University of Toronto

IONIZING RADIATION SAFETY

PROCEDURES AND POLICIES

MANUAL

Radiation Protection Service

Office of Environmental Health and Safety

Revision: Jan 2012

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 radioactive materials involved.

2. Alert Everyone in the Area

Ensure that everyone in the immediate vicinity of the accident has been alerted. Mark the area and post a sign if necessary to prevent anyone from walking on the spilled 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 with dry absorbent.

4. Clear the Area

Remove all persons from the vicinity of the spilled 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, the spill involves volatile radioactive material, or the spill of more than 1 EQ is on a person, contact the Radiation Protection Service.

During normal working hours:	**416 978-2028**
Nights & Weekends:	
St. George Campus	**416-978-2222**
University of Toronto at Mississauga	**905-828-5200**
University of Toronto at Scarborough	**416-287-7300**

State:

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

Wait for assistance to arrive.

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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 ensure that the use of radioactive materials at the University is carried out in a safe manner with due regard for employees, students, the public and the environment. The University is also committed to ensure 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 governing 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 the 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 material 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 is 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, import and export of radioactive materials, and a waste licence covering the disposal of radioactive materials.

For all matters associated with the licences:

- the Senior Radiation Safety Officer, is the primary contact person and the Signing Authority* for the University, and
- the Vice-President, Human Resources and Equity, 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 licence 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 Radiation Safety Officer(s) during the term of the licence.*

** *The CNSC defines the Applicant Authority as one of the applicant's corporate officers that signs 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 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 president or vice-president), although other arrangements can be considered.*

1. SAFETY RULES AND PROCEDURES

1.1. General Safety Practices

In the use of radioactive materials for teaching or research, consideration must also be given to other physical, chemical and biological hazards which 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 in accordance with 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 staff list must be posted with the permit in the main laboratory of the permit holder.

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 labeled 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 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. Disposable absorbent material must be replaced on a regular basis.

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 which may disrupt the air flow.

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

15. Any wound or other 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 prior to the start of such work.

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

1.1.2. Protective Clothing

1. Direct contact with radioactive materials must be avoided by the proper use of protective clothing. As a minimum, this consists of a laboratory coat and disposable, impervious gloves. Depending on the isotope and operation, double gloves, a full apron and glasses or a face shield may be necessary. Disposable items must be discarded immediately after use.

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.

1.1.3. 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 which 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 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 suspect 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, 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.

1.1.4. 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 clearly 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 clearly 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 radioactive material use in the room.

Storage, 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.

1.1.5. Radiation Warning Signs

A radiation warning sign must be posted at the boundary of and at every point of access to an area, room, enclosure or vehicle if:

- There is a radioactive nuclear substance in a quantity greater than 100 EQ in the area, room, enclosure or vehicle, or

- There is a reasonable probability that a person in the area, room, enclosure or vehicle will be exposed to an effective dose rate greater than 25 μSv/h.

In every radioisotope laboratory the area or equipment used for radioisotope work must be marked with radiation warning labels.

In U of T a radiation warning sign indicating the dose rate must be posted on any fridge, freezer or other storage area or equipment if it is reasonable to believe that a person in the area will receive a dose greater than 2.5 μSv/h (250 μrem/h).

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

1.1.6. Radioisotope Handling Precautions

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

2. Use the minimum quantity 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 other high energy beta emitter.

5. Pipetting by mouth is expressly forbidden. A variety of safe pipetters 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 completion of procedures involving radioactive material. Hands and clothing should be monitored to ensure that no contamination has occurred.

1.1.7. 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.

Nuclear Energy Workers who become aware that they are pregnant must notify the permit holder and RPS immediately in writing.

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

1.1.7.1. 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	50 (whole body)
		150 (lens of an eye)
		500 (skin)
		500 (hands and feet)
	Five years	100 (whole body)
Pregnant NEW	Balance of the pregnancy	4 (whole body)
Members of the public	One year	1 (whole body)
		15 (lens of an eye)
		50 (skin)
		50 (hands and feet)

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 Senior Radiation Safety Officer (SRSO). 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 1 mSv or equivalent dose greater than 10 mSv per year must be reported to the SRSO. The SRSO or his delegate will:

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

1.1.7.2. 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 of appropriate corrective actions.

The personnel external monitoring device most commonly employed is the thermoluminescent dosimeter (TLD). Thermoluminescent dosimeters for personnel monitoring contain detectors situated under filters. When exposed to ionizing radiation, temporary defects are

created in the thermoluminescent crystal. These defects are stable until the crystal chip is heated and the TLD releases the excitation energy as light, proportional to the absorbed dose. 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.

Thermoluminescent dosimeters (TLDs) 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 TLD must be protected from exposure to ultraviolet light. TLDs are also insensitive to the weak beta radiation from ^{3}H, ^{14}C and ^{35}S. Contamination of the TLD with beta emitters may result in non-relevant exposures being recorded. The TLD must not be stored in an area where it could receive a radiation exposure (e.g. on a laboratory coat and left near a radiation source overnight).

Two types of TLDs are used for the purpose of measuring personal external dose: a whole body TLD (used to measure the effective dose) and a ring TLD (used to measure extremity dose).

The whole body TLD is required for users of high energy beta and gamma emitters. 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 TLD, in special situations (e.g. during pregnancy, first experiment with large quantities of radioactive material, etc.).

The ring TLD is required for persons handling more than 1.35 mCi (50 MBq) of high energy beta (like P-32) or gamma emitters.

Inquiries about personal monitoring services should be directed to the RPS (416-978-4467).

To monitor the doses received by persons not using high energy beta or gamma emitters area monitors are installed in close proximity to the high energy beta or gamma emitters working area. The area monitors will register the external dose in the proximity of the working area at all times, indicating a maximum external dose to which a person not working with the radioactive materials may be exposed to.

1.1.8. 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 a 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 radioiodines 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 the bioassay monitoring is dictated by the radioisotope and its chemical and radiological behavior in the body. Bioassay techniques must be sensitive enough to ensure that any significant amount of radioactive material will be detected.

1.1.8.1. Thyroid Bioassay

Participation in the thyroid bioassay program is required when the amount of open source quantities of radioiodine used:

- exceeds 54 microCi (2 MBq) in 24 h in an open room,
- exceeds 5.4 mCi (200 MBq) in 24 h in a fume hood,
- exceeds 540 mCi (20000 MBq) in 24 h in a glove box,
- the person is involved in a spill of more than 54 microCi (2MBq) of radioiodine, or
- external contamination is detected on the person.

Persons who work with radioiodine, or those who are sufficiently close (are present in the same room) must participate in the bioassay program. Bioassay monitoring of the thyroid must be performed between 6 hours and 4 days following the use of radioiodine. Contact the Radiation Protection Service to enroll in the thyroid bioassay program or to arrange for a bioassay measurement.

Thyroid Bioassay Criteria Investigation Levels:
Any thyroid bioassay resulting in a reading of greater than 1 kBq must be reported to the SRSO. The SRSO or his/her delegate must conduct an investigation 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 must be reported to the SRSO. The SRSO or his delegate must:

- conduct an investigation to establish the cause for reaching this action level,

- identify and take action to restore the effectiveness of the protection program and to prevent such exposures, and
- notify the Canadian Nuclear Safety Commission.

1.1.8.2. Urinalyses

Urinalyses bioassays may be required following the handling of significant quantities of H-3 or C-14.

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 enroll 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 SRSO. The SRSO or his/her delegate must conduct an investigation to establish the cause for reaching this level.

Tritium Bioassay Action Level:
Any urine bioassay resulting in a reading of greater than 1 MBq/liter must be reported to the SRSO. The SRSO or his delegate must:

- conduct an investigation to establish the cause for reaching this action level,
- identify and take action to restore the effectiveness of the protection program and to 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 other such unit. Much larger sealed sources exist in exposure devices or in 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 durably 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 **prior to 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.

A permit holder is required to notify the Radiation Protection Service **prior to 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 removal of the source 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.

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 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 RPS sends the inventory sheet to the user with a unique identifier for each source. If multiple stock solutions are obtained from the initial source each one should have its own unique identifier. The person receiving the material must initial the inventory record. The date of disposal must also be noted and communicated to the RPS.

All radioisotope inventory records must be maintained for three years following 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 of 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 for fixed contamination. The criteria for non-fixed contamination are established in Bq/cm^2 and the ones for fixed contamination in microSv/h.

1.3.1.1. Contamination Criteria for Non-fixed Contamination

For the purpose of decontamination the radionuclides are classified in 3 classes:

- Class A – long lived radionuclides which emit alpha radiation
- Class B – long lived radionuclides which emit beta and/or gamma radiation
- Class C – short lived radionuclides which emit beta and/or gamma radiation

The following table contains the contamination criteria for non-fixed contamination in controlled areas (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 SRSO. An investigation must be made and the event must be reported to the CNSC.

Investigation levels are 0.05 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 microSv/h for controlled areas.

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

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

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

1.3.2. Procedures for Contamination Monitoring

All radioisotope facilities must be monitored for contamination. At a minimum, all radioisotope laboratories actively using radioactive materials must be monitored weekly for the possibility of surface contamination.

If no radioisotopes have been used since the previous survey, a notation of this fact can be made in the contamination log and posted sheet. No further action is necessary until the next usage.

A sketch of the floor plan of each room listed on the permit should be prepared. The locations of active benches, sinks and fume hoods where radioactive material is used should be numbered for reference purposes. Numbers should be assigned to areas of the floor around the locations. There should be a minimum of 4 measurement locations per active bench location, including the floor.

Before measuring for contamination, the surface should be dry. Use a surface contamination meter (direct monitoring) to measure the level of surface contamination if gamma/x-ray or strong beta emitter has been used or stored. 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 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).

4. Do the calculation to transform the readings from cpm or cps to Bq/cm^2 or verify if the threshold value written on the calibration sticker was reached (this cpm indicates for that particular instrument if the measurement is above 0.5 Bq/cm^2).

5. Record the results.

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

1. Samples shall be taken from each square meter of the surface (both from inside and outside surfaces of the equipment). Choose the locations most likely to be contaminated (e.g. door handles, the shelf where radioactive material was stored, etc.).
2. Swipe 100 cm^2 by pressing the filter paper against the surface.
3. Fold the filter paper and insert it into a liquid scintillation vial.
4. Add scintillation fluid.
5. Choose an energy window that is appropriate for the radioisotope, or use a wide open window.
6. Perform the measurement.
7. Perform the calculation to transform the readings from cpm to Bq/cm^2 or verify if the threshold value written on the calibration sticker was reached (this cpm indicates for that particular instrument if the measurement is above 0.5 Bq/cm^2).
8. Record the results.

To measure the external radiation field:

1. Use a radiation survey meter that was calibrated within the last year. Check the proper functioning of the instrument (battery, high voltage, sound, calibration sticker) and adapt the scale to the level of radiation field measured.

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

3. Record the results (at least five results should be recorded for each square meter of the available surface of the area).

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

If all contamination is removed, note this in the log book and on the posted notice. Copies of the results before and after cleaning should be kept in the log book.

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 chemical 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 was used/stored, be sure to wear 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, 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 a 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 http://www.ehs.utoronto.ca/resources/wmindex/wm5_3.htm) 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 to 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 RSO 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 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 RSO.

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 in accordance with the section 4.1.3.3 UTRPA Policy on Decommissioning.

After removal of all radioactive materials a contamination survey must be performed in accordance with 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 in accordance with section 1.3.3. Decontamination must be repeated until contamination criteria are meet.

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

When the above steps are completed the Permit Holder or the Department Chair must contact the Radiation Protection Service. A Radiation Safety Officer (RSO) will audit the decommissioning work by performing a separate contamination survey. The RSO will complete the decommissioning report, and will remove the room, area, equipment from the list of commissioned rooms, areas or equipments. When required the Senior 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 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 a RSO following the procedure approved by the CNSC. The leak test certificate is verified and signed by the SRSO. The original leak test certificate is kept in 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

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 is part of the University of Toronto CNSC waste management licence and is available from the Office of Environmental Health and Safety website (http://www.ehs.utoronto.ca/resources/wmindex/wm5_3.htm).

3. EMERGENCY PROCEDURES

3.1. Basic Emergency Procedures

IN CASE OF EMERGENCY INVOLVING RADIOACTIVE MATERIAL

Contact:
Radiation Protection Service (normal working hours)
416 978-2028

After hours, nights, weekends and holidays:
Contact the Campus Police

St. George Campus	**416 978-2222**
University of Toronto Mississauga Campus	**905 828-5200**
University of Toronto Scarborough Campus	**416 287-7333**

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 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 any emergency situation, 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. Act according to these procedures to minimize any possible exposures.

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, bench kote	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 emergency situation. In the event of any spill of radioactive material, it is important that the correct steps 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 involving alpha emitters, internal or external contamination of personnel with more than 1EQ, or more than 100 EQ on a bench or floor 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.

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 decontamination, as described below:

- wash hands in case they were contaminated during the accident
- use appropriate detector to monitor clothing and hands. If 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, 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 cleaning agent
- wash and rinse the affected areas several times
- treat all contaminated materials as radioactive waste (e.g. absorbent paper)
- continue washing until 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 log book 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 are suspected of being contaminated with radioactive material, complete the following:

- immediately assess the location and extent of the contamination
- use a survey meter, if appropriate for the suspected isotope, to locate the material and provide an assessment of the amount

- remove any contaminated clothing, place in plastic bag, labelled as to contents, tape shut
- monitor to determine if any skin contamination has occurred, its location and extent.

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

- provide assistance to 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.

If the skin is intact

- 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 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.

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. 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 Senior Radiation Safety Officer will notify the CNSC and further information or investigation must be performed.

3.6. 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**.

4. RADIATION PROTECTION PROGRAM

4.1. University of Toronto Radiation Protection Authority

At 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, security of radioactive materials, and to 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, Human Resources and Equity and to the University's Governing Council.

The members of the UTRPA are appointed by the Vice-President, Human Resources and Equity, 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 Senior Radiation Safety Officer, will act as the Secretary of the UTRPA. All enquiries regarding radiation protection are to be directed to the SRSO at 416-978-2028.

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 a strong safety culture among all faculty, staff and students involved in work 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 (Revised November 2007)

The University of Toronto Radiation Protection Authority (UTRPA) is charged with the total and overall program of radiation protection at the University of Toronto. The control exercised is complete and all-embracing, the UTRPA having the necessary executive power delegated to it by the Governing Council to enforce and maintain the required standards of radiation protection necessary for a complex teaching and research institution.

This program has, as its foundation, Federal and Provincial regulations issued by the Canadian Nuclear Safety Commission, the Department of National Health & Welfare (Radiation Protection Division), and the Ministries of Health & Labour, Government of Ontario.

The responsibility of the UTRPA includes all sources of ionizing radiation and non-ionizing radiation (both materials and machines), for whatever use, on all properties owned or controlled by the University of Toronto.

On behalf of the University the UTRPA has the sole responsibility for negotiating with the appropriate authorities and has, within the University, jurisdiction in all matters pertaining to the use, handling, storage, and disposal of radioactive prescribed materials and the installation, development and operating of equipment producing ionizing radiation & non-ionizing radiation, as well as the security of radioactive materials.

The UTRPA reports to the Governing Council through the Vice-President, Human Resources and Equity.

The UTRPA considers, and advises on, the establishment of radiation emergency measures within the University and co-operation and integration with other authorities.

The UTRPA conducts educational programs as required with respect to radiation hazards and promotes a radiation safety culture within the members of the faculty, University staff and students.

The UTRPA has the authority to consult with appropriate persons or institutions and to revise the policies and procedures for the use of radioactive prescribed materials as circumstances warrant.

The radioisotope permit holder will be held responsible at all times for all aspects of radiation safety and security of radioactive materials in areas under his or her supervision.

Radioisotope permit holders must provide adequate training to all personnel handling radioactive prescribed materials under their supervision in the proper use, handling, storage and disposal of these materials.

Radioisotope permit holders must conform to the conditions of the radioisotope permit, the UTRPA Policies and Procedures, and the requirements of the Canadian Nuclear Safety Commission. They also must ensure adequate security of all laboratories under their supervision. Failure to comply could result in the cancellation of their radioisotope permit.

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 two times a year
- establish and review the training and experience of users of radioactive materials to ensure that they can perform their duties safely and in accordance with 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 an "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 in accordance with CNSC regulations and the conditions of the licence
- receive reports from the Senior 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 which will incorporate the ALARA principle
- approve designs for new laboratories in accordance with CNSC Regulatory Guide R-52 entitled *Design Guide for Basic and Intermediate Level Radioisotope Laboratories* 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 Senior 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 principal investigator will be notified verbally by the Radiation Safety Officer (RSO) of the offence and the need for the policy.

Step 2) On the second occurrence within a year, the Senior Radiation Safety Officer will send a letter to the principal investigator, 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 RSO 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 Senior 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 1 year 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 Senior 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 Senior 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.

UTRPA Policy on Security for Radioisotope Laboratories

One of the prime methods of radiation protection at the University of Toronto is to restrict to responsible persons the access of radioactive materials. 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 at all times.

When persons designated as responsible for 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 with regard to 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 principal investigator, 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 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 an 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 the 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 practises which will minimize the probability of contamination, for monitoring their work area for contamination and for 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 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 prior to handling of food, beverages or their containers. There must be provision for hanging up 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 prior to handling food, beverages or their 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 chromatograph units, etc.)

Gas chromatograph units which employ a tritium source will not qualify for this exemption.

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 which has been encapsulated to prevent direct manipulation of the radioactive material. The encapsulating material must be substantial and able to withstand 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 is removed and the requirement to adhere to These rules are 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 the 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 interruption. The requirement for adherence to the CNSC Rules for Working with Radioisotopes can then be relaxed.

UTRPA Policy on Interrupted Laboratories

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 period of 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 a period of 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.

In order 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 period of 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 spoilage of any material.

As part of the interruption procedures, the Permit Holder will be responsible for carrying out a 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 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 year 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 with respect to 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 on a regular basis 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 pertaining to:
  - 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. Audits are normally conducted on a semi-annual basis but may be more frequent if necessary.

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 in accordance with the *UTRPA Policy on Disciplinary Action (1.1.3.1)*.

4.2.4. Services Available from the RPS

Service provided	Contact	Contact Phone #
General Inquires and radiation badges	Administrative Assistant	416-978-4467
Radioisotope permit administration	RSO	416-798-6846
Radiation Protection training	RSO	416-946-7064
Radiation compliance inspections	RSOs	416-978-6846, 416-946-7064, 416-946-3265
Radiation bioassay service	RSOs	416-978-6846, 416-946-3265
Radiation decontamination advice and assistance	RSOs	416-978-6846, 416-946-7064, 416-946-3265
Radiation instrument calibration	RSOs	416-978-6846, 416-946-7064, 416-946-3265
Radiation purchase information	RSOs	416-946-3265, 416-978-6846, 416-946-7064
Radiation surveys	RSOs	416-978-6846, 416-946-7064, 416-946-3265
Radiation warning signs	RSOs	416-978-6846, 416-946-7064, 416-946-3265
Transfer of radioactive materials	RSO	416-978-2028
Radiation waste collection and disposal	Environmental protection technicians Coordinator hazardous waste management	416-978-2050 416-978-7000
X-ray safety	RSO	416-946-6846
Regulatory agency liaison and advice service	SRSO	416-978-2028

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 sandu.sonoc@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 safe use of radioisotopes,
- designating specific work and storage areas for radioactive materials and ensuring that these areas are kept clean, are properly labeled, are adequately shielded and that existing ventilation is not impaired,
- ensuring that all staff working with radioisotopes have been issued, and wear a thermoluminescent dosimeter and participate in the bioassay program, as required,
- 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 is 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 inventory of usage of radioactive materials,
- monitor of work areas at the end of the work (must be done within 7 days of usage),
- 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 a period of 5 years; a request for renewal is made to the CNSC by the U of T.

It should be noted that use of radioactive materials in teaching hospitals and research institutions are controlled by the respective institutions under separate CNSC licences. Therefore, 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 for a combination of both. When the total amount of radioactive materials that a permit holder may have in possession 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 of time (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 of 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 to 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 for permit holders (see sect. 4.7.2 – 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 prior to the issuing of the permit (see sect. 4.5.2.5).

A radioisotope permit does not normally cover off-campus use of radioactive materials; for such use, a 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 prior to 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.

In order 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 R-52, *Design Guide for Basic and Intermediate Level Radioisotope Laboratories* 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 procedure, 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 signed and 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 a period of 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 Senior 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. Two copies are produced, and the permit holder must sign each copy, returning one for filing on record with the RPS.

A signed 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 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 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.

This section may also be continued on an appendix sheet if there are more isotopes 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 staff should ensure that they have read, understand and follow all permit conditions.

The last section of the permit contains a statement affirming that, by signing, the permit holder agrees to the terms and conditions under which the permit is issued.

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

A permit is granted on the grounds that the permit holder is aware 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 ***prior to 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 the effective time period. 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 prior to 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. In order to change any part of the permit, an application must be made for a permit revision. Applications for permit revision are available from the RPS website or office.

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 Senior Radiation Safety Officer or delegate will review the permit and indicate which permit conditions will apply.

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

Following approval of the amendment, a revised permit will be printed and signed by the permit holder to validate the revision of the 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.

No permit amendments will be considered in the calendar month preceding a permit renewal.

4.5.2.5. Radioisotope Laboratory Approval

All rooms intended to be used for the handling, storage or disposal of a radioactive material must conform to the requirements of CNSC Regulatory Guide R-52 (Rev 1) *Design Guide for Basic and Intermediate Level Radioisotope Laboratories* or updated regulation.

A radioisotope laboratory is classified as Basic Level, Intermediate Level, High Level, or Containment Level. Laboratory classification is based on the amount of open sources per container permitted to be handled in the laboratory. The permissible quantities for the types of laboratories are defined in CNSC document, C-222 (E), CONSOLIDATED USE OF NUCLEAR SUBSTANCES. The University of Toronto does not presently have any facilities designated as Containment Level. A listing of the regulated quantities for typical radionuclides is available from the RPS website or office.

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 an 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.

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 successfully 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 prior to departure. The permit holder must notify the *RPS* to cancel the permit. At the cancellation of a radioisotope permit, all rooms, areas, 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 on a regular basis 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. This information is reported to the CNSC in an Annual Report and must also be available for inspection by the CNSC on demand.

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 ***prior to ordering or receipt of the material***. A purchase order is then generated by the permit holder's business officer and forwarded to the supplier.

Some companies have an agreement with U of T to approve procurements online ("UShop"). To establish a username and a password please contact U of T Procurement Services at http://www.procurement.utoronto.ca/about/ContactPage.cfm. After an order for a radioactive material is placed on UShop, 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 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 on the individual permit on which it is ordered. This also applies if 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 prior to 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 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 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. 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://www.ehs.utoronto.ca/Assets/ehs3/rad/RadTransferring.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 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 SRSO 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 ***prior to beginning work with the 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.

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 of 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 successfully complete the Ionizing Radiation Protection Course examination.

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 on a regular basis. 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 practical session and written examination must be successfully completed. Successful candidates are provided with a certificate after completion and are then allowed to work with radioactive materials without direct supervision.

4.7.2. 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.

Information on registering for the courses is posted on the RPS homepage under training courses or can be obtained from the RPS office.

4.7.3. Summer/Special 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, but there is no final examination or certificate for this training and students who take this course may not work with radioactive

materials without direct supervision by someone who has completed the regular Ionizing Radiation Protection Course.

Information on the summer/special student training is posted on the RPS homepage under training courses or can be obtained from the RPS office.

4.7.4. Other Training

Special training is offered to the users of sealed sources and irradiators. These courses will focus on the types of radiation sources used, biological effects of that type of radiation, hazard assessment and hazards controls put in place as well as regulatory requirements for these types of sources. Information on the registration for these courses can be obtained from the radiation safety web page or from the RPS office.

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.

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 direct supervision of a person who is adequately trained and who holds a valid TDG training certificate.

4.8. Records Management

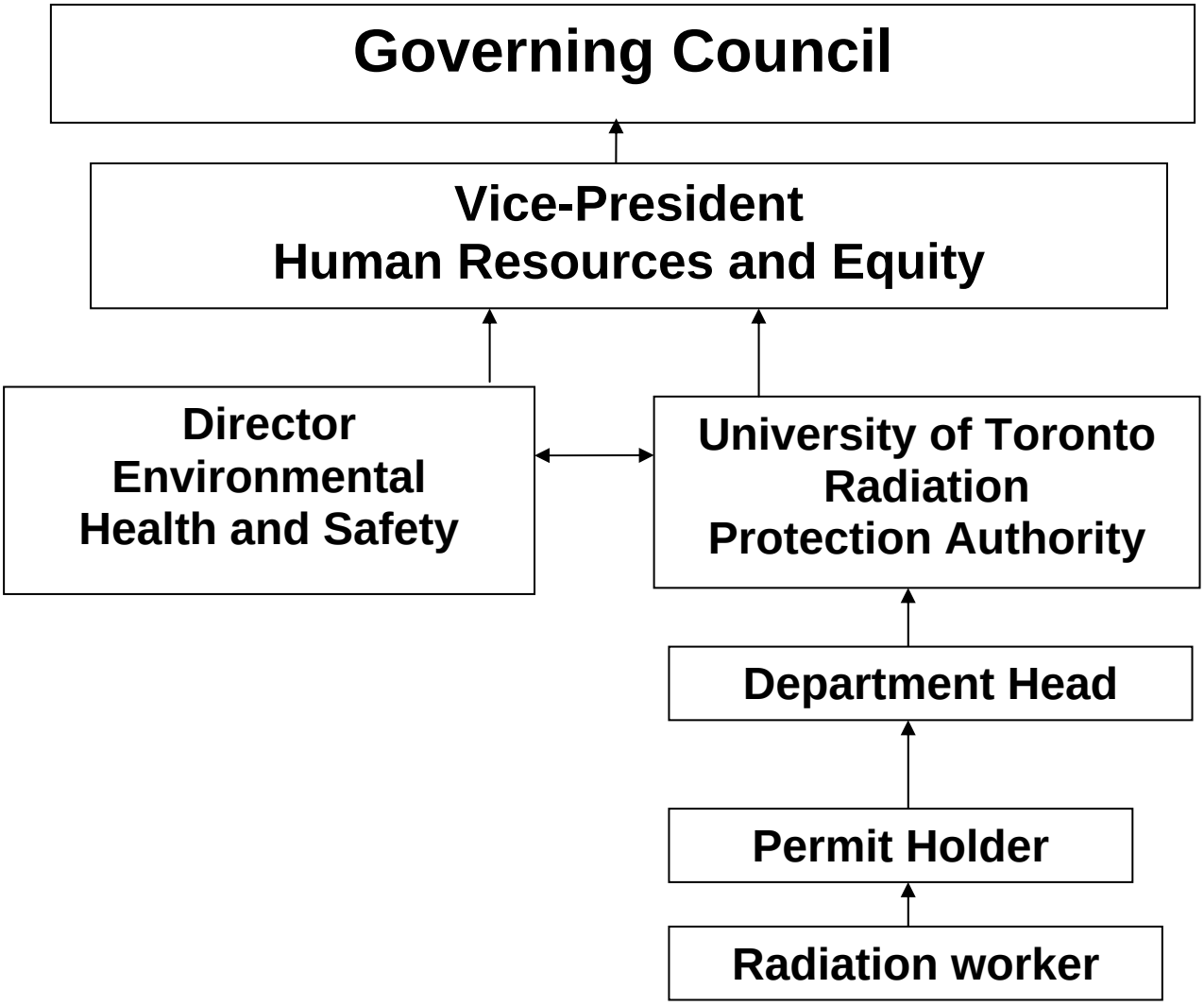
Prescribed records maintained, location where the records will be maintained, period that records will be kept and the frequency of auditing the records are presented below. The records maintained by the permit holders (in the laboratories) will be audited by RSOs during the inspections. The records maintained by the RPS will be audited annually by the SRSO.

Description of Record	Location	Period	Audit Frequency
Records of the information in respect to 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 manner in which was used	RPS	1 year after licence expiry date	Annually
Inventory, usage and disposal of radioisotopes	In the lab	3 years	2-4 times

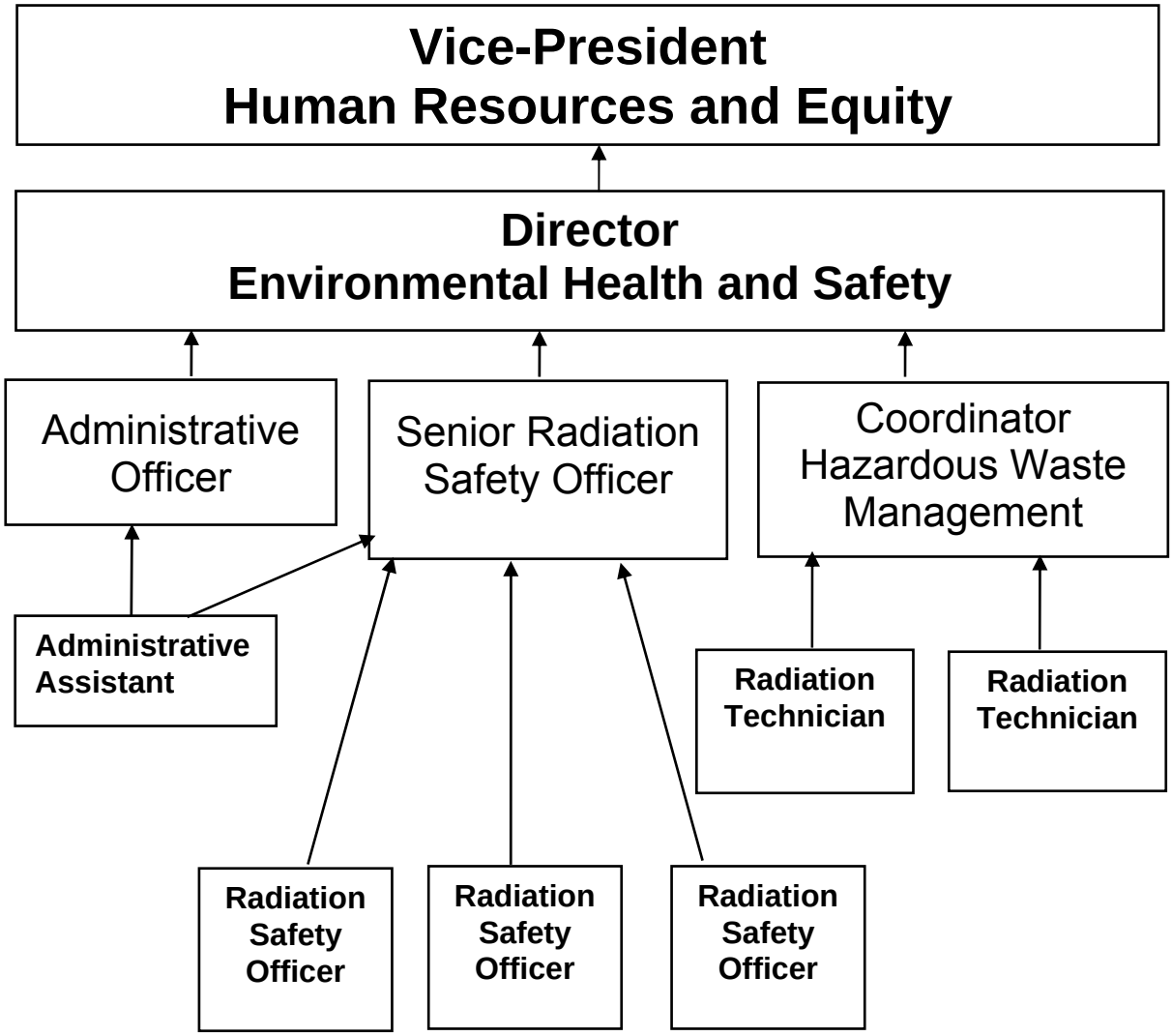
used in the laboratories			per year
Records of the name of each worker who uses or handles radioisotopes and radiation devices	RPS	1 year after licence expiry date	Annually
Records of any transfer, receipt, disposal or abandonment a) the date b) the name and address of the supplier or the recipient c) 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 device	RPS	1 year after licence expiry date	Annually
Records of radiation training	RPS	3 years after the end of employment	Annually
Records of NEW designations, names and job category	RPS	1 year after 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 licence expiry date	Annually
Thyroid screening records	RPS	1 year after licence expiry date	Annually
Leak test records	RPS	3 years	Annually
High risk sealed source tracking records	RPS	1 year after licence expiry date	Annually
Licence application and CNSC correspondence regarding licence application or licence changes	RPS	1 year after licence expiry date	Annually
Radiation permits issued by UTRPA	RPS	1 year after permit expiry	Annually
Contamination monitoring surveys	In the lab	3 years	2-4 times per year
Calibration of equipment used for contamination monitoring and gamma surveys	RPS	3 years	Annually
Equipment and laboratory decommissioning records are kept in the permit folders	RPS	1 year after 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 expiry date	Annually
UTRPA meetings, actions, recommendations and decisions	RPS	1 year after licence expiry date	Annually

A 90-days notice will be provided to the CNSC prior to 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



*Until further notice the Senior Radiation Safety Officer reports to the Director Environmental Health and Safety

Appendix C - Responsibilities for Reporting to the CNSC

Appendix C1 – General Reporting Responsibilities to the CNSC

(based on the General Nuclear Safety and Control Regulations, May 31, 2000).

12. (1) Every licensee shall
(*a*) ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the Act, the regulations made under the Act and the licence;
(*b*) train the workers to carry on the licensed activity in accordance with the Act, the regulations made under the Act and the licence;
(*c*) take all reasonable precautions to protect the environment and the health and safety of persons and to maintain security;
(*d*) provide the devices required by the Act, the regulations made under the Act and the licence and maintain them within the manufacturer's specifications;
(*e*) require that every person at the site of the licensed activity use equipment, devices, clothing and procedures in accordance with the Act, the regulations made under the Act and the licence;
(*f*) take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity;
(*g*) implement measures for alerting the licensee to the illegal use or removal of a nuclear substance, prescribed equipment or prescribed information, or the illegal use of a nuclear facility;
(*h*) implement measures for alerting the licensee to acts of sabotage or attempted sabotage anywhere at the site of the licensed activity;
(*i*) take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement;
(*j*) instruct the workers on the physical security program at the site of the licensed activity and on their obligations under that program; and
(*k*) keep a copy of the Act and the regulations made under the Act that apply to the licensed activity readily available for consultation by the workers.

(2) Every licensee who receives a request from the Commission or a person who is authorized by the Commission for the purpose of this subsection, to conduct a test, analysis, inventory or inspection in respect of the licensed activity or to review or to modify a design, to modify equipment, to modify procedures or to install a new system or new equipment shall file, within the time specified in the request, a report with the Commission that contains the following information:
(*a*) confirmation that the request will or will not be carried out or will be carried out in part;
(*b*) any action that the licensee has taken to carry out the request or any part of it;
(*c*) any reasons why the request or any part of it will not be carried out;
(*d*) any proposed alternative means to achieve the objectives of the request; and
(*e*) any proposed alternative period within which the licensee proposes to carry out the request.

15. Every applicant for a licence and every licensee shall notify the Commission of
(*a*) the persons who have authority to act for them in their dealings with the Commission;
(*b*) the names and position titles of the persons who are responsible for the management and control of the licensed activity and the nuclear substance, nuclear facility, prescribed equipment or prescribed information encompassed by the licence; and
(*c*) any change in the information referred to in paragraphs (*a*) and (*b*), within 15 days after the change occurs.

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

(*a*) a situation referred to in paragraph 27(*b*) of the Act;
(*b*) the occurrence of an event that is likely to result in the exposure of persons to radiation in excess of the applicable radiation dose limits prescribed by the *Radiation Protection Regulations*;
(*c*) a release, not authorized by the licence, of a quantity of radioactive nuclear substance into the environment;
(*d*) a situation or event that requires the implementation of a contingency plan in accordance with the licence;
(*e*) an attempted or actual breach of security or an attempted or actual act of sabotage at the site of the licensed activity;

(*f*) information that reveals the incipient failure, abnormal degradation or weakening of any component or system at the site of the licensed activity, the failure of which could have a serious adverse effect on the environment or constitutes or is likely to constitute or contribute to a serious risk to the health and safety of persons or the maintenance of security;
(*g*) an actual, threatened or planned work disruption by workers;
(*h*) a serious illness or injury incurred or possibly incurred as a result of the licensed activity;
(*i*) the death of any person at a nuclear facility; or
(*j*) the occurrence of any of the following events:
(i) the making of an assignment by or in respect of the licensee under the *Bankruptcy and Insolvency Act*,
(ii) the making of a proposal by or in respect of the licensee under the *Bankruptcy and Insolvency Act*,
(iii) the filing of a notice of intention by the licensee under the *Bankruptcy and Insolvency Act*,
(iv) the filing of a petition for a receiving order against the licensee under the *Bankruptcy and Insolvency Act*,
(v) the enforcement by a secured creditor of a security on all or substantially all of the inventory, accounts receivable or other property of the licensee that was acquired for, or used in relation to, a business carried on by the licensee,
(vi) the filing in court by the licensee of an application to propose a compromise or an arrangement with its unsecured creditors or any class of them under section 4 of the *Companies' Creditors Arrangement Act*,
(vii) the filing in court by the licensee of an application to propose a compromise or an arrangement with its secured creditors or any class of them under section 5 of the *Companies' Creditors Arrangement Act*,
(viii) the making of an application for a winding-up order by or in respect of the licensee under the *Winding-up and Restructuring Act*,
(ix) the making of a liquidation, bankruptcy, insolvency, reorganization or like order in respect of the licensee under provincial or foreign legislation, or
(x) the making of a liquidation, bankruptcy, insolvency, reorganization or like order in respect of a body corporate that controls the licensee under provincial or foreign legislation.

(2) Every licensee who becomes aware of a situation referred to in subsection (1) shall file a full report of the situation with the Commission within 21 days after becoming aware of it, unless some other period is specified in the licence, and the report shall contain the following information:
(*a*) the date, time and location of becoming aware of the situation;
(*b*) a description of the situation and the circumstances;
(*c*) the probable cause of the situation;
(*d*) the effects on the environment, the health and safety of persons and the maintenance of security that have resulted or may result from the situation;
(*e*) the effective dose and equivalent dose of radiation received by any person as a result of the situation; and
(*f*) the actions that the licensee has taken or proposes to take with respect to the situation.

(3) Subsections (1) and (2) do not require a licensee to report a situation referred to in paragraphs (1)(*a*) to (*j*) if the licence contains a term or condition requiring the licensee to report that situation, or any situation of that nature, to the Commission.

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

(*a*) interference with or an interruption in the operation of safeguards equipment or the alteration, defacement or breakage of a safeguards seal, other than in accordance with the safeguards agreement, the Act, the regulations made under the Act or the licence; and
(*b*) the theft, loss or sabotage of safeguards equipment or samples collected for the purpose of a safeguards inspection, damage to such equipment or samples, or the illegal use, possession, operation or removal of such equipment or samples.

(2) Every licensee who becomes aware of a situation referred to in subsection (1) shall file a full report of the situation with the Commission within 21 days after becoming aware of it, unless some other period is specified in the licence, and the report shall contain the following information:
(*a*) the date, time and location of becoming aware of the situation;
(*b*) a description of the situation and the circumstances;
(*c*) the probable cause of the situation;
(*d*) the adverse effects on the environment, the health and safety of persons and the maintenance of national and international security that have resulted or may result from the situation;
(*e*) the effective dose and equivalent dose of radiation received by any person as a result of the situation; and
(*f*) the actions that the licensee has taken or proposes to take with respect to the situation.

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-year period 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) 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 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. Any one 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:

- Summary of the information regarding dose limitations (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 RPS.

University of Toronto Radiation Protection Service

NUCLEAR ENERGY WORKER DESIGNATION(Female) Effective January 1, 2007

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 Worker". 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).

EFFECTIVE DOSE RATES FOR NUCLEAR ENERGY WORKERS GENERALLY:

Effective dose limits for Nuclear Energy Workers, including a pregnant nuclear energy worker, are 50 mSv for any one-year dosimetry period, but must not surpass 100 mSv for any 5 year dosimetry period.

EFFECTIVE DOSE RATES FOR PREGNANT NUCLEAR ENERGY WORKERS:

A pregnant nuclear energy worker must not receive an effective dose of greater than 4 mSv for the balance of the pregnancy. The balance of the pregnancy is defined as "the period from the moment a licensee is informed, in writing, of the pregnancy to the end of the pregnancy".

A female Nuclear Energy Worker, on becoming aware that she is pregnant, must notify the permit holder and Radiation Protection Service immediately in writing. The licensee shall make any reasonable accommodation to maintain effective doses As Low as Reasonably Achievable (Radiation Protection Regulations, Section 11).

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.

The following documents are provided for your information:

- summary of the information regarding dose limitations (Radiation Protection Regulations)
- Health Physics Society Position Statement on Radiation Risk in Perspective
- Canadian Radiation Protection Association Statement on Radiation Risk

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

- Senior Radiation Protection Officer 416-978-2028
- Radiation Safety Officers 416-946-7064, 416-978-6846, 416-946-3265
- Director of Environmental Health and Safety 416-978-5944

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 Radiation Protection Service:

Print Name: _____ Title: _____

Signature: _____ Date: _____

University of Toronto Radiation Protection Service

NUCLEAR ENERGY WORKER DESIGNATION (Male)

Effective January 1, 2007

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 Worker". 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).

EFFECTIVE DOSE RATES FOR NUCLEAR ENERGY WORKERS GENERALLY:

Effective dose limits for Nuclear Energy Workers, including a pregnant nuclear energy worker, are 50 mSv for any one-year dosimetry period, but must not surpass 100 mSv for any 5 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.

The following documents are provided for your information:

- summary of the information regarding dose limitations (Radiation Protection Regulations)
- Health Physics Society Position Statement on Radiation Risk in Perspective
- Canadian Radiation Protection Association Statement on Radiation Risk

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

- Senior Radiation Protection Officer 416-978-2028
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- Director of Environmental Health and Safety 416-978-5944

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 Radiation Protection Service:

Print Name: _____ Title: _____

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://ccsn.gc.ca/eng/information/licensees/radiation/index.cfm

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 ingestion or inhalation:	1×10^{9} Bq (27 mCi) (tritiated water)
Maximum range in 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 in experimental results.

DNA precursors (*eg tritiated thymidine*) are regarded as more toxic than tritiated water partly because activity is concentrated into cell nuclei. This is reflected by lower ALI's 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, breath measurements (CO_2)
Annual Limit on Intake: by inhalation or ingestion	4×10^7 Bq (1.1 mCi)
Maximum range in air:	24 cm

Shielding:
1 cm Perspex/Plexiglas. Thinner Perspex/Plexiglas 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 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:	1×10^7 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:	Plexiglas 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 a 50 MBq (1.35 mCi) are used, ring dosimeters must be worn. The use of lead-impregnated rubber gloves is also recommended.

Even with low-density materials (for example, Perspex/Plexiglas) the absorption of the beta-particles gives rise to relatively high energy Bremsstrahlung which may require some lead shielding when quantities 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
- plexiglas shielding should be used as shielding for all ^{32}P handling and must be used with quantities in excess of 1 mCi (37 MBq). The half-value layer (HVL) thickness for ^{32}P is 1 cm of plexiglas. 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 other high energy beta emitter

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

PHOSPHORUS 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 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:	Plexiglas or similar plastic (at least one cm)

Special Considerations for Open Sources

Phosphorus-33 is moderate energy beta emitting radionuclide, commonly encountered in research laboratories. Laboratory coats and gloves are the principle 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 mCi)
Maximum range in air:	26 cm

Shielding:
1 cm Perspex/Plexiglas. Thinner Perspex/Plexiglas 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 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/Plexiglas 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 (20 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 in the form of 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 (0.5 mCi)
Maximum range in air:	5 cm

Shielding:
Plexiglas/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 (55 μCi)
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

Volatilization of iodine is the most significant problem with this isotope. Simply opening a vial of sodium [^{125}I] iodide at 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 formation of volatile elemental iodine.

As some iodo-compounds can penetrate surgical rubber gloves, it is advisable to wear two pairs, or polythene (polyethylene) gloves over 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 spilled Iodine-125 chemically stable the area of the spill should be treated with alkaline sodium thiosulphate solution prior to commencing decontamination. Note, however, that the quantity of radioiodine in normal RIA kits (usually <2 MBq or 54 microCi) 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 prior to beginning 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 spill of free radioiodine.

Appendix G – Summary of Changes from the July 2010 Edition of the Manual

In subsection 1.1.8.1 the conditions for participation at bioassay following g the use of radioiodine were changed to reflect the new CNSC licence condition.