substances.

Personnel Monitor - A dosimeter (usually a film badge, thermoluminescent device, or ionization chamber) used for determining the exposure to an individual. Such monitoring is required for all persons who are radiation workers.

Phantom - A volume of material approximating as closely as possible the density and effective atomic number of tissue. Ideally a phantom should behave in respect to absorption of radiation in the same manner as tissue. Radiation dose measurements made within or on a phantom provide a means of determining the radiation dose within or on a body under similar exposure conditions. Some materials commonly used in phantoms are water, perspex polystyrene, Masonite, pressed wood, and beeswax.

Quality Factor (QF) - A factor by which the absorbed dose is multiplied in order to account for the different potentials for biological injury by unit absorbed dose of different types of radiation.

Quenching - the process of inhibiting continuous or multiple discharge in a counter tube which uses gas amplification.

| Radiations | QF |
|---|---|
| 200-250 keV x-rays | 1 |
| Gamma rays, beta particles, electron | 1 |
| Thermal neutrons | 3 |
| Fast neutrons (>0.8 MeV protons, alpha particles) | 10 |
| Heavy recoil nuclei | 20 |

Rad - The traditional unit of absorbed dose equal to 0.01 Joule per kilogram in any medium.

Radioactivity - The phenomenon whereby unstable atoms disintegrate with emission of radiation.

Radioiodine - For the purposes of this document, this term is used in a generic sense to include radioactive iodide, iodate or elemental iodine.

Radioisotope - Radioactive isotope of an element.

Rem - Means a dose of ionizing radiation that has the same biological effects as 200-250 kilovolt x-rays whose energy is absorbed by the body or any tissue or organ thereof in an amount of 0.01 joule per kilogram; (rem)

Roentgen (R) - The traditional unit of exposure

$$1R = 2.58 \cdot 10^{-4} \text{ C/kg in air at STP}$$

Sealed Source - A radioactive source sealed in an impervious container which has sufficient mechanical strength to prevent contact with and dispersion of the radioactive material under the conditions of use and wear for which it was designed.

Sievert (Sv) - The SI unit of dose equivalent. Sv = Gy x QF

Specific Activity - Total activity of a given nuclide per gram of a compound, element, or radioactive nuclide.

Uptake - The amount of radioactive material absorbed from the extracellular fluid by an organ and deposited within that organ.

X-ray - Extranuclear electromagnetic radiation of wavelength shorter than visible light produced by bombarding a metallic target with fast electrons in a vacuum.

This Radiation Safety Manual is prepared and distributed to aid in achieving a high level of safe radioisotope technique at U.P.E.I

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