UNIVERSITY OF
TORONTO

Ionizing Radiation Safety Procedures and Policies Manual

Radiation Protection Services
Office of Environmental Health and Safety

Revision: November 2022

EMERGENCY RESPONSE PROCEDURE FOR RADIOACTIVE MATERIAL SPILL

In the event of a spill of radioactive material, an important consideration is to prevent the spread of the material. All spills of radioactive material must be cleaned up immediately.

When a spill of radioactive material occurs, the following steps must be taken:

1. Injuries first
First aid to the injured persons takes precedence over the spill cleaning. When emergency personnel arrives, advise them about the radioactive materials involved.

2. Alert Everyone in the Area
Ensure that everyone near the accident has been alerted. Mark the area and post a sign if necessary, to prevent anyone from walking on the spilt material.

3. Confine the Spill
Take action to prevent the spread of the material. If the material is dry, lightly dampen it. If it is wet, cover it with dry absorbent.

4. Clear the Area
Remove all persons from the vicinity of the spilt material. Minimize movement in the area.

5. Decontaminate
Apply decontamination procedures in this order: personnel, laboratory, and equipment

6. Summon Aid
If there is any doubt about cleaning up the spill, the spill involves more than 100 Exemption Quantities (EQ) of radioactive material, contamination of personnel, or release of volatile material, contact the Radiation Protection Service.

During normal working hours: **416 946-3265**

Nights & Weekends:
St. George Campus **416-978-2222**
The University of Toronto at Mississauga **905 569-4333**
The University of Toronto at Scarborough **416 978-2222**

State:
- your name, phone number, location (building & room)
- that the accident involves radioactive material
- if there are any injuries

Wait for assistance to arrive.

Table of Contents

Page

EMERGENCY RESPONSE PROCEDURE FOR RADIOACTIVE MATERIAL SPILL 2
INTRODUCTION 6
1. SAFETY RULES AND PROCEDURES 8
1.1. General Safety Practices 8
1.1.1. Work Area Safety 8
1.1.2. Radiation Labeling and Signs 10
1.1.3. Protective Clothing 10
1.1.4. Receiving Radioactive Material 11
1.1.5. Storage of Radioisotopes 12
1.1.6. Radiation Signage/Posting/Labeling 13
1.1.6.1. Containers and devices 13
1.1.6.2. Posting of Signs at Boundaries and Points of Access 13
1.1.6.3. Use of Radiation Warning Symbol 13
1.1.6.4. Rooms and Equipment 14
1.1.6.5. Frivolous Radiation Symbols 14
1.1.7. Radioisotope Handling Precautions 14
1.1.8. Dose Limits and Personal Dosimetry 15
1.1.8.1. Dose Limits 16
1.1.8.2. External Dosimetry 17
1.1.9. Bioassay Requirements 18
1.1.9.1. Thyroid Bioassay 19
1.1.9.2. Urinalyses 20
1.2. Inventory Requirements 20
1.2.1. Sealed Sources 21
1.2.2. Open Sources 22
1.3. Radiation Monitoring Requirements 22
1.3.1. Contamination Criteria 23
1.3.1.1. Contamination Criteria for Non-Fixed Contamination 23
1.3.1.2. Contamination Criteria for Fixed Contamination 23
1.3.2. Procedures for Contamination Monitoring 24
1.3.2.1. Surface Contamination Direct Monitoring 24
1.3.2.2. Surface Contamination Indirect Monitoring 25
1.3.2.3. Measurement of the External Radiation Field 26
1.3.3. Decontamination Procedure 26
1.3.3.1. Safety Precautions 26
1.3.3.2. Preliminary Preparations 27
1.3.3.3. Decontamination 27
1.3.4. Decommissioning Procedures 27
1.3.4.1. Preliminary Preparation 28
1.3.4.2. Decommissioning Work 28
1.4. Sealed Sources Leak Testing 28
2. RADIOACTIVE WASTE HANDLING PROCEDURES 30

3. EMERGENCY PROCEDURES 31
3.1. Basic Emergency Procedures 31
3.2. Radioactive Material Spills 32
3.2.1. Procedure in the Event of a Spill 33
3.3. Radioactive Contamination of Clothing or Skin 34
3.4. Internal Contamination 35
3.5. Security of Radioactive Materials 35
3.6. Theft of Radioactive Material 36
3.7. Fire or Explosion Involving Radioactive Material 36
3.8. Incident Reporting to the CNSC 36
4. RADIATION PROTECTION PROGRAM 38
4.1. University of Toronto Radiation Protection Authority 38
4.1.1. The Radiation Safety Management Organizational Chart 41
4.1.2. Duties of the University of Toronto Radiation Protection Authority 41
4.1.3. UTRPA Policies 42
4.1.3.1. UTRPA Policy on Disciplinary Action 43
4.1.3.2. UTRPA Policy on Security for Radioisotope Facilities 44
4.1.3.3. UTRPA Policy on Decommissioning 45
4.1.3.4. UTRPA Policy on Laboratory Decontamination 46
4.1.3.5. UTRPA Policy on Foodstuffs in Radioisotope Laboratories 47
4.1.3.6. UTRPA Policy on Counting Facilities 48
4.1.3.7. UTRPA Policy on Interrupted Laboratories 49
4.2. Radiation Protection Service 50
4.2.1. Duties of the RPS as Related to Ionizing Radiation 50
4.2.2. Duties of the RPS to the UTRPA 51
4.2.3. Compliance Inspections 51
4.2.4. Services Available from the RPS 52
4.3. Responsibilities of the Permit Holder 53
4.4. Responsibilities of Persons Working with Radioisotopes 54
4.5. Licensing and Administrative Procedures for Use of Radioactive Material 54
4.5.1. University of Toronto Nuclear Substances and Radiation Devices Licence 54
4.5.2. Internal Radioisotope Permit 55
4.5.2.1. Internal Permit Administration 55
4.5.2.2. Application for a Radioisotope Permit 56
4.5.2.3. Content of the Internal Radioisotope Permit 56
4.5.2.4. Amendment of an Existing Permit 58
4.5.2.5. Radioisotope Laboratory Approval 59
4.5.2.6. Renewal of an Existing Permit 59
4.5.2.7. Cancellation of a Radioisotope Permit 59
4.6. Obtaining Radioactive Material 60
4.6.1. Purchase of Radioactive Materials 60
4.6.2. Blanket Orders 60
4.6.3. Gifts, Donations or Exchanges 61
4.6.4. Special Orders 61

4.6.5. Transportation and Transfers of Radioactive Material 61
4.7. Training 62
4.7.1. Radiation Protection Course 62
4.7.2. Project Student Training 63
4.7.3. Sealed Source Users Training 63
4.7.4. Refresher Radiation Protection Training 63
4.7.5. Other Training 63
4.8. Records Management 63
Appendix A - Responsibility Chart for the Management of Radiation Safety at the University of Toronto 66
Appendix B - Responsibility Chart for the Administration of Radiation Safety at the University of Toronto 67
Appendix C - Responsibilities for Reporting to the CNSC 68
Appendix C1 – General Reporting Responsibilities to the CNSC 68
Appendix C2 - Notification to the CNSC of Use of More than 10,000 EQ 68
Appendix C3 - Laboratory Classification 68
Appendix C4 – Other CNSC Reporting Requirements 69
Appendix D - Designation of Nuclear Energy Workers 71
Appendix E - Table of Unit Conversions 74
Appendix F - Common Radionuclides Used in U of T 75
Appendix G - Sealed Sources Leak Test Procedure 87
Appendix H – Summary of Changes from the August 2021 edition of the Manual 93

INTRODUCTION

Radioactive materials are used extensively at the University of Toronto, primarily for biomedical research. The use of radioactive materials is an important and valuable tool in research. Such research could be interrupted or stopped completely without the use of radioactive materials.

The University of Toronto is committed to ensuring that the use of radioactive materials at the University is carried out safely with due regard for employees, students, the public and the environment. The University is also committed to ensuring the security of radioactive materials.

The University of Toronto Radiation Protection Authority (UTRPA) is charged with ensuring an effective radiation safety program. The Radiation Protection Service is charged with the administration of the program.

Through the Radiation Protection Service (RPS) the UTRPA controls all purchases of radioactive material as well as governs the conditions under which it will be used. The Environmental Protection Service (EPS) carries out a comprehensive radioactive waste disposal program to ensure that all wastes are properly managed.

The Radiation Protection Service provides updated information on radiation safety on the radiation protection website (http://www.ehs.utoronto.ca/services/radiation.htm).

The ALARA concept has been adopted by the UTRPA as the basic philosophy governing the use of radioactive materials at the University.

***AS LOW AS REASONABLY ACHIEVABLE* (ALARA)**

The ALARA principle seeks to keep all doses of radiation as low as reasonably achievable, social and economic factors taken into consideration. No practice involving exposure to ionizing radiation may take place if there is no benefit as a result of carrying out the practice. Radiation exposures must be kept below the statutory federal limit regardless of the practice. Persons using radioactive material must endeavour to keep all radiation exposures as low as reasonably achievable.

It is the responsibility of all persons who work with radioactive materials to become familiar with the information presented in this manual and to apply the ALARA principle.

In Canada, the possession and the use of radioactive materials are governed by the Nuclear Safety Control Act and Regulations administered by the Canadian Nuclear Safety Commission (CNSC). The University of Toronto holds a consolidated licence covering the possession use, storage, disposal, import and export of radioactive materials.

For all matters associated with the licences:

- the Designated Radiation Safety Officer is the primary contact person and the Signing Authority* for the University, and
- the Vice-President, Research, and Innovation is the University's corporate officer responsible for identifying the Signing Authority and is the Applicant Authority**.

** By the title of a Signing Authority, the CNSC refers to the person who has prepared the application for the licence and who has been delegated the authority to apply for this specific license on behalf of the applicant or licensee. This person certifies that the information submitted is true and correct to the best of his or her knowledge. The Signing Authority will receive all correspondence from the Commission and will be the Commission's contact for all matters associated with the licence. Since the Signing Authority is the only person who can request changes to a licence, it is recommended that the Radiation Safety Officer be designated as the Signing Authority. The General Nuclear Safety and Control Regulations require that the Commission be advised within 15 days of any change in the information concerning its representatives, including the Signing Authority and/or Health and Safety Officer(s) during the term of the licence.*

*** The CNSC defines the Applicant Authority as one of the applicant's corporate officers who sign to certify that the person identified as the Signing Authority has the authority to prepare and submit the licence application and to represent the applicant. The Applicant Authority understands and acknowledges that all statements and representations made in the licence application and on supplementary pages are binding on the applicant. The Applicant Authority is a position within the applicant's organizational structure with the power to direct the application of financial and human resources. This person would be called upon to implement any corrective measures directed by the CNSC and to ensure that adequate resources were available to rectify potential or actual non-compliance issues. The Applicant Authority derives this designation from his or her position within the management hierarchy (typically the president or vice-president), although other arrangements can be considered.*

1. SAFETY RULES AND PROCEDURES

1.1. General Safety Practices

Radioisotope permits are required for the purchase, possession and use of nuclear substances and radiation devices. Please read section 4.5.2 for more information regarding the internal radioisotope permit. All radioisotope permits are accompanied by a list of authorized users. All persons working with radioactive materials must be listed as authorized radioisotope users under a valid radioisotope permit and have completed up-to-date radiation safety training.

In the use of radioactive materials for teaching or research, consideration must also be given to other physical, chemical and biological hazards that may arise during the procedure. Care should be taken to ensure that the safety requirements necessary for radioisotope use do not compromise the safety requirements for the use of other hazardous agents. Contact the Radiation Protection Service (RPS) if there is any concern or doubt as to the correct handling procedures for mixed hazardous materials.

1.1.1. Work Area Safety

All radioisotopes must be kept locked unless a person authorized to work with radioactive material is present. Failure to comply with this requirement will result in action being taken following the *UTRPA Policy on Disciplinary Action* (sect. 4.1.3.1 of this manual).

1. A copy of the current permit must be posted in all rooms listed on the permit. The permit will show the isotopes which may be used, together with conditions relating to the possible hazards and precautions to be taken. The current radioisotope users list must be made available.

2. A copy of the *Rules for Working with Radioisotopes in a Basic/Intermediate/High-Level Laboratory* or updated information must be posted in each room where more than 1 Exemption Quantity (EQ) of open source radioactive material is handled. The EQ is defined in the Nuclear Substances and Devices Regulations. For EQ values of each radionuclide please see http://www.ehs.utoronto.ca/services/radiation.htm.

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

4. All radioisotope usage areas must be clearly labelled with radiation warning labels.

5. Radioactive waste must not be stored under the work area without adequate shielding and containment, as this may present a risk of radiation exposure to personnel working in this area.

6. The work area must be covered with disposable absorbent materials (*e.g. bench covering material*), which must be immediately discarded if there has been a spillage of any kind. The disposable absorbent material must be replaced regularly.

7. Radioisotope work areas must be kept free of articles that are not relevant to the work carried out. For example, laboratory records and books should be away from possible contamination.

8. Work must be carried out in a fume hood in all cases where radioactive material may be volatilized, by dispersion of dust, or by spraying or splattering. When dusty radioactive materials are handled, a dry-box or transfer hood must be used. Gloves, safety glasses and, if necessary, face masks or respirators, must be worn. The RPS may be contacted for assistance when such conditions are encountered. Due to the volatile nature of iodine, all radio-iodinations must be performed in a fume hood.

9. The fume hood must not be crowded with materials that may disrupt the airflow.

10. The fume hood must be equipped with an alarming flow monitoring device.

11. Fume hoods must not be used for storage unless the materials produce hazardous discharges.

12. Where specified by the radioisotope permit, a radiation dosimeter (whole-body) must be worn at all times. An extremity dosimeter (ring badge) must also be worn if specified by the radioisotope permit for use with a specific radioisotope.

13. Monitoring and contamination control checks must be carried out routinely, within seven days of the usage of radioisotopes at a minimum. Contaminated areas must be cleaned without delay and the cleanliness verified by further contamination control checks.

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

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

16. All equipment and other items used during a radioisotope procedure must be labelled with appropriate radiation warning labels. Where feasible, this equipment should be kept separate from general laboratory use. Warning labels must be removed when the item has been decontaminated.

17. Radioactive solutions must be labelled with radiation warning tape including pertinent information as to the compound, the radioisotope, and its activity. All containers carrying radioactive materials must be properly covered and labelled.

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

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

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

21. Usually, equipment may be cleaned by washing with a laboratory detergent. If necessary a complexing agent or ultrasonic cleaning may be used. If the equipment cannot be satisfactorily decontaminated, it may be stored until the radiation has decayed sufficiently or it must be discarded as radioactive waste. Consult the RPS for assistance.

22. Where possible, coat hooks should be installed near the exit door to encourage laboratory personnel to remove such clothing before leaving the laboratory.

23. Radioisotope work areas in the vicinity where maintenance work is to be carried out must be decontaminated before the start of such work.

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

1.1.2. Radiation Labeling and Signs

1. Containers, devices, rooms, enclosures or equipment where nuclear substances are used or stored, must have radiation labels and signs according to chapter 1.1.6 of this manual.

2. No person shall post or keep posted a sign that indicates the presence of radiation or radioactive material in a place or on a container where the radioactive material indicated on the sign is not present.

1.1.3. Protective Clothing

1. Direct contact with radioactive materials must be avoided by the proper use of protective clothing. As a minimum, this consists of a laboratory coat and disposable,

impervious gloves. Depending on the isotope and operation, double gloves, a full apron, glasses or a face shield may be necessary. Disposable items must be discarded immediately after use.

2. Gloves should be checked frequently for any small punctures that may have developed. Disposable gloves used for radioisotope work must be removed before leaving the laboratory. Where more than 1.35 mCi (50 MBq) of an isotope is handled, or during radio-iodinations, two pairs of gloves are recommended. Gloves must be removed and discarded after use to prevent the spread of contamination, especially to telephones and refrigerator or freezer door handles.

3. Laboratory coats must be fully buttoned and the sleeves extended to cover the wrist of the wearer. Laboratory coats should not be worn outside the laboratory working areas and must not be worn to any eating area or cafeteria.

4. Safety glasses/goggles or appropriate shielding must be used when handling Phosphorus-32 or other high-energy beta-emitting radioisotopes. This will reduce the irradiation of eyes and skin as well as prevent the high radiation doses which may accompany contamination by splashing.

1.1.4. Receiving Radioactive Material

If radioactive materials are properly checked upon receipt, the possibility of contamination due to leaking or defective containers can be minimized. Contaminations may occur due to defective containers that have not been properly checked upon arrival. The following procedures should be used upon receipt of any radioactive material:

1. All radioactive material should be delivered to the responsible laboratory as soon as possible.

2. All shipments should be inspected immediately upon receipt.

3. Wear a laboratory coat and gloves when inspecting the package for any signs of damage or leakage of the contents. Notify the RPS immediately if there is any suspected leakage.

4. Packages containing radioactive material will bear warning labels in accordance with the CNSC Regulations or IAEA requirements.

5. Verify the isotope, activity and labelled material in the package against the order and the information on the packing slip. In the case of non-consistency, contact RPS immediately.

6. If contamination or spillage of material is suspected, open the package only in a fume hood.

7. Swipe test the suspected packaging for removable surface contamination. If contamination is detected, contact the RPS immediately.

8. Log the appropriate information in the laboratory inventory record.

9. Store the radioactive material according to the requirements of the manufacturer in a secure place in a permitted room.

10. Remove gloves and wash hands after handling the material.

11. Check hands and clothing for contamination, and wash hands following these procedures

If no contamination is found on the packaging material, the warning labels must be removed or defaced to remove any reference to radioactive material. The packaging material may then be disposed of as regular waste.

If the radioactive material is in the form of a sealed source with activity larger than 1.35 mCi (50MBq), it must be accompanied by a current Leak Test Certificate. If there is no certificate, **do not use the source**. Contact the RPS.

1.1.5. Storage of Radioisotopes

All radioactive materials must be stored in a secure location to prevent unauthorized access.

All radioactive chemicals must be kept in storage cabinets, refrigerators or freezers that have been designated for this purpose. All cabinets, refrigerators or freezers used for storage of radioactive materials must be marked with a radiation warning sign on the outside. If only a section of a cupboard or freezer is used, the inside area must be marked.

Where necessary, all cabinets, refrigerators or freezers used for the storage of radioactive materials must have a sturdy lock to prevent unauthorized access. This lock must be used in the absence of persons who are responsible for the radioactive material used in the room.

The initial opening of vials and dispensing of radioisotopes (as received from the supplier) must be carried out in a designated radiation work area equipped with absorbent bench covering material. A fume hood should be used if necessary.

Radio-labelled biological materials or other labile radioactive compounds that must be stored below -15 C may be kept in freezers in departmental laboratories as long as they are adequately protected against accidental breakage and are properly labelled.

Although some radioisotopes (such as Carbon-14 and Tritium) produce only small amounts of radiation, many radioisotopes have high energy beta and gamma energies

which can create a potential external radiation hazard (in addition to their internal hazard, if ingested). Such radioisotopes must be kept in suitably shielded containers.

Radioisotopes such as Phosphorous-32 which emit high energy beta radiation should also be kept in containers providing sufficient plexiglass shielding.

1.1.6. Radiation Signage/Posting/Labeling

1.1.6.1. Containers and devices

All containers and radiation devices that contain a radioactive nuclear substance must be labelled with:

- the radiation warning symbol and the words "*RAYONNEMENT*— DANGER — RADIATION"; and
- the name, quantity, date of measurement and form of the nuclear substance in the container or device.

This requirement does not apply in respect of a container or device:

- that is an essential component for the operation of the nuclear facility at which it is located;
- that is used to hold radioactive nuclear substances for current or immediate use and is under the continuous direct observation of the licensee;
- in which the quantity of radioactive nuclear substances is less than or equal to the exemption quantity; or
- that is used exclusively for transporting radioactive nuclear substances and labelled following the *Packaging and Transport of Nuclear Substances Regulations*.

1.1.6.2. Posting of Signs at Boundaries and Points of Access

A durable and legible sign that bears the radiation warning symbol and the words "RAYONNEMENT-DANGER-RADIATION", must be posted, at the boundary of and at every point of access to an area, room or enclosure, if

- there is a radioactive nuclear substance in a quantity greater than 100 times its exemption quantity in the area, room or enclosure; or
- there is a reasonable probability that a person in the area, room or enclosure will be exposed to an effective dose rate greater than 25 µSv/h.

1.1.6.3. Use of Radiation Warning Symbol

Whenever the radiation warning symbol is used:

a. it shall be

(i) fully visible,

(ii) of a size appropriate for the size of the container or device to which it is affixed or attached, or the area, room or enclosure in respect of which it is posted,

(iii) in the proportions depicted in Schedule 3 of the RPR 20-22: https://laws.justice.gc.ca/eng/regulations/sor-2000-203/page-1.html, and

(iv) oriented with one blade pointed downward and centred on the vertical axis; and

b. No wording shall be superimposed on it.

1.1.6.4. Rooms and Equipment

Every room or enclosure where the nuclear substance is used or stored must have, in a visible location, a durable and legible sign that indicates the name or job title and the telephone number of a person who can initiate any required emergency procedure and who can be contacted 24 hours a day.

Every personnel access opening to any equipment fitted with a radiation device must have, in a visible location, a durable and legible sign that bears

- the radiation warning symbol and the words “RAYONNEMENT — DANGER — RADIATION”, and
- the requirement to follow the personnel entry procedures required by the licence.

1.1.6.5. Frivolous Radiation Symbols

To prevent the frivolous use of radiation symbols when the room, area or equipment is no longer used for radioisotope work, and there are no plans for radiation work within a reasonable time, the room, area or equipment must be decommissioned and the radiation signs removed.

1.1.7. Radioisotope Handling Precautions

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

2. Use the minimum quantity necessary to satisfy the objective of the procedure.

3. If a radiation monitor is available, it should be kept away from the radioisotope handling areas to prevent accidental contamination. While materials such as plastic wrap may be used to prevent contamination of the monitor from routine handling, it must be considered that any material placed over the detector will reduce the efficiency of the unit.

4. Due to the high dose rates encountered, work should never be carried out above an open container of Phosphorus-32 or any other high-energy beta emitters.

5. Pipetting by mouth is expressly forbidden. A variety of safe pipettors are available. Wherever feasible, disposable pipettes or tips are to be used.

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

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

8. A radioactive solution must never be poured from one container to another but must be transferred carefully with a pipette.

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

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

11. All radioisotope work areas must be monitored as specified by the CNSC, within seven days of usage at a minimum. Records of monitoring and corrective actions must be maintained and available for inspection.

12. All equipment or devices which are to be sent for repair or maintenance must be decontaminated before being released from the radioisotope laboratory.

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

1.1.8. Dose Limits and Personal Dosimetry

Under the Radiation Protection Regulations of the Canadian Nuclear Safety Commission, there are two classifications of persons who work with radioactive materials: Nuclear Energy Workers and members of the public. Any person working with radioactive materials and having a reasonable probability of exceeding the dose limits for members of the general public must be designated a Nuclear Energy Worker (NEW). The procedure for NEW designation is presented in Appendix D. Separate dose limits are established for each category of personnel handling radioactive materials.

After being informed, in writing, that a female nuclear energy worker is pregnant or she is breastfeeding, the University of Toronto will make all possible accommodations that will not result in costs or business inconvenience constituting undue hardship, to reduce her radiation exposure.

All records regarding the NEW designation and personal dose records (including bioassay results) must be kept by the Radiation Protection Service.

1.1.8.1. Dose Limits

Dose limits for persons working with radioactive materials are set out in the following table:

Person	Period	Effective/Equivalent Dose (mSv)
Nuclear Energy Workers (NEW)	One-year dosimetry period*	50 (whole-body)
		50 (lens of an eye)
		500 (skin)
		500 (hands and feet)
	Five-years dosimetry period**	100 (whole-body)
	One-year dosimetry period*	20 (whole-body)
Pregnant NEW	Balance of the pregnancy	4 (whole-body)
Members of the public	One calendar year	1 (whole-body)
		15 (lens of an eye)
		50 (skin)
		50 (hands and feet)

* Every year from January 1st to December 31st

** The current five-year dosimetry period is 2021.01.01- 2025.12.31

If the dose of radiation received by and committed to a person or an organ or tissue, may have exceeded the dose limits, the person must stop performing any work that is likely to add to the dose. The person may return to radioactive work only with the CNSC approval.

Dose Limits Investigation Levels:
Any whole-body exposure greater than 0.4 mSv/quarter and any equivalent dose to the skin or extremities greater than 10 mSv/quarter must be reported to the Designated Radiation Safety Officer. An investigation must be carried out to determine the cause of the exposure.

Dose Limits Action Levels:
Action levels for external dosimetry are established only for NEW. Any whole body annual dose of a NEW greater than 2 mSv or equivalent dose greater than 20 mSv per year must be reported to the Designated Radiation Safety Officer.

If the action levels (for a NEW) or the dose limits (for members of the public) are reached, the Designated Radiation Safety Officer or his/her delegate will:

- investigate to establish the cause for reaching this dose,
- identify and take action to restore the effectiveness of the protection program and prevent such exposures, and
- notify the Canadian Nuclear Safety Commission.

1.1.8.2. External Dosimetry

The primary objective of personnel external monitoring is to prevent over-exposure by monitoring a radiation exposure history. Personnel external monitoring devices are worn to record the cumulative whole-body dose (measured in mSv) received from occupational exposures to external radiation. Information obtained when the dosimeters are read is useful for evaluating the effectiveness of protective measures and, when necessary, introducing appropriate corrective actions.

The personnel external monitoring devices most commonly employed are the thermoluminescent dosimeter (TLD) and Optically Stimulated Luminescent (OSL) Dosimeters. Other types of radiation badges may also be used. For the TLD radiation badges for personnel monitoring contain detectors situated under filters. When exposed to ionizing radiation, temporary defects are created in the crystal. These defects are stable until the crystal chip is heated and the crystal releases the excitation energy as light, proportional to the absorbed dose. In the case of OSL dosimeters, a passive dosimeter contains sensitive elements that absorb and store energy as the wearer is exposed to ionizing radiation. When the dosimeter is processed, the stored energy is released as light, which is measured. The reported radiation dose is proportional to the amount of light that is measured. To record whole-body exposure, dosimeters are normally worn at the chest or waist levels. If applicable, as in radiology, the dosimeter should be worn under the lead apron.

The radiation badges have certain limitations. Most apparent is that these devices must be "processed" before an indication of exposure can be obtained. The crystal chips are sensitive to ultraviolet light and may produce false results if exposed. The radiation badges must be protected from exposure to ultraviolet light. Radiation badges are also insensitive to the weak beta radiation from ^{3}H, ^{14}C, and ^{35}S. Contamination of the radiation badge with beta emitters may result in non-relevant exposures being recorded. The radiation badge must not be stored in an area where it could receive radiation exposure (e.g. on a laboratory coat and left near a radiation source overnight).

Two types of radiation badges are used to measure personal external dose: a whole-body (used to measure the effective dose) and a ring (used to measure extremity dose).

The whole body radiation dosimeter is required for users of high-energy beta and gamma emitters handling amounts larger than 1.35 mCi (50 MBq). A CNSC-certified dosimetry service provider must be used for external dosimetry measurements. Personal electronic

dosimeters are also issued, in addition to the whole body radiation dosimeter, in special situations (e.g. during pregnancy, first experiment with large quantities of radioactive material, etc.).

Extremity (ring) dosimeters are required; 1) for persons handling more than 1.35 mCi (50 MBq) of high energy beta (like P-32) or gamma emitters, or 2) There is a reasonable probability to receive an equivalent dose to the skin, or the hands and feet, that is greater than 50 mSv in a one-year dosimetry period.

Inquiries about personal monitoring services and doses received should be directed to the RPS (416-946-3265 or 416-978-6846).

To monitor the doses received by persons in the areas where high energy beta or gamma emitters are used in quantities above EQ, area monitors must be installed close to the working area. The area monitors are radiation badges similar to the personal whole body dosimeters but will have instead a person's name, the name of the building and the room number where they are installed. Since the area monitors installed in the proximity of the work area are recording the doses 24/7 their value will indicate the maximum dose a person will be exposed to.

The area, whole-body and ring radiation badges must be supplied and read by a dosimetry service licenced by the CNSC.

1.1.9. Bioassay Requirements

Bioassay techniques are the methods of determining the amount of a particular radioisotope in the body. Two methods can be used for carrying out a bioassay technique: *in vitro* and *in vivo*. *In vitro* techniques are used when a small sample of body fluid or tissue is sampled and analyzed in a detector. In U of T, this is the technique used when urine is monitored for assessing tritium or C-14 uptake.

In vivo techniques involve measuring the amount of radioactive material by placing detectors close to the surface of the body. This technique is used for assessing the uptake of radioiodine in the thyroid or uranium into the lungs.

It is the responsibility of the Permit Holder to ensure that bioassay monitoring is carried out when required by the CNSC and/or UTRPA.

Bioassay and other medical examinations are carried out at the discretion of the UTRPA and the CNSC. Results of such examinations must be made available to the person examined and the appropriate regulatory authorities. Bioassays are typically required following the handling of certain radioisotopes, notably the radioiodine and tritium (the latter only after the handling of large quantities). The permit will stipulate the conditions under which a bioassay is required. The frequency of bioassay monitoring is dictated by the radioisotope and its chemical and radiological behaviour in the body. Bioassay

techniques must be sensitive enough to ensure that any significant amount of radioactive material will be detected.

1.1.9.1. Thyroid Bioassay

Thyroid Monitoring

a) Every person who during 24 hours uses a total quantity of I-124, I-125 or I-131 exceeding:
   1. 2 MBq in an open room,
   2. 200 MBq in a fume hood,
   3. 20,000 MBq in a glove box; or
   4. 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 h 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) Every person who during 24 hours uses a total quantity of I-123 exceeding:
   1. 200 MBq in an open room,
   2. 20,000 MBq in a fume hood,
   3. 2,000,000 MBq in a glove box; or
   4. Any approved quantity in any room, area or enclosure authorized in writing by the CNSC

shall undergo thyroid screening within a period more than 8 hours after the last use that resulted in any of the above limits being exceeded, and less than 48 hours after the limit was exceeded.

c) Every person who is involved in a spill greater than 2 MBq of I-124, I-125 or I-131 or on whom external contamination is detected, shall undergo thyroid screening within a period more than 24 hours after the spill and less than 5 days after the spill or contamination
d) Every person who is involved in a spill greater than 200 MBq of I-123, or on whom external contamination is detected, shall undergo thyroid screening within a period more than 8 hours after the spill and less than 48 hours after the spill or contamination

Thyroid Screening

Persons working with radioiodine must contact the Radiation Protection Service to enrol in the thyroid bioassay screening.

Screening for internal I-123, I-124, I-125 or I-131 shall be performed using a direct measurement of the thyroid with an instrument that can detect 1kBq of I-124, I-125 or I-131, or 10 kBq of I-123.

Thyroid Bioassay Criteria Investigation Levels:

Any thyroid bioassay resulting in a reading of greater than 1 kBq of I-124, I-125 or I-131, or greater than 10 kBq of I-123, must be reported to the Designated Radiation Safety

Officer. The Designated Radiation Safety Officer or his/her delegate must investigate to establish the cause for reaching this level.

Thyroid Bioassay Criteria Action Level:
Any thyroid bioassay resulting in a reading of greater than 10 kBq of I-124, I-125 or I-131, or greater than 100 kBq of I-123, must be reported to the Designated Radiation Safety Officer The Designated Radiation Safety Officer or his/her delegate must:

- Immediately make a preliminary report to the CNSC;
- Have a bioassay performed by a person approved by the CNSC to provide internal dosimetry;
- Investigate to establish the cause for reaching this action level;
- Identify and take action to restore the effectiveness of the radiation protection program and prevent such exposures

1.1.9.2. Urinalysis

Urinalysis bioassays may be required following the handling of significant quantities of H-3 or C-14 (as per Radioisotope Permit conditions).

Due to the specific nature of tritium handling and the quantities involved, the bioassay requirements for tritium are dependent on the nature of the handling. The permit will contain a condition to that effect, where necessary. Contact the Radiation Protection Service to enrol in the tritium bioassay program or to arrange for a bioassay measurement.

Tritium Bioassay Investigation Level:
Any urine bioassay resulting in a reading of greater than 100 kBq/L must be reported to the Designated Radiation Safety Officer. The Designated Radiation Safety Officer or his/her delegate must investigate to establish the cause for reaching this level.

Tritium Bioassay Action Level:
Any urine bioassay resulting in a reading of greater than 1 MBq/litre must be reported to the Designated Radiation Safety Officer. The Designated Radiation Safety Officer or his/her delegate must:

- investigate to establish the cause for reaching this action level,
- identify and take action to restore the effectiveness of the radiation protection program and prevent such exposures, and
- notify the Canadian Nuclear Safety Commission.

1.2. Inventory Requirements

CNSC Regulations require that an inventory of all radioactive material in possession under the terms of the Nuclear Substances and Radiation Devices Licence be maintained. The UTRPA requires that each permit holder maintain an accurate, current

inventory of all radioactive materials in his/her possession. Records must be available for inspection by the RPS or the CNSC at all times.

1.2.1. Sealed Sources

Sealed sources are any radioactive materials where the radioisotope is encapsulated to prevent direct manipulation of the material. They are usually small sources used for instrument calibration. However, sealed sources also include any radioactive material incorporated into a device such as a liquid scintillation counter, gas chromatograph or another such unit. Much larger sealed sources exist in exposure devices or irradiators.

An inventory of all sealed sources held under a radioisotope permit is listed on the permit itself. This will constitute the inventory record provided that it is accurate. It is the responsibility of the permit holder to ensure that the record of sealed sources on the permit is accurate.

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

A permit holder is required to notify the Radiation Protection Service **before the receipt** of any sealed source or device containing a sealed source. Information on the radionuclide, its activity and the device in which it is located must be submitted in writing. The RPS will arrange for the permit amendment.

After the receipt of the sealed source or radiation device, the Radiation Protection Service will verify the presence of the source, the radionuclide, activity and the reference date of the source.

If the source is incorporated in a radiation device, and verification of the source presence cannot be done without disassembling the radiation device, within 30 days from the receipt, the permit holder will:

- Use the radiation device for its intended purpose and confirm that the parameters from the device's manual can be reached
- If the device is not used or the parameters described in the manual cannot be reached, the Permit Holder will contact the manufacturer, or a contractor approved by the CNSC to service the radiation device. The manufacturer or the contractor will disassemble the device, and confirm the presence of the source, radionuclide, activity, and the reference date.

A permit holder is required to notify the Radiation Protection Service **before the disposal or transfer** of any sealed source or a device containing a sealed source. Information on the device and its intended disposition must be submitted to the RPS. In the case of disposal, the RPS will make the appropriate arrangements for the removal of the source

or radiation device from the laboratory and the revision of the permit. In the case of a transfer, the RPS will arrange for the permit revision and the leak testing of the source.

The University of Toronto will not disassemble a radiation device for servicing, disposal or transfer, without written permission from the CNSC.

1.2.2. Open Sources

Open sources are any radioactive material where direct manipulation of the radioisotope or labelled material is possible. This includes most of the radioactive materials in teaching and research.

The UTRPA requires that all permit holders maintain an accurate and current inventory of all open source material in possession under the permit. The inventory records must show the order number, isotope, chemical form, total activity, date received, permit number and information about the use and disposal of the radioactive material.

The procurement of radioactive material must be approved by the RPS (see sect. 4.6). After approval, the EHS database generates a unique number for each source. If multiple stock solutions are obtained from the initial source each one should have its unique identifier. The person receiving the material must initiate the inventory record in the database. The date of disposal must also be entered into the database.

All radioisotope inventory records must be maintained for three years following the disposal of the material. If a Permit Holder leaves the University, these records should be transferred to the RPS. The inventory records must be kept up to date and available for inspection by the RPS or the Canadian Nuclear Safety Commission.

1.3. Radiation Monitoring Requirements

At the end of each experiment involving work with open sources or within 7 days from the moment of starting the experiment, the work area must be checked for contamination. There are two methods used for contamination monitoring: direct monitoring and indirect monitoring.

The direct monitoring method can be used for determining fixed contamination or loose contamination generated by high-energy beta or gamma emitters. A calibrated hand-held contamination instrument must be used for measurements in this method.

The indirect monitoring method can be used for measuring loose contamination. In this method, swipes are taken over an area of 100 cm^2 and measured using a calibrated liquid scintillation counter or automatic gamma counter.

The records of the contamination monitoring must be kept by the Permit Holder and be available in case of an inspection.

The instruments used for contamination monitoring should be calibrated annually and satisfy the criteria for measuring 0.5 Bq/cm^2. The records of the instrument calibration must be kept by the RPS.

1.3.1. Contamination Criteria

There are different criteria for loose (non-fixed) contamination and fixed contamination. The criteria for non-fixed contamination are established in Bq/cm^2 and the ones for fixed contamination in μSv/h.

1.3.1.1. Contamination Criteria for Non-Fixed Contamination

For decontamination, the radionuclides are classified into 3 classes:

- Class A – all alpha emitters and their daughter isotopes, and some beta/gamma emitters
- Class B – long-lived radionuclides which emit beta and/or gamma radiation
- Class C – short-lived radionuclides which emit beta and/or gamma radiation

For a detailed list see Appendix Y of the REGDOC-1.6.1: Licence Application Guide: Nuclear Substances and Radiation Devices - Canadian Nuclear Safety Commission.

The following table contains the contamination criteria for non-fixed contamination in controlled areas (the area where radioactive materials are stored or used) and in public areas.

Radionuclide	Controlled areas	Public areas
Class A	3 Bq/cm^2	0.3 Bq/cm^2
Class B	30 Bq/cm^2	3 Bq/cm^2
Class C	300 Bq/cm^2	30 Bq/cm^2

Any contamination discovered above these levels must be reported immediately to the Designated Radiation Safety Officer. An investigation must be made and the event must be reported to the CNSC if required by the regulations.

Investigation levels are 0.1 Bq/cm^2 for Class A radionuclides and 0.5 Bq/cm^2 for Class B and Class C radionuclides. When contamination is discovered above these investigation levels the area must be decontaminated.

Note: If floor contamination of any level is detected, immediate action (cleaning) is required.

1.3.1.2. Contamination Criteria for Fixed Contamination

When fixed contamination is discovered during a radiation monitoring process the area must be surveyed with a calibrated survey meter. The area must be cleaned until the following criterion is reached: 2.5 μSv/h for controlled areas.

If the above limits cannot be reached the area must be marked with a radiation sign indicating the dose in μSv/h.

The release of any area, room or enclosure containing fixed contamination must be approved in writing by the CNSC.

Following the completion of a contamination survey, all results must be recorded. Weekly results must be available in the laboratory.

1.3.2. Procedures for Contamination Monitoring

A sketch of the floor plan of each room listed on the permit must be prepared in consultation with the Health and Safety Officer. The locations of active benches, sinks, fume hoods, fridges, and freezers, including the floor areas where radioactive materials are used or stored will be numbered for reference purposes.

Before measuring for contamination, the surface should be dry.

1.3.2.1. Surface Contamination Direct Monitoring

Use a surface contamination meter to measure the level of surface contamination if gamma/x-ray or strong beta emitter has been used or stored (e.g.: P-32, In-111, K-42, etc.). To do so:

1. Check if your contamination meter meets the U of T criteria for surface contamination (0.5 Bq/cm^2), and the proper functioning of the instrument (battery, HV, sound, calibration sticker – the instrument should have been calibrated within the last year). If the instrument does not meet the requirements, change the instrument or use the indirect monitoring method.

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

3. Determine the readings of the instrument as close to the surfaces as possible, without touching them (recommended at 1 cm distance) by moving the instrument very slowly (recommended at 1 cm/s) covering each area from the floor plan.

4. Take the higher reading from each area marked on the floor plan.

5. Verify if the threshold value written on the calibration sticker was reached (this value in cpm or cps indicates for that particular instrument if the measurement is above 0.5 Bq/cm^2).

6. If the value read is under the threshold value record the background, the value read and the result is <0.5 Bq/cm^2.

7. If the value read is above the threshold value of the instrument, do the calculation to transform the readings from cpm or cps to Bq/cm^2. Record the background, the value read and the result in Bq/cm^2. If the value measured is above 3 Bq/cm^2 inform RPS immediately.

8. Decontaminate the areas with values above the intervention levels (0.1 Bq/cm^2 for Class A radionuclides and 0.5 Bq/cm^2 for Class B and Class C radionuclides).

9. Repeat steps 1 to 8 until the contamination is removed. Contact the RPS if contamination cannot be removed.

1.3.2.2. Surface Contamination Indirect Monitoring

Use the indirect monitoring technique to measure the level of surface contamination if low-energy beta or alpha emitters have been used/stored (e.g.: H-3, C-14, S-35, etc.). To do so:

1. Swipe 100 cm^2 by pressing the filter paper against the surface. One swipe must be taken from each area from the floor plan.

2. Fold the filter paper and insert it into a liquid scintillation vial.

3. Add scintillation fluid.

4. Use a wide-open window.

5. Perform the measurement.

6. Verify if the threshold value written on the calibration sticker was reached (this value in cpm or cps indicates for that particular instrument if the measurement is above 0.5 Bq/cm^2).

7. If the value read is under the threshold value record the background, the value read and the result is <0.5 Bq/cm^2.

8. If the value read is above the threshold value of the instrument, do the calculation to transform the readings from cpm or cps to Bq/cm^2. Record the background, the value read and the result in Bq/cm^2. If the value measured is above 3 Bq/cm^2 inform RPS immediately.

9. Decontaminate the areas with values above the intervention levels (0.1 Bq/cm^2 for Class A radionuclides and 0.5 Bq/cm^2 for Class B and Class C radionuclides).

10. Repeat steps 1 to 9 until the contamination is removed. Contact the RPS if contamination cannot be removed.

1.3.2.3. Measurement of the External Radiation Field

1. Use a radiation survey meter that is calibrated annually by a qualified service provider following the CNSC staff expectation as described in the Appendix of the CNSC/NSRD Licence Application Guide http://www.nuclearsafety.gc.ca/eng/nuclear-substances/licensing-nuclear-substances-and-radiation-devices/index.cfm

2. At least one annually calibrated survey meter will be available on each campus where high-energy beta or gamma emitting radionuclides are present. The downtown campus calibrated survey meter will be located at the Radiation Protection Service. If required, the Mississauga and Scarborough campuses' survey meters will be located within the receiving area.

3. Check the proper functioning of the instrument (battery, high voltage, sound, calibration sticker) and adapt the scale to the level of the radiation field measured.

4. Move the survey meter very slowly as close as possible without touching the area.

5. Record the highest reading in each area.

6. If the reading indicates values above the criteria from the previous chapter, post a radiation sign indicating the reading, the date and the time of the measurement.

7. The results of all measurements should be kept for three years.

1.3.3. Decontamination Procedure

This procedure applies to all areas or equipment (e.g. refrigerators, freezers, animal cages, etc.), which have contained radioactive materials or were used for radioisotope research and found contaminated during radiation monitoring.

If contamination with biological or chemically hazardous materials is possible, be sure to follow all appropriate precautions for each type of hazard.

1.3.3.1. Safety Precautions

Wear your lab coat, double gloves, and goggles. If a gamma/x-ray or strong beta energy emitting radionuclide with activity above 50 MBq (1.35 mCi) was used/stored, be sure to wear the whole body and ring TLDs.

1. Place trays or paper towels under the equipment to collect the excess water used for cleaning.

2. Dispose of all cleaning materials as radioactive waste.

3. Remove your gloves and lab coat at the end of the work.

4. Wash your hands before leaving the laboratory.

1.3.3.2. Preliminary Preparations

1. Remove all loose materials from the contaminated area. If the materials are for disposal follow the appropriate disposal procedure for each type of material (non-hazardous, hazardous: radioactive, chemical, and biological).

2. Be prepared to collect the water and check it for contamination. To do so, put 0.5 mL of water in a scintillation vial, add 5 mL of scintillation fluid and measure the vial using an LSC (be sure to use the appropriate LSC window depending on the radionuclide used/stored in the area).

3. If the water used for cleaning is contaminated (having radiation levels above the release criteria from Table 2 of the Laboratory Hazardous Waste Management and Disposal Manual, section 5.3 found at https://ehs.utoronto.ca/laboratory-hazardous-waste-management-and-disposal-manual/) dispose of the water as liquid radioactive waste. Be sure to use the appropriate liquid waste container depending on the half-life of the radionuclide used/stored in the equipment. Repeat step 2.

4. If the water used for cleaning is not contaminated, dispose of it in the drain.

1.3.3.3. Decontamination

Clean the area using water and a mild detergent. If after washing using water and mild detergent, the measurement still indicates a level of radioactive contamination above the criteria (see sect. 1.3.1), proceed with more aggressive decontamination. To do so:

1. You can use physical agents such as brushes or abrasive materials. Press hard on the contaminated surface using a circular motion. Start from the outside of the contaminated area and work towards the middle to prevent spreading the contamination.

2. You may require chemical agents (decontamination solutions or ion exchange agents).

3. After using chemical or physical agents, wash again with clean water, allow the surface to dry and measure the contamination (see sect. 1.3.2)

4. If the surface is still contaminated, the contamination will be considered fixed. In this case, contact the Radiation Protection Service. A Health and Safety Officer (HSO) will measure the level of the radiation field and make recommendations for the future use or disposal of the equipment.

1.3.4. Decommissioning Procedures

This procedure applies to rooms, equipment, areas, etc. that were used for working with or storage of radioactive materials, and are no longer needed for this use and/or are intended to be removed from a radioactive active area.

1.3.4.1. Preliminary Preparation

Depending on the amount of radioactive material used or the complexity of the radiation device a hazard assessment may need to be performed before starting any decommissioning work. To receive help with the hazard assessment please contact the Radiation Protection Service 30 days before the intended decommissioning date. A more detailed decommissioning plan will be developed if required by the HSO.

In a simpler situation when a room, enclosure, area or equipment was used for working or storage of small amounts of radioactive material you may proceed by removing the material. If the radioactive material can be reused in another permitted area, after obtaining the RSO approval it will be transferred to that area following all transfer procedures. If the material is for disposal, it will be disposed of following the disposal procedures.

All sealed sources must be removed/transferred/disposed of by the Radiation Protection Service. All instruments or radiation devices containing sealed sources must be decommissioned by the Radiation Protection Service

1.3.4.2. Decommissioning Work

The decommissioning work must be performed following section 4.1.3.3 UTRPA Policy on Decommissioning.

After the removal of all radioactive materials, a contamination survey must be performed following the procedure from section 1.3.2. If the survey indicates values above the contamination criteria (see sect. 1.3.1) decontamination of the respective area must be performed following section 1.3.3. Decontamination must be repeated until contamination criteria are met.

After ensuring that the room, area or equipment satisfies the contamination criteria, all radiation signs, laboratory rules, radioisotope permits, etc. must be removed.

When the above steps are completed the Permit Holder or the Department Chair must contact the Radiation Protection Service. An HSO will audit the decommissioning work by performing a separate contamination survey. The HSO will complete the decommissioning report and will remove the room, area, and equipment from the list of commissioned rooms, areas or equipment. When required, the Designated Radiation Safety Officer will inform the CNSC.

1.4. Sealed Sources Leak Testing

Any sealed source with activity larger than 50 MBq (1.35 mCi) must be tested for leakage by the Radiation Protection Service as follow:

- Every 24 months if the source is in storage

- Every 12 months if the source is located in a radiation device
- Every 6 months if the source is not located in a radiation device and it is used
- Immediately before using it if the source was in storage for 12 months or more
- Immediately after an event that may damage the source

The testing is performed by an HSO following the procedure from Appendix G of this manual. The leak test certificate is verified and signed by the Designated Radiation Safety Officer The original leak test certificate is kept in a file by the RPS and a copy is sent to the Permit Holder to be posted in the vicinity of the source.

Note: In case of a leakage larger than 200 Bq the use of the source must be stopped immediately, all necessary measures to control the spread of contamination must be taken and the leakage must be reported to the CNSC.

2. RADIOACTIVE WASTE HANDLING PROCEDURES

All nuclear substances associated with the licenced activities are collected and disposed of as radioactive waste.

Radioactive waste is collected by the Environmental Protection Service.

Radioactive waste handling procedures are outlined in the Laboratory Hazardous Waste Management Manual, section 5.3. This manual can be found on the Office of Environmental Health and Safety website: https://ehs.utoronto.ca/laboratory-hazardous-waste-management-and-disposal-manual/.

The university will not use the licence conditions for deliberate disposal through the municipal sewage system, solid waste disposal and releases to the atmosphere of surplus inventory of nuclear substances.

3. EMERGENCY PROCEDURES

3.1. Basic Emergency Procedures

IN CASE OF AN EMERGENCY INVOLVING RADIOACTIVE MATERIAL	
Contact:	
Radiation Protection Service (normal working hours)	**416 946-3265**
After hours, nights, weekends and holidays:	
Contact the Campus Police	
St. George Campus	**416 978-2222**
University of Toronto Mississauga Campus	**905 569-4333**
University of Toronto Scarborough Campus	**416 978-2222**

First aid to any injuries takes precedence over the decontamination procedures
In case of injuries requiring medical help, summon aid and inform medical personnel that radioactive materials are involved. Clean the radioactive materials in a wound by removing the material from the inside toward the outside of the wound.

Alert Everyone in the Area
Ensure that everyone in the vicinity of the incident has been alerted, especially for large laboratories or those divided into multiple rooms.

Confine the emergency
Restrict access to the area involved in the emergency. If the material is a liquid, use some absorbent material to prevent its spread outside the designated area. If the material is dry, lightly dampen it. When controlling access, define an area large enough to accommodate the incident such that persons at the boundary are not affected by the emergency. For example, the restricted area around a spill of radioactive material should accommodate the possibility of the material spreading, provide sufficient room to accommodate cleaning procedures and should minimize potential exposure to other personnel.

Clear the area
Remove all persons from the immediate vicinity of the emergency. Ensure a sufficient separation such that persons near to the incident cannot become exposed. Generally, this will involve marking an area with warning signs or tape, closing laboratory doors, etc.

Summon aid
In an emergency, it is mandatory to notify the appropriate personnel so that the incident can be rectified without additional risk to members of the University community.

Calls to summon aid should be made from outside the emergency area. A person not immediately involved in any of the above activities should be directed to make the appropriate notification.

3.2. Radioactive Material Spills

Good training and proper work practices will minimize the risk of accidents. In case an accident happens, you should not panic. Read and follow the spill procedure CNSC INFO-0743 found at the link: http://nuclearsafety.gc.ca/eng/nuclear-substances/licensing-nuclear-substances-and-radiation-devices/index.cfm. This procedure is posted in your laboratory.

Act according to this procedure to minimize any possible exposures you should:

1. Know the hazards of the radioisotopes you work with by reading all the information provided by the vendor/supplier.

2. Know where the emergency phone numbers are posted (Police, Permit Holder, RPS).

3. Know where the emergency spill kit is located in your lab. Be familiar with the content of the spill kit.

A typical spill kit should contain:

Item	Purpose
• chalk, marker, tape	mark spill area
• paper towels, benchkote paper	containment and absorption
• box for sharps	broken glass, needles
• tongs/forceps	safe handling
• decontamination solution	washing, decontamination
• scouring powder, scrub brush	aggressive decontamination

In normal radioisotope laboratory operations, spills of radioactive material will be the most common form of an emergency. In the event of any spill of radioactive material, the correct steps must be taken promptly to avoid the spread of contamination.

The most important immediate action is to prevent the spread of the material (provided that it can be accomplished without creating any additional hazard).

Any spill should be reported to the Permit Holder. Major spills (spills that involve more than 100 EQ, contamination of personnel, or release of volatile material) must be reported to the RPS. Also if there is a doubt about the cleaning procedure or if the cleaning is not effective, contact the RPS.

If an exposure may have occurred that is more than applicable radiation dose limits, the

RPS must inform the CNSC as required by section 3.8 of this manual.

Records of contamination monitoring measurements must be kept for 3 years. They should contain the results before cleaning, any results obtained during the cleaning, and the final record to demonstrate that the area has been decontaminated to acceptable levels.

3.2.1. Procedure in the Event of a Spill

After taking the actions noted in section 3.1 (ensure first aid to the injured persons, alert everyone in the area, confine the spill and remove unwanted persons from the area), proceed with the decontamination, as described below:

- wash hands in case they were contaminated during the accident
- use the appropriate detector to monitor clothing and hands. If a personal contamination has occurred, treat it first by washing, changing clothes, etc.
- wear a laboratory coat, properly buttoned up, to prevent contamination of clothing
- wear 2 pairs of latex gloves to protect the hands if one pair of gloves develops a defect
- use a respirator if airborne material may be present, and place all such material in the fume hood
- drop dry absorbent material on wet spills
- use water or the appropriate organic solvent to lightly dampen dry materials
- mark the location and extent of the contamination with a wax pencil or radiation warning tape
- do not let anyone leave the contaminated area without being checked for contamination
- remember to check the shoes for contamination
- begin decontamination procedures as soon as possible - any experiment or procedure in progress must be set aside until the decontamination is complete
- work inwards, from the area of lowest contamination, towards the highest contamination
- ensure that sufficient cleansers or commercial decontamination agents are available to properly clean the area to eliminate the need to leave the clean-up area unnecessarily
- gently wash the affected area with water and a cleaning agent
- wash and rinse the affected areas several times
- treat all contaminated materials as radioactive waste (e.g. absorbent paper)
- continue washing until the contamination is removed or cannot be reduced any further
- monitor the area after each wash and rinse to check progress in decontamination.

After the procedure has been completed, use a swipe test to check for the presence of any residual contamination. If the area is clean, record all results in the logbook for the

room. If cleaning is ineffective at removing the contamination, contact the RPS for assistance.

3.3. Radioactive Contamination of Clothing or Skin

If personnel is suspected of being contaminated with radioactive material, complete the following:

- immediately assess the location and extent of the contamination
- use appropriate monitoring procedures, to locate the material and provide an assessment of the amount
- remove any contaminated clothing, place it in a plastic bag, label the contents, and tape shut
- monitor to determine if any skin contamination has occurred, its location and the extent
- If contamination involves I-123, I-124, I-125 or I-131 contact RPS for a thyroid screening

If contamination of the skin is identified, notify the permit holder and RPS immediately. If necessary, the Designated Radiation Safety Officer or his/her delegate will inform the CNSC immediately and will prepare and send a report to the CNSC within 21 days (according to section 3.8 of this Manual) under the following circumstances:

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

If the skin is intact

- the flush contaminated area with copious amounts of warm water
- wet hands and apply mild soap or detergent, lather well with plenty of water
- wash for 2 to 3 minutes and rinse thoroughly, keeping rinse water confined to the contaminated area as much as possible
- monitor the effectiveness of removal by use of appropriate survey techniques
- repeat wash/rinse procedure if necessary
- if further washing does not remove the contamination, contact the RPS.

In case of serious injuries

The treatment of serious injuries takes precedence over any other consideration. Proceed as follows:

- assist injured personnel immediately, regardless of radiation contamination
- contact the Campus Police, requesting emergency medical assistance
- advise the Campus Police of the radiation hazard, the amount and chemical form of the material, and any other pertinent information

- direct someone to meet the emergency medical personnel
- advise emergency personnel of the radioactive material, extent of contamination, nature of the injuries and other relevant information. Be available for further consultation
- confine the spill to ensure that the victim cannot be further contaminated by radioactive material, and to minimize the possibility of contamination of emergency medical personnel
- notify permit holder immediately
- notify the RPS.

In case of minor wounds NOT requiring hospitalization
Minor wounds can be treated immediately at or near the site of the accident. Proceed as follows:

- clean the affected area with swabs
- wash the contaminated wound with warm water - encourage minor bleeding
- in the case of facial wounds, protect the mouth, ears, eyes, and nose from contamination
- wash wound with mild soap and water, repeating as necessary
- after decontamination, apply first aid dressing
- notify the permit holder and RPS immediately.

3.4. Internal Contamination

If internal contamination is suspected, the RPS should be notified immediately.

If the material is chemically toxic as well as radioactive, treat for chemical toxicity first. Prompt medical attention is the best procedure.

Personnel working with radioactive material should understand its chemical and radioactive properties to ensure that a prompt response to a suspected intake of material can be carried out.

3.5. Security of Radioactive Materials

All open and sealed sources must be kept secure at all times. To achieve this, security measures implemented are proportional to the risk and the quantity of radioactive material present.

The rooms in which small quantities (under 5 ALI e.g. basic level laboratories) of radioactive materials are used or stored will have a lockable door. The radioactive materials will be stored in a lockable space (e.g.: a lockable fridge or freezer, lockable box, etc.). The doors will be kept locked when no users are present in the room. The rooms at ground level will have window protection.

The intermediate and high-level laboratories will have the same security measures as basic level laboratories but the doors must be kept locked at all times, and access is restricted to authorized personnel.

The irradiator rooms will have control access, room entrance detection, and area motion detectors connected with the University Police 24/7.

3.6. Theft of Radioactive Material

The theft or other loss of radioactive material is a serious offence and **must be reported to the RPS immediately**. This applies regardless of whether the incident was reported to the Campus Police.

After a suspected theft or loss, the amount of material that may be missing must be determined from proper inventory records. All particulars involving the material should be reported.

If required, the Designated Radiation Safety Officer will notify the CNSC (see section 3.8 of this Manual) and further information or investigation must be performed.

3.7. Fire or Explosion Involving Radioactive Material

In the event of a fire or explosion where radioactive material is known or suspected to be present, **the RPS must be notified immediately**. Emergency personnel responding to the scene should be advised that radioactive materials may be present. Any information on their location amounts involved and special precautions should be provided.

Personnel having specific information on radiation hazards in the area involved should be available for consultation with members of the **RPS**.

3.8. Incident Reporting to the CNSC

The Designated Radiation Safety Officer, or the alternate HSO, will send to the CNSC a preliminary report immediately after becoming aware of an incident as defined in the General Nuclear Safety and Control Regulations article 29, Nuclear Substances and Radiation Devices Regulations article 38, Packaging and Transport of Nuclear Substances Regulations article 37/38 and Radiation Protection Regulations Article 16 (see more information about the incident reporting in Appendix C). The immediate report must be done by phoning the 24 hr CNSC Duty Officer at 613-995-0479 or toll-free # 1-844-879-0805.

The preliminary report must contain the location, the circumstances of the situation and any action that was taken by the University or is proposed to be taken.

All preliminary reports must be followed by a full incident investigation report filed with the CNSC within 21 days after the day on which the University became aware of the incident.

The 21-day report must contain, at least:

1. A description of the situation, the circumstances and the problem

2. The probable cause of the situation

3. An analysis of the root causes of the incident

4. The nuclear substances, the quantity and, if applicable, the brand name, model and serial number of the radiation device involved

5. The date, time and location where the situation occurred or, if unknown, the approximate date, time and location, and the date and time of becoming aware of the situation

6. The actions were taken by the University to re-establish the normal operations

7. The actions are taken or proposed to be taken by the University to prevent the recurrence of the situation

8. If the situation involved an exposure device, the qualifications of the workers, including any trainee, who was involved

9. The effective dose and the equivalent dose received by any person as a result of the situation

10. The health and safety of persons, the effects on the environment and the maintenance of security that has resulted or may result from the situation.

4. RADIATION PROTECTION PROGRAM

4.1. University of Toronto Radiation Protection Authority

At the University of Toronto, work with open and sealed radioisotope sources is carried out. As well, devices capable of producing radiation are used extensively in research and teaching. All work with radiation, regardless of how small a radiation dose, is regarded as a potential risk to health. All rules are established to minimize exposure to such radiation, ensure safe working conditions, the security of radioactive materials, and provide for the protection of the environment.

In 1971, the CNSC first granted to the University of Toronto a Consolidated Radioisotope Licence. Since then the consolidated licence has been renewed many times while other licences have been granted to the University.

The Governing Council of the University delegates to the University of Toronto Radiation Protection Authority (UTRPA) the responsibility for all aspects of radiation safety and security of radioactive materials at the University of Toronto. The UTRPA reports to the Vice-President, Research and Innovation, and the University's Governing Council.

The members of the UTRPA are appointed by the Vice-President, Research and Innovation, on the recommendation of the UTRPA. The UTRPA will have a minimum of 8 Members with at least four Senior Members from the Academic staff having considerable professional experience in the use of radioactive materials. The Designated Radiation Safety Officer will act as the Secretary of the UTRPA. All inquiries regarding radiation protection are to be directed to the Designated Radiation Safety Officer at 416-946-3265.

The UTRPA is committed to the concept of ***ALARA*** where all radiation exposures are kept ***A***s ***L***ow ***A***s ***R***easonably ***A***chievable, with social and economic factors taken into consideration. Also, the UTRPA will actively promote strong safety culture among all faculty, staff, and students involved in working with radioactive materials.

Ensuring compliance with the terms of Federal and Provincial Statutory regulations for the procurement and management of radioactive materials within the University is an important responsibility of the UTRPA.

The UTRPA wishes to emphasize the vital role of all users in the maintenance of a strong program of radiation safety at the University. Every person responsible for the use of radioisotopes or radiation-emitting devices must be thoroughly familiar with this manual and all policies and procedures for the responsible handling of radioactive materials. These requirements apply equally to the use of radioactive materials in teaching and research.

University of Toronto Radiation Protection Authority

Terms of Reference

The University of Toronto Radiation Protection Authority (UTRPA) is charged with oversight of the program of radiation protection at the University of Toronto. The UTRPA has been delegated authority by the Governing Council to enforce and maintain the required standards of radiation protection at the University.

All research carried out under the auspices of the University and/or in University-controlled facilities must comply with all applicable rules and regulations, including, but not limited to the following Federal and Provincial Regulations issued by the Canadian Nuclear Safety Commission (CNSC), the federal Department of National Health & Welfare (Radiation Protection Division), and the provincial Ministries of Health and Labour. These requirements apply regardless of the research funding source.

The University affirms that the primary responsibility for the regulatory compliance, safety and security of staff, students and the public lies with the Permit Holder using or authorizing the use of all sources of ionizing radiation and non-ionizing radiation (both materials and instruments). In addition, the University (through the members of the Governing Council and senior administrators) acknowledges a responsibility to provide a policy and procedural framework designed to ensure that work with radiation is being conducted safely and in conformity with the relevant Acts and Regulations. Permit Holder who holds a radioisotope or X-ray permit must provide adequate training to all personnel handling an X-ray device and/or radioactive prescribed materials under their supervision in the proper use, handling, storage and disposal of these materials. Radioisotope and X-ray permit holders must conform to the conditions of the permit, the UTRPA Policies and Procedures, the requirements of the CNSC, and any Ministry of Labour Regulations. They also must ensure adequate security of all laboratories under their supervision. Failure to comply could result in the cancellation of the radioisotope or X-ray permit.

Functions

The Vice-President, Research, and Innovation have delegated to the UTRPA the following functions, powers, and duties:

1. Establishing and monitoring policy, rules, and procedures for the radiation used at the University. All policies, rules, and procedures established must comply with those set out by the CNSC and other relevant Acts and Regulations.
2. Responsibility for the overall program of radiation protection at the University, which includes all sources of ionizing radiation and non-ionizing radiation (both materials and instruments), for whatever use, for all research carried out under the auspices of the University and/or in University-controlled facilities;
3. Responsibility for negotiating with the appropriate authorities regarding the use of radiation sources, handling, storage, and disposal of radioactive prescribed materials

and for the installation, development and operating of equipment producing ionizing radiation & non-ionizing radiation, as well as the security of radioactive materials;
4. Considering and advising on the establishment of radiation emergency measures within the University and cooperation and integration with other authorities;
5. Conducting educational programs as required concerning radiation hazards and promoting a radiation safety culture among the members of the faculty, University staff, students, and visitors;
6. Consulting with appropriate persons or institutions and revising the policies and procedures for the use of radioactive prescribed materials as circumstances warrant;
7. Reconsidering decisions concerning suspension, restriction or termination of the operation of a radiation device or the use of radioactive materials;
8. Reporting annually to the Vice-President, Research and Innovation on the operation of the Radiation Safety Program.

Membership

Academic members are appointed to the UTRPA for terms of four years (renewable) by the Vice-President, Research, and Innovation. The UTRPA membership consists of a minimum of twelve (12) members, eight (8) academic members with expertise in radiation or the use of radioactive materials and the following *ex officio* non-academic staff:

- Director, Research Safety and Compliance, EHS,
- U of T Designated Radiation Safety Officer, EHS,
- Manager, Environmental Protection Services, F&S
- Manager, Research Oversight and Compliance, ROCO.

The UTRPA Chair is appointed by the Vice-President, Research and Innovation for a four-year term (renewable one time) and the Chair is normally chosen from the existing academic member cohort on the UTRPA. The Chair and committee members shall have experience in working with radioactive material. The duties of the Chair shall include: presiding at meetings, reviewing Committee minutes before distribution and preparing meeting agendas, ensuring that the Committee carries out its functions as set out in all applicable Regulations and these Terms of Reference, and ensuring that new members understand their duties, powers, and responsibilities as prescribed in the Regulations and these Terms of Reference, and ensures that accurate records of the activities of the Committee are kept. The Chair shall be an *ex officio* member of the Senior Management Committee on Health and Safety. The Chair approves radioisotope permits and acts on behalf of the UTRPA to conduct routine business between scheduled meetings.

Resource People and Experts

The UTRPA relies on expertise from the EHS Radiation Protection Services, and F&S Environmental Protection Services, and may also call upon external or other University experts when necessary. These individuals may be called upon to attend meetings but do not have voting privileges.

Meetings

The Committee shall meet at least once per year and Minutes of the meeting shall be

taken and kept on file. The Office of Environmental Health and Safety provides administrative support to the Committee.

Reconsideration of Decisions
If new information can be provided that may affect a previous decision of the Committee, a Permit Holder may request that the Committee reconsider the previous decision. In such circumstances, the Permit Holder shall notify the Chair of the UTRPA in writing, providing all relevant documentation and a detailed basis for the request. The Chair will provide the materials submitted by the Permit Holder to the UTRPA members, and he/she shall convene a special meeting of the UTRPA to review the request. This meeting shall normally take place within 30 days of receipt of materials from the Permit Holder. The decision of the UTRPA regarding the reconsideration request is final.

Quorum
A quorum shall be required for all issues that are brought to a vote by the committee. A quorum is six (6) of the academic members and one (1) non-academic staff.

Updates to the Terms of Reference
The Committee may recommend changes to these Terms of Reference at any time. All changes to these Terms of Reference must be approved by the Vice-President, Research and Innovation.

4.1.1. The Radiation Safety Management Organizational Chart

The responsibility chart for the management of radiation safety at the University of Toronto is presented in Appendix A.

4.1.2. Duties of the University of Toronto Radiation Protection Authority

The UTRPA has the following duties and responsibilities.

- meet at least once a year
- establish and review the training and experience of users of radioactive materials to ensure that they can perform their duties safely and follow regulatory and local requirements
- maintain a program to ensure that all persons, whose duties may require them to work in the vicinity of radioactive material, are properly instructed
- designate any person to be considered as a "Nuclear Energy Worker" under the *Nuclear Safety and Control Regulations*
- be available for consultation on problems dealing with radioactive materials and hazards
- review and, if the requirements are met, authorize all requests for the use of radioactive material within the institution by issuing radioisotope permits

- review the entire radiation safety program to determine that all activities are being conducted safely and following CNSC regulations and the conditions of the licence
- receive reports from the Designated Radiation Safety Officer and implement preventative, remedial or disciplinary action to correct any deficiencies
- maintain written records of all meetings, actions, incidents and 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 Guide R-80, *Preparation of an Annual Report for a Consolidated Licence* or updated regulations
- advise the institution's administration of the resources necessary to set up and maintain an adequate radiation safety program that will incorporate the ALARA principle
- approve designs for new laboratories following CNSC Regulatory Guide GD-52 entitled *Design Guide Nuclear Substances Laboratories and Nuclear Medicine Rooms* or updated regulations.

4.1.3. UTRPA Policies

In addition to the information and requirements set out in this Manual, the UTRPA may impose additional requirements as necessary. Each policy must be approved by the UTRPA and notification sent to each permit holder. The policies are effective upon approval by the UTRPA.

The UTRPA reserves the right to amend or rescind any existing policy. Such changes will be reviewed at a regular meeting of the UTRPA and the revised policy sent to each permit holder.

4.1.3.1. UTRPA Policy on Disciplinary Action

The policy allows for the enforcement of the requirements of the CNSC and this manual. While the UTRPA and Radiation Protection Service are committed to education, enforcement is available when necessary. At least four members of the UTRPA must approve a Step 4 action. The Designated Radiation Safety Officer may take immediate action when there is an actual or perceived threat to health, safety or security.

UTRPA Policy on Disciplinary Action

Failure to comply with a policy or procedure established by the UTRPA will result in the following actions:

Step 1) On the first occurrence, the Permit Holder will be notified by the Health and Safety Officer (HSO) of the offence and the need for the policy.

Step 2) On the second occurrence within three years, the Designated Radiation Safety Officer will send a letter to the Permit Holder, copied to the Departmental Chair, outlining the need for the policy, the duties of the permit holder in that respect and the consequences of further infractions. The HSO will issue a "Notice of Non-Compliance" to the permit holder.

Step 3) On a third occurrence, the Chair of the UTRPA will arrange for the permit to be transferred to the Chair of the Department/senior permit holder in which the permit holder performs the majority of the radioisotope work. Further work under this permit will only be allowed under the direct control of the Departmental Chair or senior permit holder. All purchase requisitions will require their approval.

Step 4) If a fourth violation is noted, the permit holder will be required to show cause as to why the permit should not be revoked. This will be conducted at a meeting with the Departmental Chair, the Chair of the UTRPA and the Designated Radiation Safety Officer. If the permit holder cannot provide justification for retaining the permit, the permit will be revoked and all radioactive materials will be disposed of through the Radiation Protection Service.

The permit holder may appeal a permit revocation to the UTRPA at the next meeting of the Authority.

Any violations greater than 3 years old will not be considered in further actions. The UTRPA however reserves the right to bypass any one or more of the above-noted steps if a serious violation occurs.

Notwithstanding any of the above actions, if it is the opinion of the Designated Radiation Safety Officer, that a serious, immediate risk to health, safety or security exists, the Radiation Protection Service shall have the authority to suspend operations or cancel a permit. The Designated Radiation Safety Officer will report on the situation, and the steps taken, to the Chair of the UTRPA.

4.1.3.2. UTRPA Policy on Security for Radioisotope Facilities

The purpose of the policy is to provide for the protection of personnel by restricting access to radioactive material. Guidelines were established for the requirement of adequate security where radioactive material is involved.

<u>UTRPA Policy on Security for Radioisotope Laboratories</u>

One of the prime methods of radiation protection at the University of Toronto is to restrict access to radioactive materials only to authorized users. Precautions must be taken to prevent the unauthorized removal of material from radioisotope laboratories.

The University of Toronto Radiation Protection Authority (UTRPA) has a set policy on laboratory security for those areas where radioactive materials are handled.

The basic premise of the security policy is that any radioactive material must be kept secure <u>at all times</u>.

When persons designated as responsible for the radioactive material are not present in a room containing radioactive material, that material must be locked within a storage cabinet, refrigerator or freezer. This policy applies at all times, day or night. Failure to comply with the above requirements will result in steps being taken as outlined in the UTRPA Policy On Disciplinary Action.

These steps will be taken concerning all rooms listed on an individual's permit; it does not have to be the same room that is involved in each case (e.g. four rooms under the control of the same Permit Holder, each left once unsecured, will lead to a Step 4 action). The above policy has been adopted to ensure that all permit holders understand the seriousness of this matter.

To summarize, the UTRPA considers it essential that all radioactive material be kept secure.

4.1.3.3. UTRPA Policy on Decommissioning

This policy establishes the requirements for the decommissioning of any facility where radioactive material was used. It also determines the responsibilities for providing for the costs associated with the decommissioning.

Procedures for decommissioning are presented in section 1.3.4 and are also available from the RPS website (http://www.ehs.utoronto.ca/services/radiation.htm).

UTRPA Policy on Decommissioning

When a facility/laboratory is to be decommissioned, the Permit Holder responsible for the facility/laboratory will notify the Radiation Protection Service in writing.

The Permit Holder will be responsible for ensuring that:
a) all radioactive substances are removed,
b) potential radiation fields are assessed with a survey meter,
c) swipe samples are taken covering a minimum of 100 square centimetres in various locations of potential concern and assessed to confirm acceptable limits,
d) if the radiation field(s) or contamination is above the acceptable limits, the source of the radiation must be determined and removed/cleaned to acceptable levels,
e) all radioactive signs, rule cards, and labels are removed from the laboratory, and
f) removal of all radioactive waste containers is arranged with the Environmental Protection Services (EPS).
The RPS will audit the above procedures and remove the laboratory from the Permit.

If the Permit Holder leaves the University without meeting the above requirements, the department which operated the facility/laboratory will be responsible for the following (including costs, as applicable):

- ***a) any fees charged by licensing authorities,***
- ***b) the disposal of any sealed sources,***
- ***c) the disposal of any open radioactive sources,***
- ***d) the disposal of any contaminated machinery,***
- ***e) labour required for radiation and non-radiation related work,***
- ***f) the removal of all signage associated with the use of radioactive materials, and***
- ***g) any other costs associated with decommissioning of the facility/laboratory.***

The Radiation Protection Service (RPS) will arrange for trained personnel for decontamination of the facility if required and will arrange for the Environmental Protection Services (EPS) to remove all radioactive waste materials generated in the course of the decontamination process. The RPS will arrange for the disposal of this material and will charge back all costs associated with the facility decommissioning to the department.

4.1.3.4. UTRPA Policy on Laboratory Decontamination

The policy is designed to establish responsibilities for the decontamination of radioisotope facilities. It sets out the responsibilities of the Permit Holder and the Radiation Protection Service in this regard.

UTRPA Policy on Laboratory Decontamination

An important aspect of a comprehensive radiation protection program is ensuring that no one is receiving unnecessary exposure to ionizing radiation. One method by which this can be accomplished is to monitor the laboratories where radioisotope work is carried out to ensure that no areas of contamination exist. It is recognized that some inadvertent contamination or exposure incidents may arise during routine or special procedures. It is prompt attention to these that will reduce exposure to radioactive material.

The Permit Holders are responsible for all persons working with radioactive material or potentially exposed to radiation from radioactive materials under their control. They must ensure that all users are properly trained and follow the requirements of the University of Toronto Radiation Protection Authority (UTRPA).

Users of radioisotopes are responsible for employing good work practices which will minimize the probability of contamination, monitoring their work area for contamination and the prompt reporting and clean-up of spills.

When contamination of an area in a radioisotope laboratory has been found, the persons responsible for radioisotope use in that laboratory will be responsible for decontaminating the areas.

The Permit Holder is responsible for ensuring that the decontamination is carried out immediately. The Radiation Protection Service is available for advice or assistance in this regard.

Failure to comply with this policy will be dealt with according to the provisions of the UTRPA Policy on Disciplinary Action.

4.1.3.5. UTRPA Policy on Foodstuffs in Radioisotope Laboratories

The policy reinforces the requirement that no eating, drinking or storage of foodstuffs is allowed in radioisotope laboratories. It establishes the criteria for allowing such activities in ancillary rooms which are not used for radioisotope work.

UTRPA Policy on Foodstuffs in Radioisotope Laboratories

Permit holders are responsible for compliance with all legislation regarding the handling of radioactive material. Where a permit holder can not or will not ensure compliance, measures will be taken by the UTRPA according to the UTRPA Policy on Disciplinary Action.

The storage or consumption of food and beverages in radioisotope laboratories at the University of Toronto is prohibited under any circumstance. This prohibition extends to food or beverage containers of any kind.

Storage or consumption of food and beverages shall be permitted under the following conditions in a room other than the one used for the handling or storage of radioisotopes:

1. The room designated for storage/handling of foods/beverages is physically separated from the lab.

2. Where the designated room is located within a radioisotope laboratory (e.g. separate office), all foods & beverages brought through the laboratory must be covered and not opened outside the room.

3. Laboratory coats must be removed before handling food, beverages or their containers. There must be a provision for hanging up the laboratory clothing outside of the designated room.

4. There is a monitor available to ensure that hands and clothing are free from contamination.

5. Hands must be washed before handling food, beverages or containers.

Failure to comply with this policy will be dealt with according to the provisions of the UTRPA Policy on Disciplinary Action.

4.1.3.6. UTRPA Policy on Counting Facilities

The policy is applied to radioisotope laboratories with sealed sources or for sample analysis (e.g. rooms containing just sealed sources used for instrument calibration, facilities containing liquid scintillation counters and gas chromatography units, etc.)

UTRPA Policy on Counting Facilities

Radioisotope Laboratories with Sealed Sources or Used for Sample Analysis

To reduce the number of radioisotope laboratories in which weekly monitoring is required, the University of Toronto Ionizing Radiation Protection Authority (UTRPA) identifies rooms in which there is no handling of open sources of radioactive material.

These rooms include:

1) Any room in which only sealed sources are used. Sealed sources are defined as radioactive material that has been encapsulated to prevent direct manipulation of the radioactive material. The encapsulating material must be substantial and able to withstand the normal handling of the material. This does not apply to materials sealed into plastic or glass vials. Normally, sealed sources are purchased directly from a manufacturer. All such sealed sources must be listed on the permit for the room.

2) Any room that is used exclusively for sample analysis such as liquid or crystal scintillation counting, autoradiography, etc. These rooms will be listed on the permit as counting facilities. If an instrument (e.g. liquid scintillation counter) contains a sealed source, the source must be listed on the permit for the room.

Permit Holders may apply to the UTRPA for relaxation of the requirements for these rooms.

- ***(i) The poster Rules for Working with Radioisotopes are removed and the requirement to adhere to these rules is lifted.***
- ***(ii) Weekly surface contamination monitoring is not required.***
- ***(iii) Restrictions on eating and drinking are removed. Restrictions on this for chemical or biological hazards may still apply.***
- ***(iv) Any procedures normally carried out in an ordinary laboratory with non-radioactive material are permitted.***

Permit Holders must obtain authorization from the UTRPA before their requirements are relaxed. Permits will be amended to indicate the changes in room designations.

4.1.3.7. UTRPA Policy on Interrupted Laboratories

The purpose of this policy is to allow for the temporary cessation of work with radioisotopes without cancelling the internal radioisotope permit. The radioisotope permit will become inactive and the laboratories will be decommissioned. Materials may be disposed of or stored by the Radiation Protection Service with no further purchases allowed during the interruption. The requirement for adherence to the CNSC Rules for Working with Radioisotopes can then be relaxed.

<u>UTRPA Policy on Interrupted Laboratories</u>

The University of Toronto Radiation Protection Authority (UTRPA) recognizes that the nature of research may involve the infrequent use of radioactive materials. Therefore, the UTRPA has approved this policy for Permit Holders who may wish to temporarily stop using radioactive materials.

If a Permit Holder wishes to interrupt the use of radioactive material in his or her possession for a specific time, an application may be made to the UTRPA to designate the permit as being Interrupted, and to store all the radioactive material in alternative storage.

The interruption must be for not less than three (3) months and may not exceed the term of the current permit. The interruption can apply only to rooms that are listed exclusively on a permit and cannot apply to shared facilities.

To qualify for an interruption of the permit, the Permit Holder must ensure that all radioactive material is properly packaged and labelled for storage. The label must contain the Permit Holder's name and permit number, the isotope and activity, the time for which the material is being stored and the storage instructions (e.g. room temperature, refrigerator or freezer). The packaged and labelled material will be stored by the Radiation Protection Service while the permit is interrupted.

Note:
The Radiation Protection Service (RPS) does not have facilities for the storage of material. While reasonable care will be taken, the RPS cannot be responsible for the spoilage of any material.

As part of the interruption procedures, the Permit Holder will be responsible for carrying out comprehensive monitoring of the laboratory (or laboratories) to demonstrate that all areas are free of contamination.

When a permit has been interrupted, the requirements of the CNSC Rules for Working with Radioisotopes do not apply (e.g. weekly monitoring, eating/drinking restrictions, etc.) It should be noted that although the requirements for radioisotope work may not apply, other restrictions for chemical or biological hazards may still be in effect.

No purchases will be allowed on permits that are interrupted. However, the permit may be reactivated without delay on a written request by the Permit Holder.

Refresher radiation protection training will be required of all authorized users, including Permit Holders, who have not received radiation protection training within the last 3 years period.

4.2. Radiation Protection Service

The Radiation Protection Service (RPS) is a service of the Office of Environmental Health and Safety. Its function is to carry out the ionizing radiation safety program as directed by the UTRPA, as well as responsibilities for non-ionizing radiation. The responsibility chart for the administration of radiation safety at the University of Toronto is presented in Appendix B.

4.2.1. Duties of the RPS as Related to Ionizing Radiation

The Radiation Protection Service has the following duties and responsibilities in administering the Nuclear Substances and Radiation Devices Licences issued to the administration by the CNSC:

- act as the contact for the institution concerning licensing matters (see Appendix C “Responsibilities for Reporting to the CNSC”, based on the General Nuclear Safety and Control Regulations, May 31, 2000),
- be available to radioisotope users on a full-time basis,
- establish, implement, and maintain the ionizing radiation safety control program under the direction of the UTRPA,
- systematically and periodically review survey programs for ionizing radiation and contamination levels in all areas where radioactive materials are used, stored or held for disposal,
- ensure the proper operation of the personnel monitoring program, including bioassay programs,
- ensure that ionizing radiation safety instruments are available to the RPS in sufficient number, calibrated and serviced as required,
- conduct a review of occupational radiation exposures and recommend ways of reducing exposures in the interest of the ALARA principle,
- supervise decontamination procedures as necessary,
- ensure that waste disposal procedures satisfy the conditions of the radioisotope licence,
- ensure that the necessary leak testing of sealed sources is performed,
- control the purchase, use, and disposal of radioactive materials through the issuance of radioisotope permits and the enforcement of requirements,
- obtain approval of the CNSC for any projects requiring greater than 10,000 exemption quantities,
- ensure that appropriate radiation protection training is provided regularly for all users and for those who regularly come into contact with radioactive material,
- maintain required records,
- ensure that each radioisotope permit is amended when necessitated by changes to facilities, equipment, policies, isotopes, conditions of use or procedures,
- coordinate the development of plans to be used in the case of an emergency involving radioactive materials,
- investigate all overexposures, accidents, and losses of radioactive materials and report to the CNSC, when necessary, and

- liaise with radioisotope users to ensure that ionizing radiation doses satisfy the ALARA principle.

4.2.2. Duties of the RPS to the UTRPA

The Radiation Protection Service shall:

- function as a link between the UTRPA and radioisotope users at the University of Toronto,
- review the ionizing radiation safety manual every two years in consultation with the UTRPA,
- prepare an annual report to the CNSC (Regulatory Guide R-80 or updated regulations), and
- have major input in matters of:
  - facility and equipment design,
  - work practices and procedures,
  - evaluation, issuance, and enforcement of radioisotope permits,
  - disciplinary action necessitated by non-compliance, and
  - radiation safety training

4.2.3. Compliance Inspections

The RPS conducts periodic audits of operations carried out under each radioisotope permit. The audit frequency is based on risk as follows:

- Quarterly for high and intermediate-level laboratories
- Semi-annually for basic level laboratories
- Annually for under EQ areas.

The audit frequency may be increased when necessary for ensuring compliance.

Operational areas which are reviewed during audits include:

- General Requirements (*permit posted, supervision, training, dosimeters worn*)
- Record Keeping (*monitoring, inventory, bioassays*)
- Storage and Handling (*receipt, storage, work area safety*)
- Protection (*laboratory coat, gloves, shielding, fume hoods*)
- Spills and Contamination (*procedure, cleaning*)

Permit Holders will be advised when improvements are required in their laboratories and operations. The RPS staff is available to assist Permit Holders in improving ionizing radiation safety in their areas.

When the Permit Holder does not correct items of non-compliance or the same problems reoccur, steps will be taken following the *UTRPA Policy on Disciplinary Action (1.1.3.1)*.

4.2.4. Services Available from the RPS

Service provided	Contact	Contact Phone #
General Inquiries and radiation badges	Administrative Assistant	416-978-1012
Radioisotope permit administration	HSO	416-946-3265 416-798-6846
Radiation Protection training	Designated Radiation Safety Officer	416-946-3265
Radiation compliance inspections	HSOs	416-946-3265 416-978-6846
Radiation bioassay service	HSOs	416-978-6846 416-946-3265
Radiation decontamination advice and assistance	HSOs	416-946-3265 416-946-3265
Radiation instrument calibration	HSOs	416-978-6846 416-946-3265
Radiation purchase information	HSOs	416-946-3265 416-978-6846
Radiation surveys	HSOs	416-946-3265 416-978-6846
Radiation warning signs	HSOs	416-946-3265 416-978-6846
Transfer of radioactive materials	HSO	416-946-3265 416-978-6846
Radiation waste collection and disposal	Environmental protection technicians Manager, Environmental Protection Services	416-946-3473 416-978-7000
Regulatory agency liaison and advice service	Designated Radiation Safety Officer	416-946-3265

Mailing address:
Radiation Protection Service, 215 Huron Street, 7th Floor
University of Toronto, Toronto, Ontario M5S 1A2
Facsimile: 416-971-1361

Where it is noted in this manual that written notification to the UTRPA or RPS is required, such notification must be sent by facsimile (416-971-1361) or by e-mail to vanieshree.ranganathan@utoronto.ca

4.3. Responsibilities of the Permit Holder

The Permit Holder has specific responsibilities to the University, the UTRPA and the personnel working in the laboratory, teaching and/or research situations. The Permit Holder is responsible for the following:

- ensuring that the conditions stated in the permit are fulfilled and that safe laboratory practices are followed. This includes ensuring compliance with policies and procedures of the UTRPA and requirements of CNSC,
- ensuring that all staff using radioactive materials are authorized to use radioactive materials and knowledgeable regarding the policies and procedures for the use of radioactive materials at the University as per the requirements of the UTRPA and CNSC,
- ensuring that students working with radioactive materials in teaching situations are properly supervised and instructed in the safe handling procedures including the fundamentals of radiation protection,
- ensuring that provision has been made for specific training in radioisotope handling that is necessary for the safe use of radioactive materials in his or her laboratories,
- ensuring that staff work according to policies, procedures, and requirements for the safe use of radioisotopes,
- designating specific work and storage areas for radioactive materials and ensuring that these areas are kept clean, are properly labelled, are adequately shielded and that existing ventilation is not impaired,
- ensuring that all persons working with radioisotopes have been issued, wear a radiation badge and participate in the bioassay program, as required,
- providing and enforcing the use of personal protective equipment by all persons working with radioactive materials
- maintaining an inventory of all radioactive materials,
- ensuring that all required contamination monitoring has been performed as required and that all necessary records are maintained,
- ensuring that any radiation monitoring equipment used by the laboratory staff is adequate to the task and functioning properly,
- notifying the RPS whenever the permit holder will be unavailable to supervise, identifying another permit holder who has accepted the responsibility as the temporary supervisor,
- ensuring that decommissioning and decontamination are performed when required, and
- reporting all abnormal incidents involving radiation/radioactive material to the RPS.

4.4. Responsibilities of Persons Working with Radioisotopes

All persons working with radioactive material have specific responsibilities. These are:

- work in compliance with all policies, procedures and requirements at the University,
- use protective and/or monitoring equipment required for the safe use of radioactive materials and register for bioassay if required,
- maintain an inventory of usage of radioactive materials,
- monitor work areas at the end of the work (must be done within 7 days of usage),
- follow the personal monitoring procedures and report any skin contamination
- follow waste disposal procedures,
- report to the Permit Holder or RPS any defective equipment, violation or situation that may endanger a worker or create an unauthorized release of radioactive materials to the environment, and
- not create or participate in any activity which may endanger themselves, any other worker or create the potential for unauthorized release of radioactive materials to the environment

4.5. Licensing and Administrative Procedures for Use of Radioactive Material

4.5.1. University of Toronto Nuclear Substances and Radiation Devices Licence

Due to the number of researchers and radioisotope laboratories, the University of Toronto has obtained a Consolidated Nuclear Substances and Radiation Devices Licence from the CNSC. This is a University-wide licence governing the purchase, possession, and use of open and sealed source material at all locations owned or controlled by the University of Toronto. This licence is normally valid for 5 years; a request for renewal is made to the CNSC by the U of T.

It should be noted that the use of radioactive materials in teaching hospitals and research institutions is controlled by the respective institutions under separate CNSC licences. Therefore, the material being transferred between the University and these facilities must adhere to the CNSC requirements for transport between licensees. Permit Holders must contact the RPS to make appropriate arrangements for such transfers.

Individual researchers using radioactive materials are granted radioisotope permits by the UTRPA under the authority of the Nuclear Substances and Radiation Devices Licence.

4.5.2. Internal Radioisotope Permit

Radioisotope permits are required for the purchase, possession and use of sealed and open-source radioactive material. No person may purchase, possess or use any radioactive material in any form without a valid radioisotope permit issued by the RPS.

A radioisotope permit may be issued for open sources only, for sealed sources only or a combination of both. When the total amount of radioactive materials per container (in storage or use) is under an Exemption Quantity (as defined in Nuclear Substances and Radiation Devices Regulations) the permit is called an EQ permit.

A temporary permit may be issued for unique situations requiring the use of radioactive materials over very short periods (e.g.: under one week).

A permit holder may possess more than one radioisotope permit depending on the type of activity.

A signed copy of the permit application and the internal radioisotope permit must be kept by the Radiation Protection Service.

4.5.2.1. Internal Permit Administration

A prospective radioisotope user must obtain a UTRPA internal radioisotope permit *before* any purchase of radioactive materials is made or possession obtained. This applies to all acquisitions of radioactive material, whether purchased, transferred, or donated.

Permits are normally issued only to U of T-appointed professors having documented training and at least two years of experience in the use of radioisotopes. The issuing of radioisotope permits to other U of T personnel or persons having less than 2 years' experience will be considered on a case-by-case basis by the UTRPA.

Permits are issued with a normal term of 3 years. This term is concurrent with the authorized period for radiation safety training of the permit holder. Maintaining safety training is mandatory for all users of radioactive materials and permit holders (see sect. 4.7.4 – Refresher Training). If the Permit Holder desires to continue work with radioactive materials, the permit must be renewed at the time of expiration for another term.

Laboratory facilities for radioisotope work must be approved by the Radiation Protection Service before the issuing of the permit (see sect. 4.5.2.5).

A radioisotope permit does not normally cover the off-campus use of radioactive materials; for such use, separate approval is required from the UTRPA. Contact the RPS for details.

4.5.2.2. Application for a Radioisotope Permit

An application form must be completed before the issuing of an internal radioisotope permit. The application form and a guide to the completion of a radioisotope permit application are available from the RPS website or office. Upon completion, the form is returned to the RPS office for review and approval by the UTRPA. If appropriate, a valid permit may then be issued by the UTRPA.

To approve a permit, the UTRPA may require copies of supporting documentation and evidence of previous experience. The permit application will require the approval and signature of the departmental chair of the prospective Permit Holder.

If a laboratory has not been previously approved, it will require an inspection by the RPS. All radioisotope laboratories must conform to CNSC Regulatory Guide GD-52 or updated regulation. Each laboratory must be inspected and corrective action may be required before the use of radioactive materials is permitted in the laboratory.

Upon submission of the permit application, a file is opened with the Radiation Protection Service. If the radioactive work involves new radionuclides or new procedures, a hazard assessment must be performed by the RPS. The hazard assessment may involve dose calculations, effluents to the environment, etc. Once approved, a permit number is assigned and a copy of the approved Permit is added to the file. The file will contain all direct correspondence with the Permit Holder as well as a record of any disciplinary action taken against the Permit Holder. Copies of all requests for amendments and renewals of the permit are also kept in the file. The file is closed upon revocation or cancellation of the permit and retained by the RPS for at least three years.

A permit application requires the signature of the Chairperson of the UTRPA or their delegate for approval. The final person to evaluate the permit application is the Designated Radiation Safety Officer or delegate, who will review the comments of the UTRPA, and assign the conditions to the permit.

Once a permit has been issued, there may be no changes to the facilities used, isotopes and quantities allowed without prior approval from the UTRPA.

4.5.2.3. Content of the Internal Radioisotope Permit

Following the approval by the UTRPA, an internal radioisotope permit is issued to each researcher using nuclear substances or radiation devices at the University of Toronto.

A copy of the current revision of the radioisotope permit must be posted in each laboratory listed on the permit.

Section 1
The radioisotope permit lists the researcher's name, position, radioisotope permit number, the revision number of the permit, department, and building. It also lists the locations of the laboratories where radioactive material may be used. *Radioactive material may not be used, stored, or disposed of in a location not listed on the Permit.*

Section 2
This section shows the period during which the permit is valid.

Section 3
The radioactive prescribed substances that may be in the possession of the permit holder are listed in this section, as well as the locations approved for such use. Devices containing sealed sources are listed by a radioisotope, type of device and activity. For open-source material, the radioisotopes and the delivery rate of the material are specified. The rate of delivery must not be exceeded without prior approval of the UTRPA. Radioisotopes other than those listed on the permit must not be purchased or obtained by the permit holder.

The sum of total amounts that may have all permits for each radioisotope must be under the University CNSC licence limit.

This section may also be continued on an appendix sheet if more isotopes are being used than space allows. The appendix sheet, if any, will follow the remainder of the permit.

Section 4
This section provides a brief description of the experimental procedures in which the radioactive material is to be used. Deviations from this procedure are allowed within the normal operations of a research laboratory. The UTRPA must be informed of major changes from the listed procedures. This section also notes whether the material will be used *in vitro* or *in vivo*.

Note: The University of Toronto Consolidated Radioisotope Licence specifically prohibits radioactive materials procured under this Licence from being used in humans.

Section 5
This section lists the permit conditions specific to the individual permit. For example, if a permit allows the purchase of 1.35 mCi (50 MBq) or more of phosphorus-32 at any one time, there will be a permit condition requiring the use of extremity dosimeters (rings) when handling more than 1.35 mCi (50 MBq) of the isotope. Permit holders and authorized radioisotopes users should ensure that they have read, understand and followed all permit conditions.

The last section of the permit contains a statement affirming that the permit holder must follow the laws, the regulations, and the terms and conditions under which the permit is issued.

A permit is valid once approved by the UTRPA. Unless renewed, a permit is not valid beyond the expiry date shown.

A permit is granted because the permit holder is aware of and responsible for the activities in the radioisotope facilities. If a permit holder is taking a sabbatical or other type of leave where he or she will not be able to administer this responsibility, arrangements must be made ***before taking the leave*** (Condition 1). A temporary interruption of the permit may be arranged or the responsibility for the work may be assumed by another current permit holder. The latter arrangement must be confirmed in writing by both parties stipulating an effective time. Any permit holder acting on behalf of another permit holder is responsible for all activities under both permits and will be subject to any necessary disciplinary action. If a permit holder does not advise the RPS before taking leave, the facilities may be considered to be abandoned.

All changes to a permit must receive the prior approval of the UTRPA. This includes changes to rooms or buildings used, isotopes ordered or the quantity permitted. To change any part of the permit, an application must be made for a permit revision.

4.5.2.4. Amendment of an Existing Permit

To request a change, the permit holder must notify the RPS of the proposed changes. This notification can be done by facsimile/e-mail and must identify the permit holder and number. Upon receipt of the request for the amendment, the RPS will complete a permit amendment form and obtain the necessary approvals. The Designated Radiation Safety Officer or delegate will review the permit and indicate which permit conditions will apply.

Before increasing the possession limit for an existing radioisotope or adding a new radioisotope RPS will verify the total possession limits in the University against the CNSC licence limit. If the CNSC licence limit is reached, the permit revision will not be approved until a revision of the CNSC licence is obtained.

The permit holder may not implement the requested changes until the amendment is approved.

Following approval of the amendment, a revised permit will be sent to the Permit Holder and posted in all radioisotopes rooms listed on the revised permit. The revision number in the top right corner of the permit will be incremented to reflect the current revision.

All permit amendments are issued with a term not exceeding that of the current permit.

4.5.2.5. Radioisotope Laboratory Approval

All rooms intended to be used for the handling, storage or disposal of radioactive material must conform to the requirements of the CNSC Regulatory Guide GD-52 or updated regulation.

Laboratory classification is determined depending on the amount of nuclear substance handled in the room and on the nature of the work performed. The permissible quantities for the types of laboratories are defined in CNSC document, GD-52: Design Guide for Nuclear Substance Laboratories and Nuclear Medicine Rooms A listing of the regulated quantities for typical radionuclides is available from the RPS website or office.

A radioisotope laboratory is classified as:

- **Basic Level:** The activity used at a single time does not exceed 5 times its corresponding annual limit on intake (ALI).

- **Intermediate Level:** The activity used at a single time does not exceed 50 times its corresponding ALI.

- **High Level:** The activity used at a single time does not exceed 500 times its corresponding ALI.

- **Containment Level:** The activity used at a single time exceeds 500 times its corresponding ALI. The University of Toronto does not presently have any facilities designated as Containment Level.

For Intermediate and High-Level radioisotope laboratories, approval from the CNSC is required before they can be used.

Any room in which radioactive material has been previously used may have approval on file in which case no further inspection is required. This does not apply where extensive renovations or modifications have been carried out in the laboratory.

Rooms in which radioactive materials under EQ are used will not require approval but will be recorded by the RPS.

4.5.2.6. Renewal of an Existing Permit

Permits are issued with a normal term of 3 years. Renewal of the permit will be done after the permit holder has completed the refresher radiation training.

4.5.2.7. Cancellation of a Radioisotope Permit

Cancellation of a permit may be accomplished at any time. Cancellation of a permit is required if a permit holder is leaving the University of Toronto and must be completed before departure. The permit holder must notify the *RPS* to cancel the permit. At the

cancellation of a radioisotope permit, all rooms, areas, and equipment used for radioisotope work or storage of radioactive materials must be decommissioned following the decommissioning policy (see sect. 4.1.3.3) and decommissioning procedure (see sect. 1.3.4).

In the case of abandoned facilities, the *RPS* will immediately arrange for the decommissioning of the facilities and the disposal of all radioactive material in those facilities. A facility may be declared to be abandoned when the permit holder is no longer in the employ of the University of Toronto and has not notified the *RPS*. A facility may also be declared to be abandoned if the permit holder takes a sabbatical/ leave, is not at the University of Toronto facility regularly and has not notified the *RPS* of any alternative arrangements. If significant costs are involved in this procedure, all costs will be charged to the department with the abandoned facility.

4.6. Obtaining Radioactive Material

The CNSC requires that the University maintain a record of radioactive materials being received under the Nuclear Substances and Radiation Devices Licence. All purchases, donations, gifts, transfers, etc. of nuclear substances to the University are approved by the RPS. Approval is given only to the permit holders that have the radioisotope on their permit and in the amount allowed by the radioisotope permit.

4.6.1. Purchase of Radioactive Materials

All radioactive material purchases must be submitted by the permit holder or business officer as a requisition through the University AMS/FIS purchasing system or otherwise approved (released) by the RPS ***before ordering or receipt of the material***. A purchase order is then generated by the permit holder's business office and forwarded to the supplier.

Some companies have an agreement with U of T to approve procurements online ("USource"). To establish a username and a password please contact U of T Procurement Services at http://www.procurement.utoronto.ca/programs-and-services/usource. After an order for radioactive material is placed on USource, the order is automatically sent for approval by the RPS. After the order is approved, it is automatically sent to the supplier.

In both systems, the following information is required by the RPS to approve the order: the internal radioisotope permit number, the radioisotope, its chemical form, the activity of the material ordered, the supplier's name and any other special delivery information.

Radioactive material arriving at the University without prior approval may be confiscated by the RPS.

4.6.2. Blanket Orders

Individual orders must be cleared through the RPS before the order is placed. The amount of a radioisotope ordered must be within the limits of the individual permit on which it is

ordered. This also applies if the material is being received under more than one type of order (i.e. the total amount of material being received under a purchase requisition and a simultaneous transfer or donation must be less than the total delivery rate allowed for the permit).

4.6.3. Gifts, Donations or Exchanges

Some radioactive materials for research are obtained from outside institutions or companies as gifts, donations or exchanges. All radioactive material received for which no purchase is required must be cleared through the RPS before receipt. Such receipts of material will only be allowed if within the maximum delivery rate of the permit under which they are received.

4.6.4. Special Orders

Any special orders not within the conditions outlined above must receive prior clearance from the RPS. This includes a one-time ordering of material that exceeds the current permit limits and special labelling of material. If such approval is obtained before receipt of the material, there will be no difficulty when the material arrives. If the material is not cleared before receipt, it may be impounded by the RPS pending an investigation. From there, the radioactive material may be returned to the permit holder, returned to the supplier or sent for disposal.

4.6.5. Transportation and Transfers of Radioactive Material

Radioactive material transferred between permit holders must not exceed the receiving permit holder's allowed amount (as shown on the radioisotope permit). Radioactive material may not be used in any room or building not noted on the permit. Radioactive material must not be transferred between buildings. The RPS will arrange the necessary paperwork and may arrange for transportation of the material between U of T buildings if required.

External institutions, such as hospitals and research centres, are licensed separately by the CNSC. This applies to the teaching hospitals and others who are affiliated with the University. Radioactive material purchased at an external institution may not be transferred to the University, or vice versa, without prior approval from the UTRPA.

To transfer radioactive materials off-campus the Permit Holder must fill in the form found at http://ehs.utoronto.ca/wp-content/uploads/2016/11/Transfer-of-Radioactive-Material-Off-Campus-Form-Updated-1.pdf. The Permit Holder must prepare the package following instructions received from the RPS and arrange for transportation of the material if required. The RPS must verify the package to certify that it does satisfy the requirements of Canadian and IAEA regulations, complete the necessary paperwork, and verify that the courier used for transportation meets the CNSC requirements.

The export of radioactive materials may require a separate CNSC Export licence. The Permit Holder must contact the U of T Designated Radiation Safety Officer at least one month before the intended export.

All records referring to the transfer off-campus, export, packaging and transportation of radioactive materials must be kept in the permit files.

Failure to adhere to this requirement will be cause for action under the *UTRPA Policy on Disciplinary Action* and may lead to revocation of the permit.

4.7. Training

The CNSC requires that all persons working with radioactive material obtain training in the safe handling of radioactive material ***before beginning work with radioactive material***.

This training must include information on:

- basic radiation physics and radiation units,
- principles of radiation protection,
- biological risks associated with exposure to ionizing radiation,
- principles of radiation measurements and functioning of radiation instruments,
- receiving, safe use, handling, storage and disposal of radioactive material,
- administrative rules, and
- emergency preparation and radioactive spill cleaning.

Refresher training is required for all authorized users, including Permit Holders, every 3 years. The refresher training is not required for EQ permit holders.

It is the responsibility of the permit holder to ensure that all persons working with radioactive materials have received the appropriate training and know the proper policies and procedures for the use of radioactive materials at the University of Toronto before beginning work.

The UTRPA may exempt a person from the requirement to complete the University of Toronto Ionizing Radiation Protection Course if he or she provides information on completion of an equivalent course at another institution or facility. However, all persons must be familiar with the policies and procedures in force at the University of Toronto and complete the Ionizing Radiation Protection Course examination.

Information on the registration for the radiation safety courses can be obtained from the radiation safety web page or the RPS office. All training records must be kept by the Radiation Protection Service.

4.7.1. Radiation Protection Course

The RPS offers an Ionizing Radiation Protection Course regularly. This consists of training sessions with theoretical and practical information as well as a final exam. Lecture material may be provided through lecture or electronic means, but a practice session and

written examination must be completed. Successful candidates are provided with a certificate of completion and are then allowed to work with radioactive materials (open or sealed sources) without direct supervision.

4.7.2. Project Student Training

Summer students and other temporary employees at the University of Toronto must also comply with the requirement for training before beginning work with radioactive materials. For these individuals, the RPS offers similar training. The students who take this course may work with radioactive materials only in the presence and under the direct supervision of a person who has completed the regular Ionizing Radiation Protection Course.

4.7.3. Sealed Source Users Training

For persons working only with sealed sources, special training is offered. This training focuses on the types of radiation sources used, the biological effects of that type of radiation, hazard assessment and, hazard controls put in place as well as regulatory requirements for these types of sources. Persons working with irradiators only will have the sealed sources training completed and additional training on how to use the irradiators.

4.7.4. Refresher Radiation Protection Training

Refresher radiation protection training is required of all authorized users, including Permit Holders, who have not attended the University of Toronto radiation protection training within the last 3-year period. The refresher training will contain updates on regulation changes, new requirements of the U of T radiation safety program, etc.

4.7.5. Other Training

Training is also offered to those with incidental contact with nuclear substances and radiation devices, for example, housekeeping, skilled trades, Campus Police, receptionists, movers, and recyclers. This training focuses on radiation signs, radiation biological effects on the human body, and control measures put in place.

A person who handles, offers for transport, or transports radioactive materials, will receive Transport Dangerous Goods (TDG) training according to section 6.2 of the Transport Dangerous Goods Act and Regulations, or will perform those activities in the presence and under the direct supervision of a person who is adequately trained and who holds a valid TDG training certificate.

4.8. Records Management

All prescribed records required under the Nuclear Safety & Control Act and Regulations, including those as stated in the GNSC 28: http://laws.justice.gc.ca/eng/regulations/SOR-2000-202/page-4.html#h-35, and in the NSRD 36: http://laws.justice.gc.ca/eng/regulations/SOR-2000-207/page-6.html#docCont will be maintained on file and will be retained for the regulatory

retention periods.

1. The Designated Radiation Safety Officer must keep a record of all information related to the licence that is submitted to the CNSC
2. All records must be retained for the period specified in the applicable regulations
3. If no period is specified in the regulations, the records must be retained for one year after the expiry of the licence
4. The records must be disposed of only if:

a. They are no longer required by the applicable regulations to be kept, and
b. The CNSC was notified by the Designated Radiation Safety Officer of the date of the disposal and the nature of the record at least 90 days before the date of disposal

5. The Designated Radiation Safety Officer may be required by the CNSC to file the record or a copy of the record before its disposal.

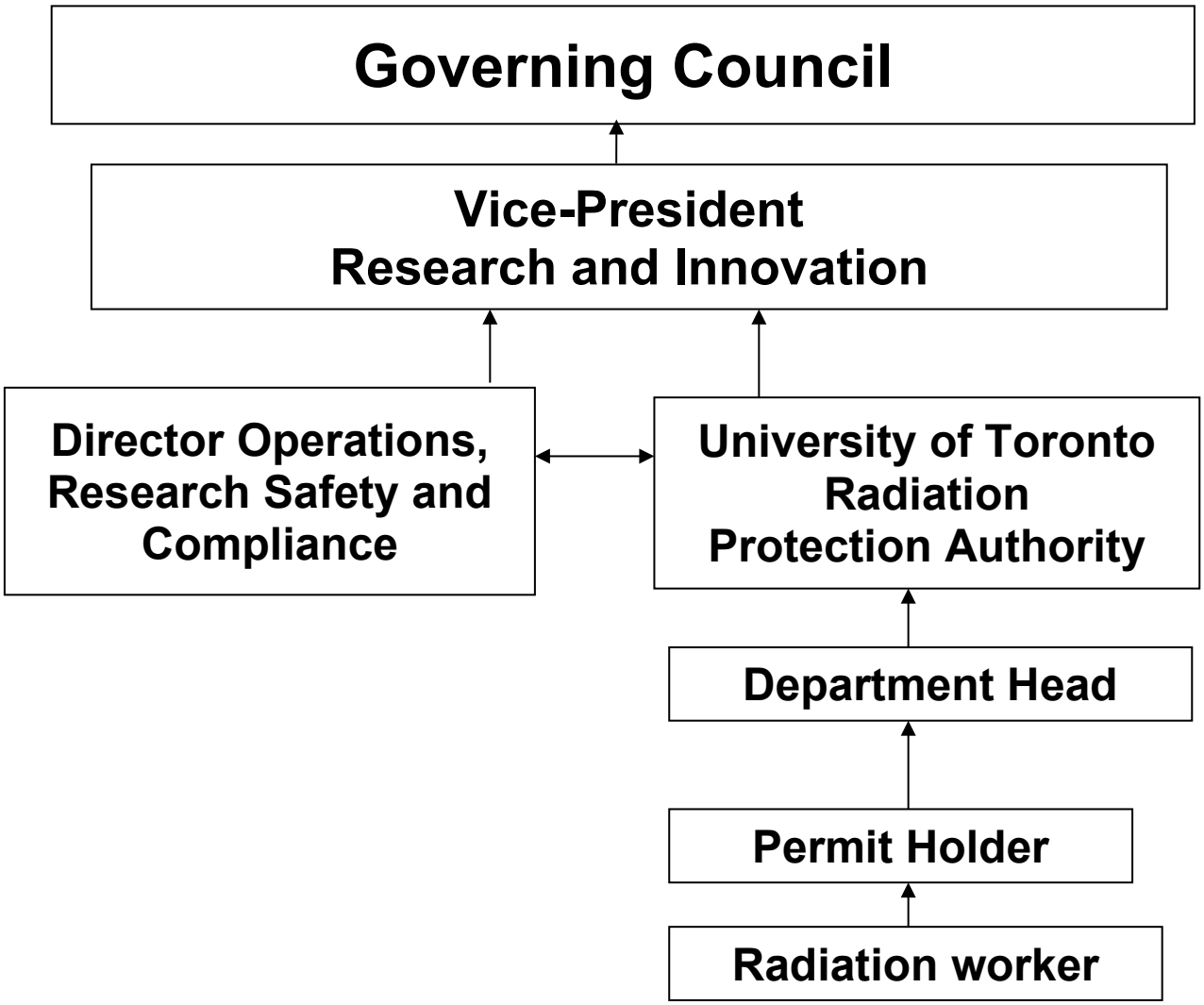
A list of the prescribed records maintained, the location where the records will be maintained, a period that records will be kept and the frequency of auditing the records are presented below. The records maintained by the permit holders (in the laboratories) will be audited by HSOs during the inspections. The records maintained by the RPS will be audited annually by the Designated Radiation Safety Officer.

Description of Record	Location	Period	Audit Frequency
Records of the information concerning any nuclear substance in U of T possession a) name, quantity, form, and location, b) for sealed sources model and serial number of the source c) for sealed sources in a radiation device the model and serial number of the device d) the quantity used and how was used	RPS	1 year after the licence expiry date	Annually
Inventory, usage, and disposal of radioisotopes used in the laboratories	In the lab	3 years	2-4 times per year
Records of the name of each worker who uses or handles radioisotopes and radiation devices	RPS	1 year after the licence expiry date	Annually
Records of any transfer, receipt, disposal or abandonment a) the date b) the name and address of the supplier or the recipient c) the name, quantity, and form of the nuclear substance d) for sealed sources the model and serial number e) for sealed sources in a radiation device the model and serial number of the	RPS	1 year after the licence expiry date	Annually

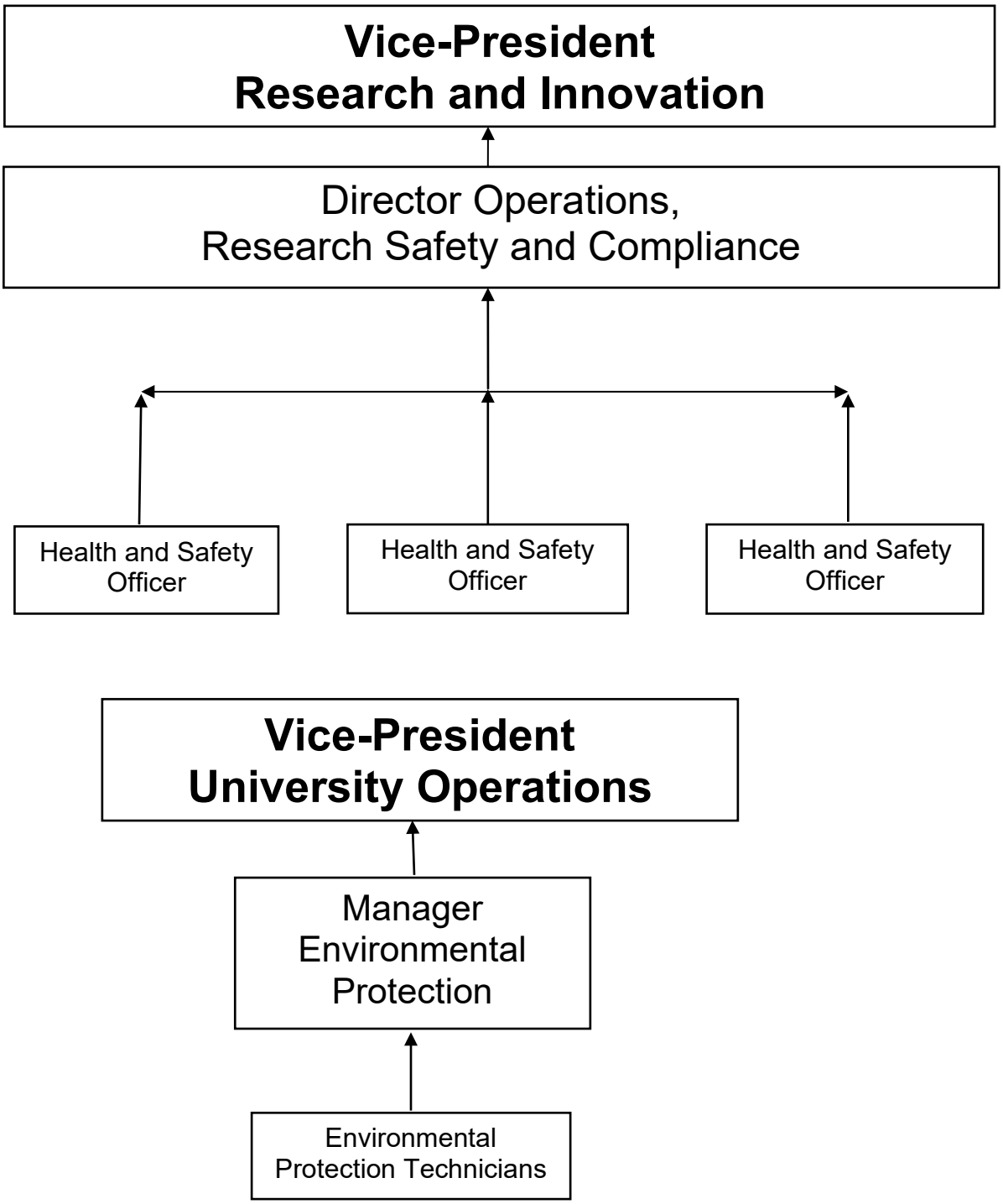
device			
Records of radiation training	RPS	3 years after the end of employment	Annually
Records of inspections, measurements, and tests made by the HSOs in the radiation labs	RPS	1 year after the licence expiry date	Annually
Records of NEW designations, names and job category	RPS	1 year after the licence expiry date	Annually
Dose records for non-NEW	RPS	3 years	Annually
Dose records for the current one-year and five-year dosimetry period for NEW	RPS	1 year after the licence expiry date	Annually
Thyroid screening records	RPS	1 year after the licence expiry date	Annually
Leak test records	RPS	3 years	Annually
High-risk sealed source tracking records	RPS	1 year after the licence expiry date	Annually
Licence application and CNSC correspondence regarding licence application or licence changes	RPS	1 year after the licence expiry date	Annually
Radiation permits issued by UTRPA	RPS	1 year after permit expiry	Annually
Results of contamination monitoring surveys	In the lab	3 years	2-4 times per year
Certificates of calibration of equipment used for contamination monitoring and gamma surveys	RPS	1 year after the licence expiry date	Annually
Laboratory commissioning	RPS	1 year after the permit expiry date	Annually
Equipment and laboratory decommissioning records are kept in the permit folders	RPS	1 year after the permit expiry date	Annually
Radioisotope shipment records are kept in the radioisotope permit folder	RPS	2 years after transportation	Annually
Export licence for restricted materials	RPS	2 years after transportation	Annually
TDG training and TDG training certificates	RPS	2 years after the expiry date	Annually
UTRPA meetings, actions, recommendations and decisions	RPS	1 year after the licence expiry date	Annually

A 90-day notice will be provided to the CNSC before any prescribed records disposal.

Appendix A - Responsibility Chart for the Management of Radiation Safety at the University of Toronto



Appendix B - Responsibility Chart for the Administration of Radiation Safety at the University of Toronto



Appendix C - Responsibilities for Reporting to the CNSC

Appendix C1 – General Reporting Responsibilities to the CNSC

The reporting has two components: an **immediate** preliminary report upon becoming aware of the reportable incident (**by phoning the 24 hr CNSC Duty Officer at 613-995-0479 or the toll-free # 1-844-879-0805)**, followed by an incident investigation **21-day report**.

The immediate report must contain:

- the time and location of the incident,
- the circumstances of the situation, and
- any action that was taken by the University or is proposed to be taken.

The 21-day report must contain the regulatory requirements applicable to the incident.

For: general reports, safeguards reports, and deficiency in record reports, the requirements from http://laws.justice.gc.ca/eng/regulations/SOR-2000-202/page-4.html#docCont must be applied.

For incidents related to radiation devices, the requirements from http://laws-lois.justice.gc.ca/eng/regulations/SOR-2000-207/page-5.html#docCont must be applied.

For dangerous occurrences during the transportation of nuclear substances, the requirements from http://laws-lois.justice.gc.ca/eng/regulations/SOR-2015-145/page-8.html#h-14 must be applied.

When the dose limits have exceeded the requirements from
http://laws.justice.gc.ca/eng/regulations/SOR-2000-203/page-3.html#docCont
must be applied.

Appendix C2 - Notification to the CNSC of Use of More than 10,000 EQ

The Licensee shall obtain written approval from the Commission or a person authorized by the Commission before starting any work requiring the use of more than 10,000 exemption quantities of a nuclear substance at a single time. This is listed as Condition 2. Project Approval: University of Toronto's Nuclear Substances and Radiation Devices Licence

Appendix C3 - Laboratory Classification

The laboratory classification is connected with the ALI. ALI or "annual limit on intake" means the activity, measured in becquerel, of a radionuclide that will deliver an effective dose of 20 mSv during the 50 years after the radionuclide is taken into the body.

The Licensee shall classify each room, area or enclosure where more than one exemption quantity of an unsealed nuclear substance is used at a single time as:
(a) basic-level if the quantity does not exceed 5 ALI
(b) intermediate-level if the quantity does not exceed 50 ALI
(c) high-level if the quantity does not exceed 500 ALI
(d) containment-level if the quantity exceeds 500 ALI; or
(e) the special purpose if approved in writing by the Commission or a person authorized by the Commission.

Except for the basic-level classification, the licensee shall not use unsealed nuclear substances in these rooms, areas or enclosures without the written approval of the Commission or a person authorized by the Commission. This is listed as Condition 5: Area Classification: University of Toronto's Nuclear Substances and Radiation Devices Licence.

Appendix C4 – Other CNSC Reporting Requirements

In the case of:

- a major spill (spill involving more than 100 EQs, contamination of personnel, or release of volatile material),
- any internal contamination of a person,
- if more than 1000 Bq of I-125 or 131 is measured in the thyroid,
- radioactive material is missing
- a radiation device is damaged to an extent that could impair its normal use
- the sealed sources are separated from the radiation device when the latter is not being serviced
- the sealed source fails to return to the shielded position inside the radiation device
- a leakage of a sealed source of more than 200 Bq is identified

the Designated Radiation Safety Officer or his/her delegate will inform the CNSC immediately and will prepare and send a report to the CNSC within 21 days (see: NSRD 38 (2)).

In case a package is involved in a dangerous occurrence:

- a conveyance carrying radioactive material is involved in an accident
- a package shows evidence of damage, tampering or leakage
- any failure to comply with the CNS Act
- radioactive material is lost, stolen or no longer in control of the person that should have the control
- radioactive material has escaped from a containment system, a package or a conveyance during transport,

the Designated Radiation Safety Officer or his/her delegate must inform the CNSC immediately, and prepare and send a report to the CNSC within 21 days.

If the dose of radiation received by and committed to a person or an organ or tissue, may have exceeded the dose limits (as identified in chapter 1.1.8.1), the person must stop performing any work that is likely to add to the dose. The person may return to radioactive work only with the CNSC approval.

The Designated Radiation Safety Officer or his/her delegate must notify the CNSC of the discovery of

- any inaccuracy or incompletes in the Licence Documents
- radioactive material not contained in the licence is found
- change of the applicant or signing authority for the licence
- if a location is no longer used for licenced activities

Appendix D - Designation of Nuclear Energy Workers

The University of Toronto stresses adherence to the ALARA policy of maintaining doses As Low As Reasonably Achievable. All radiation programs are directed towards safety, ensuring that the potential for exposure is minimized. Anyone with a reasonable probability of receiving doses due to radiation greater than the limit for Members of the General Public will be designated a Nuclear Energy Worker (NEW), as defined in the Radiation Protection Regulations.

The following documents are provided to the worker for information:

- Radiation Protection Regulations
- Health Physics Society Position Statement on Radiation Risk in Perspective
- Canadian Radiation Protection Association Statement on Radiation Risk

All NEWs must read and understand the information provided, acknowledging their designation by signing the following form. The approved copy of the designation form must be kept by the RPS.

Effective: October 2021

NUCLEAR ENERGY WORKER DESIGNATION (Male)

As required by the Radiation Protection Regulations of the Canadian Nuclear Safety Commission, this information is being provided to all staff designated as "Nuclear Energy Workers". The regulation requires the University to designate users of nuclear materials as “Nuclear Energy Workers" if there is a reasonable probability of receiving an effective dose greater than that allowed to members of the general public (1 mSv per annum whole body).

In the course of your work with radiation, you may be exposed to radiation risks. The following documents regarding the radiation risks are provided for your information:

- Health Physics Society Position Statement on Radiation Risk in Perspective
- Radiation Protection Regulations.

Effective dose limits for Nuclear Energy Workers are 50 mSv for any one-year dosimetry period, but must not surpass 100 mSv for any 5-year dosimetry period. The equivalent dose limits are:

- 50 mSv for the lens of an eye for a one-year dosimetry period
- 500 mSv for the skin for a one-year dosimetry period
- 500 mSv for the hands and feet and 500 mSv for a one-year dosimetry period

The University of Toronto stresses adherence to the ALARA policy of maintaining doses As Low As Reasonably Achievable. All radiation programs are directed towards your safety, ensuring that the potential for exposure is minimized. You will be informed of the dose received on an annual basis.

During an emergency, saving a life takes precedence over radiation exposure. During actions required to minimize the dose consequences for members of the public, your effective dose may be as high as 100 mSv and your equivalent dose as high as 1000 mSv. During actions required to prevent critical injuries, or could significantly affect people and the environment, your effective dose limit may be as high as 500 mSv and the equivalent dose as high as 5000 mSv. The Radiation Protection Service is available to answer any questions you may have.

- Health & Safety Officers 416-946-3265, 416-978-6846
- Designated Radiation Safety Officer 416-946-3265
- Director, Research Safety and Compliance 416-978-6612

I have read the information provided regarding my designation as a Nuclear Energy Worker, as defined by the regulations. I understand the risks, my obligations, and the radiation dose limits that are associated with being designated a Nuclear Energy Worker.
I confirm my acceptance of this designation.

Print Name:_____ Department: _____
Signature: _____ Date: _____

Approved by the University of Toronto Radiation Protection Service:
Print Name:_____ Signature: _____
Date: _____

Effective: October 2021

NUCLEAR ENERGY WORKER DESIGNATION (Female)

As required by the Radiation Protection Regulations of the Canadian Nuclear Safety Commission, this information is being provided to all staff designated as "Nuclear Energy Workers". The regulation requires the University to designate users of nuclear materials as “Nuclear Energy Workers" if there is a reasonable probability of receiving an effective dose greater than that allowed to members of the general public (1 mSv per annum whole body).

In the course of your work with radiation, you may be exposed to radiation risks. In addition to the risk to your body, the radiation may affect the embryos, fetuses, and breastfed infants. The following documents regarding the radiation risks are provided for your information:

- Health Physics Society Position Statement on Radiation Risk in Perspective
- Radiation Protection Regulations

Effective dose limits for Nuclear Energy Workers are 50 mSv for any one-year dosimetry period, but must not surpass 100 mSv for any 5-year dosimetry period. The equivalent dose limits are:

- 50 mSv for the lens of an eye for a one-year dosimetry period
- 500 mSv for the skin for a one-year dosimetry period
- 500 mSv for the hands and feet and 500 mSv for a one-year dosimetry period

The embryos and fetuses are more sensitive to radiation at the beginning of the pregnancy. You have the right to accommodations to reduce radiation exposure if you are pregnant or breastfeeding. After being informed, in writing, that a female nuclear energy worker is pregnant or she is breastfeeding, the University of Toronto will make all possible accommodations that will not result in costs or business inconvenience constituting undue hardship, to reduce her radiation exposure. The effective dose limit from the moment of informing the Designated Radiation Safety Officer to the remaining of the pregnancy is 4 mSv.

The University of Toronto stresses adherence to the ALARA policy of maintaining doses As Low As Reasonably Achievable. All radiation programs are directed towards your safety, ensuring that the potential for exposure is minimized. You will be informed of the dose received on an annual basis.

During an emergency, saving a life takes precedence over radiation exposure. During actions required to minimize the dose consequences for members of the public, your effective dose may be as high as 100 mSv and your equivalent dose as high as 1000 mSv. During actions required to prevent critical injuries, or could significantly affect people and the environment, your effective dose limit may be as high as 500 mSv and the equivalent dose as high as 5000 mSv.

The Radiation Protection Service is available to answer any questions you may have.

- Health & Safety Officers 416-946-3265, 416-978-6846
- Designated Radiation Safety Officer 416-946-3265
- Director, Research Safety and Compliance 416-978-6612

I have read the information provided regarding my designation as a Nuclear Energy Worker, as defined by the regulations. I understand the risks, my obligations, and the radiation dose limits that are associated with being designated a Nuclear Energy Worker.
I confirm my acceptance of this designation.

Print Name:_____ Department: _____
Signature: _____ Date: _____

Approved by the University of Toronto Radiation Protection Service:

Print Name:_____ Signature: _____
Date: _____

Appendix E - Table of Unit Conversions

THE RAD (rad) IS REPLACED BY THE GRAY (Gy)

1 kilorad (krad)	=	10 gray (Gy)
1 rad (rad)	=	10 milligray (mGy)
1 millirad (mrad)	=	10 microgray (μGy)
1 microrad (μrad)	=	10 nanogray (nGy)

THE GRAY (Gv) REPLACES THE RAD (rad)

1 gray (Gy)	=	100 rad (rad)
1 milligray (mGy)	=	100 millirad (mrad)
1 microgray (μGy)	=	100 microrad (μrad)
1 nanogray (nGy)	=	100 nanorad (nrad)

THE REM (rem) IS REPLACED BY THE SIEVERT (Sv)

1 kilorem (krem)	=	10 sievert (Sv)
1 rem (rem)	=	10 millisievert (mSv)
1 millirem (mrem)	=	10 microsievert (μSv)
1 microrem (μrem)	=	10 nanosievert (nSv)

THE SIEVERT (Sv) REPLACES THE REM (rem)

1 sievert (Sv)	=	100 rem (rem)
1 millisievert (mSv)	=	100 millirem (mrem)
1 microsievert (μSv)	=	100 microrem (μrem)
1 nanosievert (nSv)	=	100 nanorem (nrem)

THE CURIE (Ci) REPLACES THE BECQUEREL (Bq)

1 kilocurie (kCi)	=	37 terabecquerel (TBq)
1 curie (Ci)	=	37 gigabecquerel (GBq)
1 millicurie (mCi)	=	37 megabecquerel (MBq)
1 microcurie (μCi)	=	37 kilobecquerel (kBq)
1 nanocurie (nCi)	=	37 becquerel (Bq)

THE BECQUEREL (Bq) REPLACES THE CURIE (Ci)

1 terabecquerel(TBq)	=	27 curie (Ci)
1 gigabecquerel (GBq)	=	27 millicurie (mCi)
1 megabecquerel (MBq)	=	27 microcurie (μCi)
1 kilobecquerel (kBq)	=	27 nanocurie (nCi)
1 becquerel (Bq)	=	27 picocurie (pCi)

Appendix F - Common Radionuclides Used in U of T

Below you can find radiation safety data sheets for the following radionuclides: **H-3, C-14, P-32, P-33, S-35, Ca-45, Cr-51, Fe-59, Ni-63, and I-125.** For more radiation safety data sheets please visit:
http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/Radionuclide-Information-Booklet-2018-eng.pdf

TRITIUM ^{3}H

Radioactive half-life $T_{1/2}$:	12.4 years
Principal emission:	18.6 keV beta (maximum)
Monitoring for contamination:	Swipes counted by liquid scintillation
Biological Monitoring:	Urine samples
Annual Limit on Intake by ingestion or inhalation:	1×10^{9} Bq (27 mCi) (tritiated water)
Maximum range in the air:	6 mm
Shielding required:	none

Special Considerations for Open Sources
Tritium, because of its low beta-energy, cannot be monitored directly and therefore special care is needed to keep the working environment clean and tidy. Regular monitoring by counting swipes is advisable in areas where this nuclide is used.

Tritium can be absorbed through the skin. Volatile compounds containing tritium, tritiated water, and tritium gas should be handled in a fume hood.

External contamination, although not causing a radiation dose itself, should be kept as low as possible as it can lead to internal and hence hazardous contamination; it can also interfere with experimental results.

DNA precursors (*e.g. tritiated thymidine*) is regarded as more toxic than tritiated water partly because the activity is concentrated into cell nuclei. This is reflected by lower ALIs for the material in this form.

Bioassays may be required for handling high amounts. Consult permit.

CARBON 14 ^{14}C

Radioactive half-life $T_{1/2}$:	5730 years
Principal emission:	0.156 MeV beta (maximum)
Monitoring for contamination:	Swipes counted by liquid scintillation Thin end - window Geiger-Müller detector
Biological Monitoring:	Urine samples, breathing measurements (CO_2)
Annual Limit on Intake: by inhalation or ingestion	4×10^7 Bq (1.08 mCi)
Maximum range in air:	24 cm

Shielding:
1 cm Perspex/Plexiglass. Thinner Perspex/Plexiglass down to 3 mm, although adequate to reduce doses, does not have good mechanical properties. Glass containers, although not generally recommended for shielding of beta radiation, are effective for small quantities of ^{14}C.

Special Considerations for Open Sources
There is a possibility that some organic compounds can be absorbed through gloves.

Care needs to be taken not to generate carbon dioxide which could be inhaled.

Work with volatile compounds or those likely to generate carbon monoxide or carbon dioxide in a fume hood.

PHOSPHORUS 32 ^{32}P

Radioactive half-life $T_{1/2}$:	14.3 days
Principal emission:	1.709 MeV beta (maximum)
Monitoring for contamination:	Swipes counted by liquid scintillation Geiger-Müller detector
Biological Monitoring:	Urine samples
Annual Limit on Intake (ALI) by ingestion or inhalation:	1 x 10^7 Bq (0.27 mCi)
Maximum range in air:	790 cm
Dose rate from 1 MBq (27 □Ci) in 1 ml:	210 mSv/h (21 rem/h) at surface 2.5 μSv/h (0.25 mrem/h) at 1 m
Shielding required:	Plexiglass or similar plastic (at least one cm)

Special Considerations for Open Sources
Phosphorus-32 is the highest energy beta-emitting radionuclide commonly encountered in research laboratories and as such requires special care. Avoid exposure as much as possible (*e.g. do not hold tubes containing even small quantities of ^{32}P any longer than necessary - use a stand or holder*).

If quantities greater than 50 MBq (1.35 mCi) are used, the whole body and ring dosimeters must be worn. The use of lead-impregnated rubber gloves is also recommended.

Even with low-density materials (for example, Perspex/Plexiglass), the absorption of the beta-particles gives rise to relatively high energy Bremsstrahlung which may require some lead shielding when quantities are greater than a few hundred MBq (or tens of millicuries) are being handled.

Specific Precautions for the Handling of Phosphorus-32

Solutions containing more than 1 mCi (37 MBq) of ^{32}P or carrier-free solutions of ^{32}P require specific handling precautions. Carrier-free material is readily absorbed by the skin and will contribute significant doses to the bone where it is preferentially deposited. Careful handling can avoid high radiation doses to the hands while working with this material.

- follow all general radioisotope safety precautions (Sect. 1.1)
- double glove (disposable), changing the outer pair frequently during the procedure
- plexiglass shielding should be used as shielding for all ^{32}P handling and must be used with quantities above 1 mCi (37 MBq). The half-value layer (HVL) thickness for ^{32}P is 1 cm of plexiglass. Lead or other high-density material may be used as secondary shielding
- safety glasses or goggles should be used when handling ^{32}P. This will reduce the external irradiation of the eye and skin as well as prevent the high radiation doses which accompany accidental contamination by splashing
- ring radiation dosimeters, as well as whole-body dosimeters, must be worn if handling quantities of 1.35 mCi (50 MBq) or larger
- more than one person should be present during handling involving more than 1 mCi (37 MBq)
- due to the high dose rates encountered, work should never be carried out above an open container of ^{32}P or another high-energy beta emitter

A solution of phosphate buffer is most effective in removing ^{32}P contamination from surfaces.

P**HOSPHORUS 33** ^{33}**P**

Radioactive half-life $T_{1/2}$:	25.4 days
Principal emission:	0.249 MeV beta (maximum)
Monitoring for contamination:	Swipes counted by liquid scintillation Geiger-Müller survey meter with pancake detector
Biological Monitoring:	Urine samples
Annual Limit on Intake (ALI) by ingestion or inhalation:	80 x 10^6 Bq (2.16 mCi)
Maximum range in air:	89 cm
Dose rate from 1 MBq (27 □Ci) in 1 ml:	30 mSv/h (3 rem/h) at surface 3.6 μSv/h (0.36 mrem/h) at 1 m
Shielding required:	Plexiglass or similar plastic (at least one cm)

Special Considerations for Open Sources
Phosphorus-33 is a moderate energy beta-emitting radionuclide, commonly encountered in research laboratories. Laboratory coats and gloves are the principal protection since skin dose and contamination are the primary concerns - approximately 14% of P-33 beta particles can be transmitted through the skin.

Drying can form airborne P-33 contamination.

SULPHUR-35 ^{35}S

Radioactive half-life $T_{1/2}$:	87.4 days
Principal emission:	0.167 MeV beta (maximum)
Monitoring for contamination:	Swipes counted by liquid scintillation Thin end-window Geiger-Müller detector
Biological Monitoring:	Urine samples
Annual Limit on Intake (ALI) by inhalation or ingestion:	2×10^8 Bq (5.40 mCi)
Maximum range in air:	26 cm

Shielding:
1 cm Perspex/Plexiglas. Thinner Perspex/Plexiglass down to 3 mm, although adequate to reduce doses, does not have good mechanical properties. Glass containers, although not generally recommended for shielding of beta radiation, are effective for small quantities of ^{35}S.

Special Considerations for Open Sources
Note that organic compounds are often strongly retained and no limits of exposure have been set for them.

Be careful not to generate sulphur dioxide or hydrogen sulphide which could be inhaled.

Radiolysis of ^{35}S-amino acids during storage and use may lead to the release of ^{35}S-labelled volatile impurities. Handle such material in a fume hood. Although the level of these impurities is small (typically less than 0.05%), contamination of the internal surfaces of storage and reaction vessels may occur. Vials should be opened and used in fume hoods.

CALCIUM-45 ^{45}Ca

Radioactive half-life $T_{1/2}$:	163 days
Principal emissions:	0.257 MeV beta (maximum)
Monitoring for contamination:	Swipes counted by liquid scintillation End-window Geiger-Müller detector
Biological Monitoring:	Urine
Annual Limit on Intake (ALI) by inhalation (most restrictive):	1×10^7 Bq (0.27 mCi)
Maximum range in air:	52 cm

Shielding:
1 cm Perspex/Plexiglass cuts out all betas. Glass containers, although not generally recommended for shielding of beta radiation, are effective for small quantities of ^{45}Ca.

Special Considerations for Open Sources
In general, Calcium-45 does not require any special precautions over and above those necessary for any beta-emitting radionuclide of this energy of emissions.

The majority of Calcium-45 is deposited in the bone: retained with a long biological half-life.

CHROMIUM-51 ^{51}Cr

Radioactive half-life $T_{1/2}$:	27.7 days
Principal emissions:	0.32 MeV gamma (9.8%) 5 keV X-ray (22% V-51 K X-rays)
Monitoring for contamination:	Swipes counted by liquid scintillation End-window Geiger-Müller detector
Biological Monitoring:	Whole body
Annual Limit on Intake (ALI) by inhalation :	7×10^8 Bq (18.91 mCi)
Dose rate from 1 GBq (27 mCi) point source at 1m:	4.7 μSv/h (0.47 mrem/h)
First half value layer:	3 mm lead

Special Considerations for Open Sources
In general, Chromium-51 does not require any special precautions over and above those necessary for any radionuclide of this energy of emissions.

Chromium-51 as chromate is not selectively absorbed by any organ in the body.

IRON-59 ^{59}Fe

Radioactive half-life $T_{1/2}$:	44.6 days
Principal emission:	1.292 MeV gamma 1.099 MeV gamma 0.466 MeV beta (maximum) 0.273 MeV beta (maximum)
Monitoring for contamination:	Swipes counted by liquid scintillation Thin end-window Geiger-Müller detector
Biological monitoring:	Urine samples
Annual Limit on Intake by inhalation:	5×10^6 Bq (0.14 mCi)
Dose Rate from 37 MBq (1 mCi) At 1 meter	6.1 μSv/hr (0.61 mR/hr)
Shielding:	Lead
First half value layer:	9.7 mm lead

Special Considerations for Open Sources
Near an unshielded ^{59}Fe source, dose rates from beta radiation can be much higher than dose rates due to gamma radiation.

Store ^{59}Fe behind lead shields.

Avoid direct eye exposure by interposing transparent shields or indirect viewing.

Urinalysis to determine uptake is only effective from 4 to 24 hours after handling ^{59}Fe.

Wear extremity and whole body dosimeters while handling more than 1.35 mCi (50 MBq) quantities.

Handle potentially volatile compounds and powder in fume hoods.

NICKEL-63 ^{63}Ni

Radioactive half-life $T_{1/2}$:	100 years
Principal emission:	0.066 MeV beta (maximum)
Monitoring for contamination:	Swipes counted by liquid scintillation
Biological Monitoring:	Urine samples
Annual Limit on Intake by inhalation:	2×10^7 Bq (0.54 mCi)
Maximum range in air:	5 cm

Shielding:
Plexiglass/Perspex if necessary. Glass containers, although not generally recommended for shielding of beta radiation, are effective for small quantities of ^{63}Ni.

Special Considerations for Open Sources
Millicurie quantities of ^{63}Ni do not represent a significant external exposure hazard since the low energy betas emitted cannot penetrate the outer skin layer.

The critical organ for ^{63}Ni is the bone. The elimination rate of ^{63}Ni depends on the chemical form. A few percent of most compounds taken into the body are eliminated via the urine.

Handle ^{63}Ni compounds which are potentially volatile or in powder form in fume hoods.

Many ^{63}Ni compounds cannot be detected with sufficient sensitivity by liquid scintillation counting (LSC) of small volume urine samples. If insoluble compounds are handled, 24-hour urine samples should be periodically collected and analyzed (LSC) to ensure that controls are adequate.

IODINE-125 ^{125}I

Radioactive half-life $T_{1/2}$:	59.6 days
Principal Emissions:	35 keV gamma (7% emitted, 93% internally converted) 27-32 keV X-rays (140% Te K X-rays)
Monitoring for contamination:	Swipes counted by liquid scintillation Thin end-window Geiger-Müller detector
Biological Monitoring:	Thyroid scans (scintillation detector NaI)
Annual Limit on Intake (ALI) by inhalation:	2 x 10^6 Bq (54 microCi)
Dose rate from 1 GBq point-source at 1 m:	41 μSv/h (4.1 mrem/h)
First half value layer:	0.02 mm lead

Special Considerations for Open Sources
The volatilization of iodine is the most significant problem with this isotope. Simply opening a vial of sodium [^{125}I] iodide at a high radioactive concentration can cause minute droplets of up to 100 Bq to become airborne. Solutions containing iodide ions should not be made acidic nor stored frozen: both lead to the formation of volatile elemental iodine.

As some iodo-compounds can penetrate surgical rubber gloves, it is advisable to wear two pairs of polythene (polyethene) gloves over the rubber.

In the event of suspected or actual significant contamination of personnel, the thyroid should be blocked by administration of stable iodine as tablets of potassium iodate (170 mg) or potassium iodide (130 mg) which are available at hospitals.

To render any spilt Iodine-125 chemically stable the area of the spill should be treated with alkaline sodium thiosulphate solution before commencing decontamination. Note, however, that the quantity of radioiodine in normal RIA kits (usually <2 MBq or 54 μCi) is such that these can be handled safely with reasonable care on the open bench.

Specific Precautions for the Handling of Radioiodine
- follow all general radioisotope safety practices (Sect. 1.1)
- users of radioiodine must participate in the thyroid bioassay program (Sect. 1.1.8)

- background bioassay must be conducted before beginning the use of radioiodine
- bioassays of the thyroid must be performed within four days after radioiodine use
- contact the *RPS* for information on this service
- double glove (disposable), changing the outer pair frequently during the radioiodine procedure
- ensure that the radioiodine container has been properly checked for leakage upon receipt
- vials containing radioiodine should be opened only in a fume hood, and containers of radioiodine should be kept closed when not required
- carry out all work involving volatile forms of radioiodine in a fume hood
    - a properly functioning VentAlert alarm system will warn users if the fume hood does not have a proper air exhaust in the range of 100-200 linear feet per minute. Contact the RPS if there is any doubt as to the proper operation of the fume hood
    - charcoal filtration of the exhaust may be required for large quantities of radioiodine
- direct contact with unshielded containers of radioiodine should be avoided
- shielding material of sheet lead will reduce doses received from external gamma radiation
- minimizing the time near radioiodine sources will reduce doses from external radiation
- radioactive waste contaminated with volatile radioiodine should be kept in the fume hood
- shielding may be necessary to reduce radiation fields near the waste
- radioiodine solutions with a pH of 8 or more are less likely to produce vapours
- during the experiment and afterwards, monitor the area with appropriate detection equipment.

A solution consisting of 0.1 M sodium iodide, 0.1 M sodium hydroxide and 0.1 M sodium thiosulphate is effective in cleaning radioiodine spills.

Wash hands immediately following a radioiodine procedure.

Contact the RPS immediately in case of a spill of free radioiodine.

Appendix G - Sealed Sources Leak Test Procedure

Introduction

At the University of Toronto, a wide variety of sealed sources are used in different applications. These range in size from large sources containing hundreds of TBq (kCi) to very small sources of less than a few tens of kBq (μCi). The Canadian Nuclear Safety Commission's regulations require that leak tests are performed on most sealed sources. The exceptions are gaseous sources, sources of tritium or any other source containing a radioactive prescribed substance that is less than 50 MBq.

This document outlines the procedures used for sampling removable contamination and the analysis of the samples that are taken. The procedures and equipment described in this document are intended to meet the expectations of the CNSC as outlined in the Appendix of the CNSC/NSRD Licence Application Guide (http://www.nuclearsafety.gc.ca/eng/nuclear-substances/licensing-nuclear-substances-and-radiation-devices/index.cfm). The University of Toronto conducts leak test sampling and measurement of sealed sources under this procedure.

In this document, the sampling methods are provided followed by the measurement methods available. A table of sources and their locations is maintained by the Radiation Protection Service. Finally, a sample copy of a completed leak test certificate is provided.

1. Sampling Procedure

1.1. General Description of the Method of Wipe Sampling

1.1.1. All samplings are to be conducted by staff of the Radiation Protection Service unless otherwise authorized in writing. The staff of the Radiation Protection Service is familiar with the sources, their use and the hazards associated with the radiation field that may be encountered near the source. The person taking the samples must be familiar with this procedure.

1.1.2. Survey the surrounding area of the source with a suitable radiation monitor and ensure that there are no excessive radiation field readings.

1.1.3. During the sampling, the radiation monitor should be on and checked regularly to ensure that the radiation does not increase to unacceptable levels.

1.1.4. Follow the procedure of the method for wipes sampling determined by the source type. Samples are collected dry unless otherwise noted. This conforms to the procedure used throughout the University of Toronto for contamination monitoring.

1.1.5. For each sample not to be contaminated by any other samples, each envelope should be marked and contain only one sample.

1.1.6. After the sample is taken, the source should be returned to its proper storage position.

2. Specific Sampling Procedures

2.1. Gammacell AECL 20, 220, Nordion 1000 and Nordion 40 Exactor

2.1.1. The procedure of the Method for Wipe Sampling.

2.1.1.1. Move the source into the irradiation position using the control panel.

2.1.1.2. After one minute return the source to the storage position using the control panel.

2.1.1.3. Turn off the control panel.

2.1.1.4. Open the shielding to access the sample chamber.

2.1.1.5. For swiping, use one-quarter of a circular piece of filter paper 9 cm in diameter. The filter paper is used because it removes any free particles from the surface of the source.

2.1.1.6. Hold the filter paper with a pair of tweezers.

2.1.1.7. Swipe the surface of the irradiator opening with the filter paper.

2.1.1.8. Place the filter paper into a marked envelope which will then be taken to the measuring facility.

2.1.1.9. Measure the samples by looking for Co-60 for the samples collected from Gammacell 220 and Cs-137 for Gammacell 20, Nordion 1000 or Nordion 40 Exactor.

2.2 Gamma and Neutron Sources (Applies to sources that can be removed from the container)

2.2.1. The procedure of Method for Wipe Sampling

2.2.1.1. Place absorbent surface liner near the source container.

2.2.1.2. Remove the source from the storage position using a pair of tweezers or a rod and place it on the absorbent surface liner.

2.2.1.3. For swiping, use one-quarter of a circular piece of filter paper 9 cm in diameter. The filter paper is used because it removes any free particles from the surface of the source.

2.2.1.4. Hold the filter paper with a pair of tweezers.

2.2.1.5. Swipe the surface of the source with the filter paper.

2.2.1.6. Place the filter paper into a marked envelope which will then be taken to the measuring facility.

2.3. Gamma Calibration Source (Applies to sources that cannot be removed from the container)

2.3.1. The procedure of the Method for Wipe Sampling.

2.3.1.1. Remove the screws which hold the shielding of the source in place and then remove the shielding.

2.3.1.2. For swiping, use one-quarter of a circular piece of filter paper 9 cm in diameter. The filter paper is used because it removes any free particles from the surface of the source.

2.3.1.3. Hold the filter paper with a pair of tweezers.

2.3.1.4. Swipe the surface of the source with the filter paper.

2.3.1.5. Place the filter paper into a marked envelope which will then be taken to the measuring facility.

2.4. Beta Calibration Source

2.4.1. The procedure of the Method for Wipe Sampling.

2.4.1.1. Place an absorbent surface liner near the source container.

2.4.1.2. Remove the source from the storage position using a pair of tweezers and place it on the absorbent surface liner.

2.4.1.3. For swiping, use one-quarter of a circular piece of filter paper 9 cm in diameter. The filter paper is used because it removes any free particles from the surface of the source.

2.4.1.4. Hold the filter paper with a pair of tweezers.

2.4.1.5. Swipe the source environment with the filter paper.

2.4.1.6. Place the filter paper into a 5 ml liquid scintillation sample vial.

2.4.1.7. Place the vial into a marked envelope which will then be taken to the measuring facility.

2.5. Sources within an Instrument

2.5.1. The procedure of the Method for Wipe Sampling.

2.5.1.1. Find the orifice closest to the source.

2.5.1.2. For swiping, use one-quarter of a circular piece of filter paper 9 cm in diameter. The filter paper is used because it removes any free particles from the surface of the source.

2.5.1.3. Hold the filter paper with a pair of tweezers.

2.5.1.4. Swipe the source environment with the filter paper.

2.5.1.5. Place the filter paper into a 5 ml liquid scintillation sample vial.

2.5.1.6. Place the vial into a marked envelope which will then be taken to the measuring facility.

3. Measuring Procedure

3.1. Liquid Scintillation Counting

3.1.1. Analyzer Unit

Liquid Scintillation Counter
Model: HIDEX 300
This LSC uses a Triple-Double Counting Ratio (TDCR) method to determine the intrinsic activity of the sample without an external source. The TDCR efficiency is determined for each sample.

3.1.2. Follow the instructions to set up, operate and measure samples.

3.1.2.1. At the measuring facility, add 5 ml of the liquid scintillation cocktail[1] into the vial.

3.1.2.2. Place the filled vial into the sample tray for measuring.

3.1.2.3. Set up the regions of interest (ROIs) as required by the users' manual

3.1.2.4. Set the counting time to ten minutes. At this counting time, the instrument is capable of measuring activities less than 10 Bq per sample.

3.1.2.5. Place the sample tray containing the sample vial and control vial in the counting position and start to count.

3.1.2.6. Subtract the background counts from the sample counts.

3.1.2.7. Calculate the activity using the TDCR efficiency of the counter.

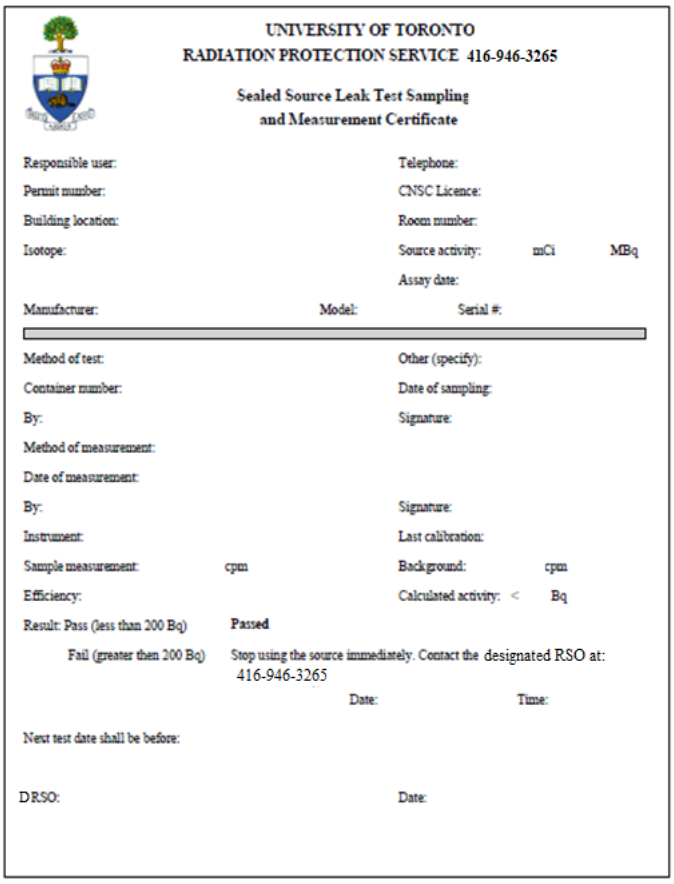
3.1.3. Description of the tests using check sources

3.1.3.1 Use a Tritium and a Carbon – 14 calibration source to verify the correct functioning of the instrument. Unquenched H-3 and C-14 samples are available for this assessment.

3.1.3.2. Calibration sources will be measured annually and a record of the measurement will be kept.

1 "Ultima Gold" of Perkin-Elmer or equivalent

Leak test certificate sample



UNIVERSITY OF TORONTO
RADIATION PROTECTION SERVICE 416-946-3265

Sealed Source Leak Test Sampling
and Measurement Certificate

Responsible user: Telephone:
Permit number: CNSC Licence:
Building location: Room number:
Isotope: Source activity: mCi MBq
Assay date:
Manufacturer: Model: Serial #:

Method of test: Other (specify):
Container number: Date of sampling:
By: Signature:
Method of measurement:
Date of measurement:
By: Signature:
Instrument: Last calibration:
Sample measurement: cpm Background: cpm
Efficiency: Calculated activity: < Bq
Result: Pass (less than 200 Bq) **Passed**
Fail (greater then 200 Bq) Stop using the source immediately. Contact the designated RSO at: 416-946-3265
Date: Time:

Next test date shall be before:

DRSO: Date:

Appendix H – Summary of Changes from the September 2022 edition of the Manual

- Page 1 Revision October 2022
- On pages 2, 31,38, 52,71,72 the contact number updated
- On pages: 7,16,17,19,20,23,28,34,36,38,40,42,43,56,58,61,63,64,69,70,71,72 Senior Radiation Safety Officer changed to Designated Radiation Safety Officer
- On page 17, Optically Stimulated Luminescent (OSL) Dosimeters added and explained along with TLD
- Pages 40, 41 UTRPA meeting frequency changed
- Page 53 TLD changed to radiation badge
- Page 92 Leak test certificate sample copy updated
- Page 67 Changes in responsibilities chart for HSOs and EPS technicians
- Page 16 updated for dose to the eye lens of NEWs
- Page 18 updated to include extremity dose requirements according to section 8 of REGDOC-2.7.1 to address the regulatory expectations.
- Page 34, section 3.3 updated to reflect CNSC expectations for licensee response during skin contamination events.
- Page 59 section 4.5.2.5 updated based on GD-52