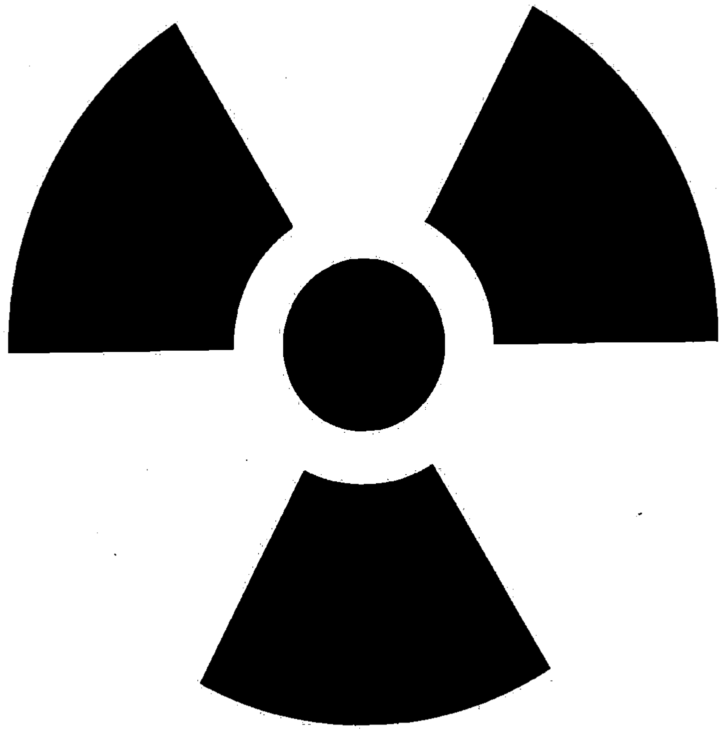
YORK
UNIVERSITÉ
UNIVERSITY

Radiation Safety Manual



Prepared by: **Health, Safety & Employee Well-Being (HSEWB)**
Reviewed by: **HSEWB, Radiation Safety Committee, JHSCs**
Last Revision: December 2015

Contact information:
Tel: 416-736-5491 or ext. 55491
Email: hsewb@yorku.ca

TABLE OF CONTENTS

Appendices

Emergency Procedure For Major Spills Of Radioactive Materials

RATIONALE

In the event of an emergency involving radioactive material, the immediate objectives are to prevent or reduce the chance of personnel contamination, prevent dispersal of the contaminant, begin personnel decontamination (if necessary), and to decontaminate the area under supervision.

In the event of fire in the radiation area, the standard fire instructions will apply. In all cases, the Radiation Safety Officer must be notified.

NOTE: For minor radioactive spills and routine clean-up/decontamination, Section 8 of the program manual should be followed. The user should take into consideration the severity of the incident and the amount spilled to determine which protocol to use.

PROCEDURE FOR MAJOR SPILLS OF RADIOACTIVE MATERIALS

1. Tell people in the room.
2. Remove people from the area, BUT hold them nearby until they have been checked for contamination by the Radiation Safety Officer (RSO).
3. Call (Have an uncontaminated person make the call if possible) from safe place:

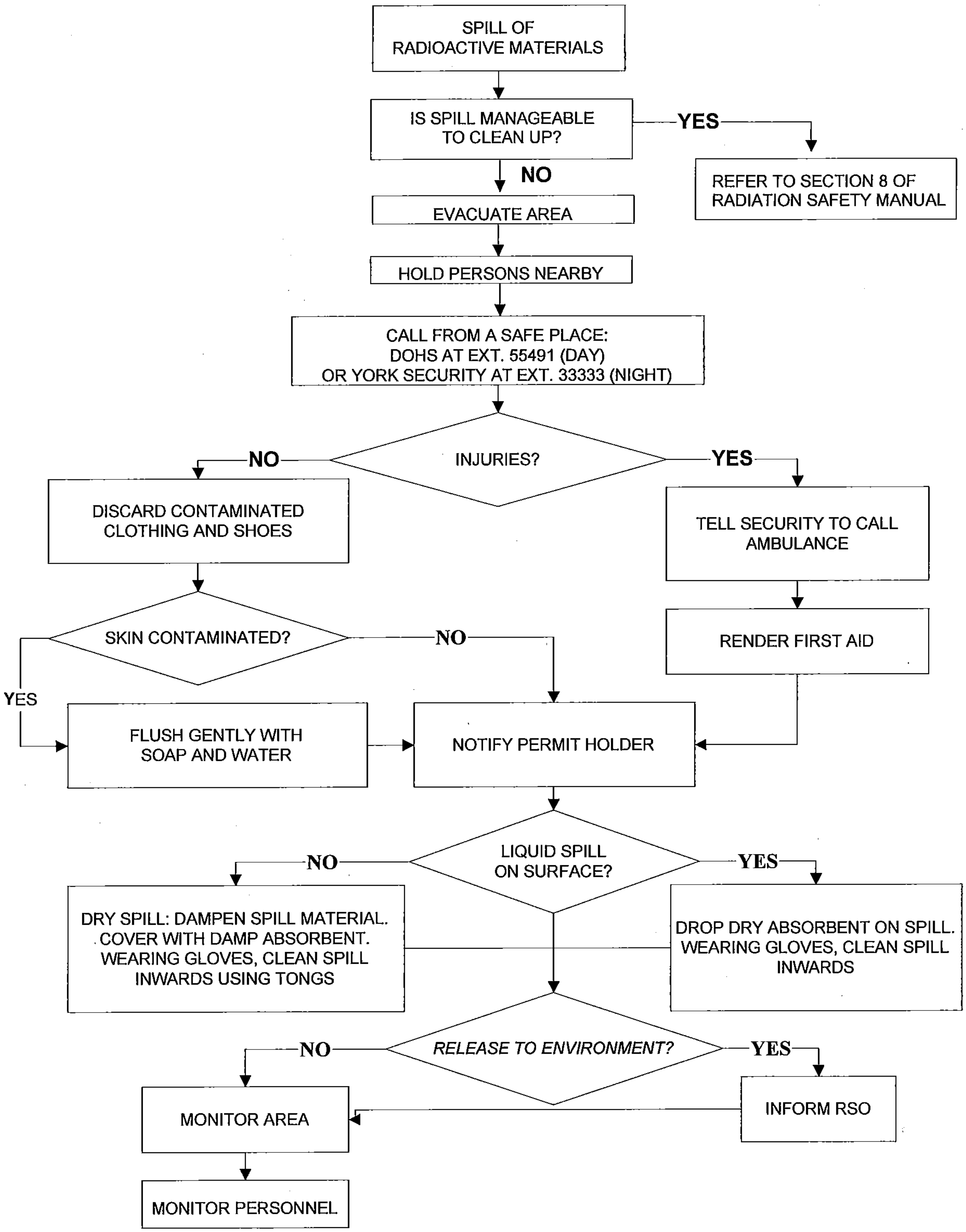
   Normal Working Hours: ext. 55491 (HSEWB)
   Off Hours: ext 33333 (York's Security)

4. State:
   - Location of accident (Building and Room Number).
   - Your name, location where you can be reached.
   - What happened?
   - Any injuries?
5. RSO will be advised by HSEWB or SECURITY.
6. Injuries: Give immediate first aid (do NOT let the possibility of radioactive contamination hinder first aid efforts).
7. Notify your supervisor.
8. Discard contaminated clothing and shoes.
9. If skin contaminated, flush gently with soap and water.

DECONTAMINATION (supervised by RSO or supervisor):

1. Start spill clean-up procedure.
2. Monitor area.
3. Monitor personnel.

Emergency Response Procedure for Spills of Radioactive Materials Flow Chart



RSO= RADIATION SAFETY OFFICER
IF EXTENSIVE AMOUNT IS RELEASED TO ENVIRONMENT:
1) CALL CNSC WITHIN 24 HOURS (TEL: 1-613-995-0479)
2) CALL MINISTRY OF ENVIRONMENT SPILL REPORTING (TEL: (416)325-3000)

Revised December 2015

Radiation Safety Program for the Protection of Persons Working With and Exposed to Potentially Harmful Radiation

1. PREFACE

1.1 Introduction

The use of radioactive isotopes contributes greatly to many fields of scientific endeavour. However, all personal exposure to ionizing radiation constitutes a potential health hazard and it is, therefore, essential to observe certain precautions to ensure that operations are safe. These precautions are detailed in the Radiation Safety Program.

1.2. Objectives

The objectives of the Radiation Safety Program are:

1. To take all reasonable precautions, consistent with the Nuclear Safety and Control Act and Occupational Health and Safety Act and Regulations, to protect persons and others working with potentially harmful radiation sources;

2. To provide information, resources, safe handling procedures, precautionary measures, and emergency response procedures for users of sources or devices containing radioactive materials so as to prevent unnecessary human radiation exposure;

3. To identify the responsibilities of the Radiation Safety Committee, the radioisotope permit holder, and the Radiation Safety Officer; and

4. To comply with the related government regulations.

2. Responsibilities: RSO, RSC, Supervisor, Worker

2.1 Radiation Safety Officer (RSO)

2.1.1 The Radiation Safety Officer shall be a member of the Radiation Safety Committee.

2.1.2 The Radiation Safety Officer shall be responsible for the issuing of Radiation dose monitoring devices to all personnel who require dose monitoring. He/she shall arrange for the collection of such devices and for their assessment and shall maintain records.

2.1.3 The Radiation Safety Officer shall be responsible for overseeing that regular monitoring of radioactive contamination is conducted by each laboratory. Cleaning staff are instructed to clean only the floors of radioisotope laboratories. It is the responsibility of the permit holder to ensure that all sources of radiation are adequately shielded. The Radiation Safety Officer will provide radiation safety awareness training to cleaning staff, and this training will be refreshed every 4 years.

2.1.4 The Radiation Safety Officer shall be responsible for overseeing that records are maintained for all regular contamination monitoring carried out.

2.1.5 The Radiation Safety Officer shall be responsible for ensuring that all radioisotope laboratories and all laboratories containing x-ray equipment are labeled in accordance with this code of practice.

2.1.6 The Radiation Safety Officer will be responsible for coordinating, or participating in, emergency responses to accidents involving radioactive materials. He/she shall also give advice on the decontamination of contaminated areas.

2.1.7 The Radiation Safety Officer shall give advice in the routine handling of radioactive materials and also in also in the operation of x-ray equipment and lasers.

2.1.8 The Radiation Safety Officer shall satisfy himself/herself that operations conducted in radioisotope laboratories, and laboratories containing x-ray equipment are in accordance with this program.

2.1.9 The Radiation Safety Officer shall satisfy himself/herself that arrangements for storage of radioactive waste, prior to its collection, are in accordance with this program.

2.1.10 The Radiation Safety Officer shall be available on call outside normal working hours to render assistance in the event of an emergency affecting a radioactive laboratory.

2.1.11 The Radiation Safety Officer shall be responsible for the calibration and maintenance of the monitoring equipment held by the Radiation Safety Committee. He/she shall advise and assist on the calibration of monitoring equipment held by individual permit holders.

2.2 Radiation Safety Committee (RSC)

Possession and use of radioactive material in Canada is regulated by the Nuclear Safety and Control Act, which is administered by the Canadian Nuclear Safety Commission (CNSC). The CNSC has authorized the University to issue individual permits subject to its approval. These permits will be issued by the Radiation Safety Committee.

Under the terms of reference, (Appendix II), the Radiation Safety Committee has overall responsibility for monitoring the usage of radioactive isotopes within York University. It has the authority to control and veto operations at any time where they may consider that they are potentially hazardous (See Appendix XV Revoking and Reinstatement of Permits).

2.3 Supervisors – include radioisotope permit holders

Radioisotope Permit Holder
The radioisotope permit holder for a particular piece of research has the overall responsibility for ensuring that the scientists or technicians working with radioactive isotopes are competent and have been trained in the operation concerned. The permit holder has overall responsibility for the safety of operations carried out under the terms of his grant or contract.
The provision of appropriate monitoring equipment for carrying out such routine and day-to-day measurements is the responsibility of the permit holder.
It shall be the responsibility of the permit holder to ensure that any conditions attached to radioisotope permit are strictly observed.

2.4 Workers – include scientists and technicians

Every worker is responsible for his/her own radiological protection and for ensuring that his/her operations with radioactive isotopes do not constitute a hazard to other people working in the laboratory and members of the public.

All workers using radioactive isotopes shall:

1. ensure that unacceptable levels of contamination, whether of air or surfaces in the laboratory do not occur (see Section 4, Tables 1a and 1b);
2. work in compliance with the Nuclear Safety and Control Act and regulations and the Occupational Health and Safety Act and regulations;
3. use or wear protective equipment, devices and/or clothing that the employer requires to be worn;
4. report to the supervisor the absence of or defect in any equipment or protective device of which the worker is aware and which may endanger themselves or another worker;
5. report to their supervisors the existence of any hazard of which they are aware.

3. Radioisotope Laboratories – Permits, Commissioning, Decommissioning and Inventory

3.1. Requirements

No operation involving any radioactive isotope or radioactive source shall be performed at York University, nor shall any such isotope or source be obtained by any person in the employ of York University or its grant or permit holders without the prior possession of a valid radioisotope permit. Outside contractors to York University working on campus also come under the scope of these regulations with respect to radioisotopes on York University campus. Outside contractors are required to provide a copy of their license and radiation safety program to York University prior to bringing radioactive materials onto the university's property.

3.2. Large Projects

All projects involving more than 10,000 exempted quantities (Appendix VIIB) of unsealed nuclear substances must be authorized by the RSO. The RSO will consult with the CNSC prior to issuing an internal authorization permit for large projects.

3.3. Permits

a. Permit Application
A radioisotope permit application form (see Appendix III) can be obtained from the Radiation Safety Officer. A completed radioisotope permit application form should be returned to the Radiation Safety Officer or the Chair of the Radiation Safety Committee.

b. Permit Approval
The RSO and Radiation Safety Committee will review the permit application for approval. Where it is approved, the Committee will issue the applicant a radioisotope permit. In addition, the approved applicant will also receive: a Radiation Safety Manual, sample radiation signs, Emergency Response Procedure for Spills of Radioactive Materials, sample waste disposal labels and Radioisotope Laboratory Rules.

3.4. Laboratory Commissioning/Decommissioning

a. Commissioning
If an unsealed radioactive isotope or source is required for use in a laboratory, which has not previously been designated as a radioisotope laboratory, a Design Compliance Form, which will be completed by the Radiation Safety Officer, is required before the laboratory can be considered for work with radioactive materials. The Radiation Safety Committee may then designate the laboratory as a radioisotope laboratory and classify the lab (basic, intermediate, or high level) in accordance with the nature and the amount of radioactive material being handled (see Section 6, table 3).

Posting (Ref.: Radiation Protection Regulations, sec.20-22 and Nuclear Substances and Radiation Devices Regulations, sec.23)

If a sealed radioactive source is required for use in a laboratory, which has not previously been designated as a radioisotope laboratory, a Design Compliance Form for sealed sources, is required to be completed by the Radiation Safety Officer prior to the sealed sources being kept in the lab.

The following should be posted when a lab is commissioned:

1. Radiation warning sign at the boundary of and at the point of access to an area or room. The legislation requires the posting of a radiation sign when the quantity of radioactive substance exceeds 100 times its exemption quantity (see Appendix VIIb) or when a person may have a probability of receiving an exposure exceeding 2.5 uSv/h (0.25mr/h).
2. 24-hour emergency contact name and number.

3. Radioisotope permit.
4. Appropriate radioisotope safety poster for each lab classification if the lab will contain an unsealed source (see section 6, table 3).

b. Decommissioning
Where radioisotopes are no longer required to be used or stored in a laboratory, the permit holder shall notify the Radiation Safety Officer (RSO) and decommission the location. For laboratories using unsealed sources, a contamination survey shall be performed by the permit holder and a copy of the survey must be provided to the RSO. Where no contamination is found, permit holders will be asked to remove or deface all radiation warning signs.

3.5. Radioisotope Inventory

Each holder of a radioisotope permit shall provide an inventory of radiation sources in possession to the RSO annually
An inventory form (see Appendix V) will be sent to permit holders by the RSO for completion.

4. Radiation Monitoring and Record Keeping

4.1. Surface Contamination Monitoring

The maximum permissible levels of surface contamination for Class A to C unsealed radionuclides are given below in Table 1 as outlined in York University Nuclear Substance and Radiation Devices Licence issued by the CNSC.

Table 1a (source: CNSC. York University Nuclear Substance and Radiation Devices Licence)

Class A: Alpha emitters and higher hazard isotopes	Class B: Isotopes such as Fe-59	Class C: Isotopes such as P-32, S-35, C-14, H-3, P-33, I-125
A. Active Areas: 3 Bq/cm2	A. Active Areas: 30 Bq/cm2	A. Active Areas: 300 Bq/cm2
B. Inactive Areas: 0.3 Bq/cm2	B. Inactive Areas: 3 Bq/cm2	B. Inactive Areas: 30 Bq/cm2

It is stressed that these are maximum permissible levels and are not acceptable levels. In all cases, doses should be kept to an as low as reasonable achievable (ALARA) level. It is only in exceptional cases that contamination levels in a laboratory should approach these figures and, if they do, fairly stringent decontamination measures would be required. Advice should be sought from the Radiation Safety Officer.

Note: York University uses a more stringent level following the ALARA principle. The following is the contamination criteria that users must follow and are included in the Radiation Safety Training:

Table 1b

5 Bq/cm2 for active areas (except for alpha emitter) 0.5 Bq/cm2 for other areas And As Low As Reasonably Achievable (ALARA)

4.1.1. Maximum radiation dose levels in work areas

Radiation levels in radioisotope laboratories shall not exceed 25 uSv/hr (2.5 mR/hr). Radiation levels in storage areas shall not exceed 2.5 uSv/hr(0.25 mR/hr).

4.1.2. Frequency of Monitoring

All normally accessible working surfaces in a radioisotope laboratory should be monitored daily using a contamination meter (where such a meter can detect the isotopes used), and at least weekly or when work is completed using wipe test (refer to Appendix XI for wipe test method). Keep records of monitoring.

4.1.3. Leak Testing of Sealed Sources

All sealed sources greater than 50 MBq will be leak tested by the Radiation Safety Officer in accordance to frequency as required under York's Radioisotope license. Records will be maintained for inspection by the Canadian Nuclear Safety Commission. If removable contamination in excess of 0.2 kBq is detected, the source shall immediately be removed from service. The permit holder shall be provided with a leak test certificate upon completion of the leak test.

4.1.4. Specific Devices (See section 9)

All operations with equipment incorporating radioactive sources, e.g. the moisture meter and certain gas chromatographs shall be carried out strictly in accordance with the manufacturer's instructions and with any other conditions specified in the radioisotope permit. The sources must be leak tested by the Radiation Safety Officer as specified, the handling of the equipment must be kept to the absolute minimum, and extreme care should be taken so that gas chromatographs do not become overheated.

4.1.5. Dose Rate Survey Meter

Dose rate survey meter must be calibrated annually in accordance with the CNSC Regulatory Expectations for Calibration of Survey Meters

4.1.6 Response to Contamination

If the measurement from detection indicates reading exceeding 3 times the blank, clean the area with detergent and water;
Re-test or re-wipe the area carefully and thoroughly (use additional wipes divided into smaller areas) to ensure that contamination has been removed. If contamination is still detected, repeat step (ii).
If contamination cannot be removed after several re-clean and re-test, contact supervisor and RSO. Keep all monitoring records.

4.2. Personal Dose Monitoring

General Rules:

a. All persons who work with P-32 or who enter a radioactive waste storage room must wear a personal dose monitoring device. The Radiation Safety Officer or the terms of the radiation permit may require additional personal dosimeters to be worn for specific operations. Arrangements for the reading of dosimeters will be made by the Radiation Safety Officer.
b. It is not practical to issue all undergraduate course students who may be doing a particular experiment with a radiation monitoring device. It is imperative, therefore, that each experiment to be performed by such students shall have previously been performed by the Faculty member responsible

wearing a personal dosimeter, and that the doses incurred shall be recorded. It is also essential that the students are adequately instructed before they perform the experiment, and that they should be closely supervised when working with radioisotopes.

c. Personal dosimeter will only be issued to individuals who have a record of radiation safety training.

4.2.1. External Dose Monitoring

The following two types of personal dosimeters are available at York University and they are issued on a quarterly wearing cycle:

a. Whole body and skin monitoring dosimeter

Optically Stimulated Luminescence (OSL)
Thermal Luminescent Dosimeter (TLD)
The personal monitoring device for whole body and skin at York University is based on the optically stimulated luminescence (OSL) technology. The dosimeter measures radiation exposure due to x, gamma and beta radiation. The detector strip is configured from a specially formulated aluminum oxide crystalline material. Radiation exposure is measured in a laboratory by stimulating the aluminum oxide material with selected frequencies of laser light causing it to luminesce in proportion to the amount of radiation exposure. The monitoring device for extremity (finger) is the thermoluminescent dosimeter (TLD). TLD contains two lithium fluoride (LiF) crystal chips located under a filter. When exposed to ionizing radiation, temporary defects are created in the TLD crystal. These defects are stable until the LiF chip is heated and the TLD releases the excitation energy in the form of light. The intensity of the emitted light is proportional to the absorbed dose.

Rules for wearing TLD badge:

- Wear badge at the chest or waist levels
- Always wear only your own badge
- When not worn by the individual, store it away from a radiation source and prevent it from ultraviolet light exposure (LiF chips are sensitive to ultraviolet light and may produce false results if exposed)

b. Extremity Monitoring Dosimeter (finger ring)

Thermoluminescent Dosimeter (TLD)
The monitoring device for extremity (finger) is also the TLD.

Rules and criteria for wearing extremity TLD:

- Required for handling more than 1 mCi P-32 or similar beta emitters with maximum energy of 1 MeV or greater. This includes the handling

of stock vial. Employees who routinely handle P-32 should also use extremity monitors.
- Wear on the dominant hand and on the index finger. The chip should face the palm side and under the glove.

c. Dosimetry Reports
Upon receipt of dosimetry reports from the dosimetry service provider, the RSO will review all personal doses to identify if any exposure is at or exceeds the action level (see section 4.2.5). If the exposures are within the permissible exposure limit for the general public or are below the action level, the RSO will distribute the reports to relevant permit holders. If any exposures are at or exceed the action level, refer to section 4.2.5.2 for details.

4.2.2 Internal Dose Monitoring

Radiation can become an internal radiation source through ingestion, inhalation, or exposure from surface contamination. In particular, inhalation or ingestion of tritium or radioiodine is possible and bioassay requirements have been established for those who routinely handle these radioisotopes. Permits which allow the handling of this material may list, as a condition, the requirement for the appropriate bioassay to be carried out. It is the responsibility of the Permit Holder to ensure that bioassays for tritium and radioiodine work (125I, 131I) are performed as required by the RSC. The RSO shall be notified where iodination or the handling of tritium in gaseous form is involved.

4.2.3. Nuclear Energy Worker (NEW)

A Nuclear Energy Worker (NEW) is a person who is required, in the course of the person's business or occupation in connection with a nuclear substance or nuclear facility, to perform duties in such circumstances that there is a reasonable probability that the person may receive a dose of radiation that is greater than the prescribed limit for the general public i.e. 1mSv per year (see table 2).

Requirements
The Radiation Protection Regulation (sec. 7-11) requires that York University informs each NEW in writing (via RSO or designate):

(a) that he/she is a NEW;
(b) of the radiation risks associated with his/her work (including the risks associated with the exposure of embryos and fetuses) ;
(c) of the applicable effective and equivalent dose limits, and
(d) of the worker's radiation dose levels, and
(e) shall inform each female NEW, in writing, of the rights and obligations of a pregnant NEW (refer to section 4.2.3.1)

The NEW shall provide a written acknowledgement to the university via the RSO that he/she has received the information in (a) and (b) and (e) each female NEW of the rights and obligations of a pregnant NEW as included in sec.4.2.3 above. (Ref. Radiation Protection Regulation, sec.7(3))

See Appendix VIII for the "Notification of NEW status" and "Notification of NEW Dose Levels".

4.2.3.1 NEW Rights and Obligations

Nuclear Energy Workers who become aware that they are pregnant must notify the permit holder and the RSO immediately in writing (see sec.4.2.4 Prenatal Radiation Exposure). The employer shall, in order to comply with the effective dose limits for a pregnant NEW, make any reasonable accommodation or give the option to refuse work involving radioisotopes. (Ref. Radiation Safety Regulation, sec.11(1-2))

4.2.4. Prenatal Radiation Exposure

Notification:

a. The CNSC requires that every nuclear energy worker who becomes aware that she is pregnant shall immediately inform the licensee (i.e. York University) in writing.
b. Even though the regulation only refers to pregnant nuclear energy workers, York University also recommends that a non-nuclear energy worker, who becomes pregnant inform her supervisor and the Radiation Safety Officer. Pregnant non-nuclear energy workers have the option to choose not to work with radionuclides during their pregnancy. If a pregnant worker chooses to continue working with radionuclides, then special precautions can be taken to provide the proper degree of protection to the fetus during the term of the pregnancy.

Exposure Limit:
The CNSC limits the radiation exposure (effective dose limits) of the pregnant nuclear energy worker to 4 mSv from external sources during the remaining term of the pregnancy once it has been recognized (see section 4.2.5).

TLD Badge Monitoring:
For a non-nuclear energy worker (this will apply to all radioisotopes users at York based on exposure records), it is recommended that a pregnant worker not be issued with a personal dosimeter on a more frequent reading schedule than that used before her pregnancy. This is likely to result only in a less sensitive measure of the dose she receives since doses of less than 0.1 mSv per dosimeter are not recorded.
Note: To monitor with a quarterly TLD badge, subtract the exposure from 4mSv to determine the permissible exposure for the rest of the pregnancy.
For nuclear energy workers, double badging (e.g. one badge will be changed quarterly, one monthly) is recommended.

Special Restrictions to pregnant workers:

- Depending on the individual's exposure history, working with large quantities (mCi's) of P-32 may not be permissible.
- Radioiodinations will not be permitted for pregnant worker.
- Routine thyroid scans for workers using trace quantities (<1 uCi or <40 kBq) of bound radioiodine.

4.2.5. Dose Limits

Effective* Dose Limits

Every permit holder shall ensure that the effective dose received by the type of person during the period set out in the table below, does not exceed the prescribed effective dose.

Table 2a

Item	Person	Period	Effective Dose (mSv)
1	Nuclear energy worker, Including a pregnant Nuclear energy worker	a. One-year dosimetry period b. Five-year dosimetry period	50 100
2	Pregnant Nuclear Energy Worker	Balance of the pregnancy	4
3	A person who is not a Nuclear Energy Worker	One calendar year	1

Ref.: Radiation Protection Regulation, sec.13(1)

* "Effective Dose" means the sum of the products, in sievert, obtained by multiplying the equivalent dose of radiation received by and committed to each organ or tissue by its weighting factor. The weighting factor for the whole body is 1. The weighting factors for specific organs are listed in the Radiation Protection Regulation sec. 25, schedule 1& 2.

Table 2b

Organ or Tissue	Person	Period	Equivalent Dose (mSv)
Lens of an eye	(a) Nuclear Energy Worker	One-year dosimetry period	150
	(b) any other person	One calendar year	15
Skin	(a) Nuclear Energy Worker	One-year dosimetry period	500
	(b) any other person	One calendar year	50
Hands and feet	(a) Nuclear	One-year	500

	Energy worker	dosimetry period	
	(b) any other person	One calendar year	50

Ref.: Radiation Protection Regulation, sec.14(1)

4.2.5.1 Action Level

The University has adopted the following action level for the general public:
Whole body: 0.8 mSv/year
Skin, hands and feet: 40 mSv/year
Where the action level is reached, an internal investigation will be conducted to determine the cause for the exposure and to develop measures with the intention of reducing the dose to as low as reasonably achievable.

4.2.5.2 When Dose Limit Exceeded

When the University becomes aware that the dose limit of an individual has been exceeded, the University (via the RSO or designate) shall (ref. Radiation Protection Regulation, sec.16):

(a) immediately notify the person and the CNSC of the dose;
(b) require the person to leave any work that is likely to add to the dose;
(c) conduct an investigation to determine the magnitude of the dose and to establish the causes of the exposure;
(d) identify and take any action required to prevent the occurrence of a similar incident; and
(e) within 21 days after becoming aware that the dose limit has been exceeded, report to the CNSC the results of the investigation or the progress that has been made in conducting the investigation.

The University shall not return the worker to work (as described in 4.2.5c) until authorization for the return has been received from the CNSC or a designated officer.

4.3. Record Keeping

All permit holders shall keep records (date and activity) on the purchase, usage, disposal, and monitoring of radioisotope. A sample log (Appendix XII) indicating the types of information required to be recorded is shown for reference.

5. *Radiation Protection: Training, Safe Handling, Storage, Transportation and Working with Animals*

5.1. General

5.1.1. All operations in radioisotope laboratories should be designed to achieve the desired result in keeping exposure level to as low as reasonably achievable (ALARA). THERE IS ALWAYS A SAFE WAY OF CARRYING OUT ANY OPERATION.

5.1.2. Good radiation protection is primarily a matter of good housekeeping and common sense.

5.1.3. Eating and drinking, and the use of cosmetics or other materials coming in contact with the mouth is forbidden in a radioisotope laboratory. In the case of radioisotope laboratories, which contain an office area physically separated from the laboratory, eating, and drinking are permitted in the office area provided that hands are thoroughly washed and protective clothing is discarded before entering it. Food must not be stored in a refrigerator used to store isotopes.

5.1.4. After any operations with radioactive materials, all persons must wash their hands thoroughly with detergent and water.

5.1.5. All radioisotope laboratories shall be locked when unoccupied.

5.2. Training

The CNSC requires that all persons working with radioactive materials be trained prior to beginning work with the radioactive material. This training must include information on the safe use, handling, storage and disposal of radioactive material as well as an explanation of the risks associated with the exposure to ionizing radiation.

It is the responsibility of the Permit Holder to ensure that all persons have received the appropriate training and know the proper policies and procedures for the use of radioactive materials at York University before beginning work in radioisotope laboratories.

All persons who do not work with radioactive materials, but who may regularly be in close proximity to radioactive materials, shall complete a radiation safety awareness training course.

Refresher training for both the full radiation safety, and radiation awareness courses shall be taken once every 4 years, and can be completed online.

5.2.1. Radiation Safety Training at York University

The Radiation Safety Officer offers a Radiation Safety Training Course. This consists of a half day training session with theoretical and practical information as well as a final test. Successful candidates are provided with a certificate after completion. After this

course has been successfully completed, the person is allowed to work with radioactive materials without direct supervision.
Information on the next available course may be obtained by contacting the Radiation Safety Officer.

5.3. Handling of Radioactive Materials

5.3.1. Protective laboratory coats, disposable gloves, and if necessary, disposable aprons must be worn at all times to avoid direct contact with radioactive materials. Disposable items should be discarded immediately after use. Ingestion of radioactive isotopes is possible not only through the nose and the mouth but also through cuts or wounds in the skin. The cuts and wounds must be covered with waterproof bandaids and, in addition, intact disposable gloves must be worn.

5.3.2. Pipettes:

- Pipettes must be inspected (e.g., for leaks) before use
- Pipettes must not be overfilled
- Pipetting of radioactive solutions by mouth is strictly forbidden.
- Pipettes must be stored upright when there are liquid in the pipettes

5.3.3 Confine work area or bench to a fairly secluded area of the laboratory which will be marked with warning labels. The work area should be covered with disposable absorbent materials, e.g. benchkote, which must be discarded if there has been spillage of any kind.
In all cases where radioactive material may be lost by volatilization, by dispersions of dust or by spraying or splattering, work must be carried out under a fume hood. Gloves, safety goggles and, if necessary, a face mask must be worn.

5.3.4 All equipment used for radioactive work must be labeled with warning stickers and kept separate from equipment used generally in the laboratory.

5.3.5 Radioactive solutions must never be heated directly over flames and, if heating is necessary, a hot plate with an oil bath or water bath must be used. In all cases in which radioactive solutions are heated during chemical procedures, safety glasses and/or face mask must be worn. Hands must be protected by wearing gloves and wherever possible, by using long forceps.

5.3.6 Whenever radioactive solutions are transported, the container must be carried in an outer metal container or on a tray lined with absorbent liner which will be designed to absorb any radioactive contamination in the event of spillage or breakage.

5.3.7 Radioactive solutions should never be poured from one container to another but transferred carefully with automatic pipettes.

5.3.8 Wherever feasible, glassware should be exclusively designated for radioisotope work. This glassware should be washed separately, preferably with a detergent such as FL70, followed by such other cleaning procedures as may be required for the particular assay. The glassware should be dried and stored in a separate area, suitably marked, to avoid mixing with general laboratory glassware. Before being returned to general use, all such glassware should be properly decontaminated and monitored by swipe test.

5.3.9 All operations involving iodination with radioactive iodine must be performed in a fumehood. The Radiation Safety Officer must be informed in advance before iodination is performed.

5.4. Storage of Radioactive Materials:

5.4.1. All radioactive chemicals must be kept in locked storage cabinets, refrigerators, or freezers designated for this purpose and clearly marked on the outside. If only a section of a cabinet or freezer is used, the inside area must also be clearly marked. Wherever possible, existing storage areas must be used. New areas should not be created unnecessarily. Such storage areas should be kept locked.

5.4.2. Storage, initial opening of vials and dispensing of radioisotopes as received from the supplier must be carried out in a suitably equipped area. Labeled biological materials or other labeled radioactive compounds that must be stored below -15°C may be kept in freezers in departmental laboratories so long as they are adequately protected against accidental breakage and are properly labeled. These materials must be taken to the area previously referred to for dispensing. Radioactive tissue extracts from animals incorporating radioactive material may, in general, be stored and handled in the department laboratory. Levels of activity must not exceed authorized levels as specified in Section 6.

5.5. Packaging and Transport of Radioactive Materials:

There are federal regulations pertaining to the packaging and transport of nuclear substances, including the design, production, use and maintenance of packages and the preparation, consigning, handling, loading, carriage, storage during transport, receipt at final destination and unloading of packages.

The requirements are detailed in the "Packaging and Transport of Nuclear Substances Regulations" and are referenced in the "General Nuclear Safety and Control Regulations" and the "Nuclear Security Regulations". These documents are available online or from the Health, Safety, and Employee Well-Being office. If the transportation of nuclear substances is required the RSO shall be consulted.

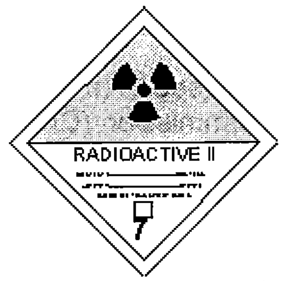
5.6 Receipt of Radioactive Packages

The procedure (see below) for receiving radioactive packages is included in the Radiation Safety Training for users. Stores personnel are also provided with training and there is a special container in the Stores to hold radioisotope deliveries. Packages that have not been picked up by the users on the same day of delivery will be kept in a locked storage overnight by the store keeper.

5.6.1 Procedure for receiving radioactive packages:

1. Observe the following signs:

Category I-White
≤5 uSv/h on external
surface of package



Category II-Yellow
≤500 uSv/h on external
package, TI=1

Category III-Yellow
≤ 2mSv/h on external
package, TI≤10

2. Keep your distance
3. Visually check outer container for signs of leakage or damage, e.g., wet package etc.
   - if the package is damaged or leaking, isolate package to minimize radiation exposure and contamination (e.g.,mark area where the package is located or place package in a tray or container)
   - contact the Radiation Safety Officer (RSO)
   - decontaminate areas following instructions from the RSO
4. Verify the nuclear substance, the quantity, and other details on the packing slip. Report any anomalies.
5. Wear protective clothing and gloves while opening the package.

5.7 Safety Precautions for Animal Rooms

5.7.1 All the precautions 5.1-5.7 must be observed. Animal cages must be on a separate rack, preferably in a separate room, or at least in separate area of the room, and must be suitably marked. Special steps must be taken to isolate and dispose of contaminated waste from animal cages. All waste must be bagged in plastic, marked with warning tape and labeled as to contents and activity level, etc. These wastes must be stored in the laboratory's designated freezer until arrangements with the Radiation Safety Officer have been made for their collection. Waste label must indicate: name of permit holder, animal species, number of carcasses, date of sacrifice, isotope and maximum activity per animal carcass.

5.7.1 Cages must be meticulously cleaned after use. FL70 or a similar preparation must be used. Animals dosed with Carbon 14 or Tritium in volatile form must be housed in a well-ventilated area.

5.7.2 It may be that specific revision of these general guidelines for animal rooms may be warranted in special situations where the nature of the experimental work requires either additional precautions or more stringent or less stringent adherence to the safety precautions outlined. Such revisions should be drawn up by the grant or contract holder involved for use in that department only and presented to the Radiation Safety Committee for comment and clearance.

5.8 Loss or Theft of a Nuclear Substance

The Nuclear Safety and Control Act (sec.27(b)) requires that every licensee file a report to the Canadian Nuclear Safety Commission (CNSC) reporting any theft or loss of a nuclear substance or equipment.

Procedure:

1. Report any loss or theft of a nuclear substance or equipment (including sealed nuclear sources or devices) to the Radiation Safety Officer (RSO) immediately.
   State:
   - Name of permit holder
   - Location where the source was lost or stolen
   - Description of the source: radioisotope, activity, type of source (e.g., open or sealed source), supplier and any other information specific to the source (e.g., lot or serial number, model etc.)

2. The RSO will provide a preliminary report immediately to (a) the CNSC of the location and circumstances of the situation and of any action the University has taken; and (b) the Radiation Safety Committee (RSC).

3. The RSO or the RSC will file a full report to the CNSC within 21 days after becoming aware of the incident, and the report will 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 University has taken or proposes to take with respect to the situation.

Ref.:
1. The Nuclear Safety and Control Act (sec.27(b))
2. General Nuclear Safety and Control Regulations (sec.29)

6. *Permissible Quantity of Radioactivity in Designated Radioisotope Laboratories*

All rooms intended to be used for the handling, storage, or disposal of more than one Exemption Quantity (EQ) of unsealed nuclear substances must conform to the requirements of CNSC GD-52 Design Guide for Nuclear Substances Laboratories and Nuclear Medicine Rooms. The requirements of this Regulatory Guide apply to any new construction or major renovations (such as demolishing walls, changes to existing shielding, or installing new fumehoods etc.) all new or renovated facilities designed after 1 January 1986. Older facilities will be assessed in accordance with their performance to this standard.

A radioisotope laboratory is classified as either Basic, Intermediate or High Level. The classification of the laboratory is based on the amounts of radioactive material to be handled in the laboratory. The classification does not apply if the area, room or enclosure is used only for storage of unsealed nuclear substances or for the use or storage of sealed nuclear substances or radiation devices. The permissible quantities for the three types of laboratories are shown in Table 3.

Table 3 (ref.: GD-52 Design Guide for Nuclear Substances Laboratories and Nuclear Medicine Rooms. Table A)

CLASSIFICATION	DESCRIPTION
Basic-Level Room	The quantity of unsealed nuclear substance used at a single time does not exceed 5 times its corresponding annual limit on intake (ALI)**.
Intermediate-Level Room	The quantity of unsealed nuclear substance used at a single time does not exceed 50 times its corresponding ALI.
High-Level Room	The quantity of unsealed nuclear substance used at a single time does not exceed 500 times its corresponding ALI.

**"ALI" or "annual limit on intake" means the activity, 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 of a person 18 years old or older or during the period beginning at intake and ending at age 70 after it is taken into the body of a person less than 18 years old.
See Appendix VIIB for ALI of typical radioisotopes.

Note: Appropriate safety poster must be posted based on each lab classification. To obtain a copy of the poster, contact the RSO.

7. Radioisotopes – Purchasing and Disposal

7a. Radioisotopes Purchasing Procedure

Only persons with a radioisotope permit can purchase radioactive materials. The University purchasing department receives a list of radioisotope permit holders from the Radiation Safety Officer.
When ordering a sealed source, the RSO must be notified. The most recent leak test results and a radioisotope license must be received by the RSO from the owner or the supplier of the source if applicable.

Procedure:

1. Purchase Orders are required to buy radioactive material regardless of the value of the order, unless prior special arrangements have been made with the RSO. Radioisotope permit holder must complete and issue a "Requisition To Purchase" form available on the Finance Division website at: (http://www.yorku.ca/procurement/forms.html) under the "Procurement" section.

   Complete the following details on the form:
   - Supplier (or vendor) information
   - Under "Ship To Information": enter Radioisotope permit holder name as contact
   - Under "Other Information", check off "Radioactive" and enter Radioisotope Permit Number and date required.
   - Under "UOM", enter activity of radioisotope ordered (e.g., UOM: 500 uCi)
   - Under "Description of Item" section, enter the chemical form and radioisotope (e.g. P-32, C-14 etc.)

   Note: To ensure compliance with CNSC restrictions, verbal orders and Blanket Purchase Orders cannot be issued for radioactive material. Where frequent delivery is required, multiple lines with different delivery dates can be submitted on one "Requisition To Purchase" form.

2. E-mail or Fax completed form to the Radiation Safety Officer (RSO) within the Health, Safety, and Employee Well-being Department.

3. RSO or designate ensures quantity of materials ordered will be within York's licence specifications and approves order prior to sending to the Purchasing department.

4. Purchasing issues and sends a purchase order to the vendor. A receiving copy of the order is sent to the permit holder indicated under the "Ship To Information" section.

5. The radioisotope permit holder or designate receives the order and verifies the quantity is as ordered and then signs the receiving copy and sends it to Finance Division for Accounts Payable to pay the vendor.

7b. Disposal of Radioactive Wastes

Radioactive materials, whether sources or carcasses of laboratory animals in which radioactive material has been incorporated, or contaminated equipment or laboratory materials awaiting disposal, shall be stored in one of the radioactive storage rooms (Room G111, Farquharson or Room 030F, Petrie). Access to the radioactive storage rooms is limited to personnel who are wearing a radiation TLD badge.
Radioactive waste collections will be arranged by the Radiation Safety Officer in conjunction with a contracted disposal service. Materials for waste collection, e.g. celite/gel containers and garbage containers, will be supplied. Every radioisotope permit holder is reminded that it is a federal requirement to maintain records regarding the use, storage and disposal of all radioactive materials at the university.

7.1 Phosporus-32 Waste

Refer to Appendix IX for disposal procedure.

7.2 Liquid Radioactive Waste
Flammable Liquids

Volatile or flammable liquids containing radioactive materials are to be poured into gel containers. Gel containers can be picked up in the Radioactive Waste Storage Rooms (Farquharson Building, Rm.G111, or Petrie Building, Rm. 030F). Large volume transfer should be done in the fumehood to prevent exposure to aerosol. Liquid scintillation vials for disposal must be securely sealed, stored in the laboratory in their original cartons or transparent plastic bags, taped and labeled as to activity and isotopes, and sealed in poly bags ready for collection.

7.3 Acid Solutions

All acids containing radioactive materials should be transferred to plastic jars containing celite. Jars will be labeled with the appropriate information as to name of permit holder, radionuclides and activity or activities.

7.4 Aqueous Solutions

Radioactive aqueous solutions must be poured into containers containing gel, labeled, securely sealed and made available for collection. Gel containers can be picked up in the Radioactive Waste Storage Rooms (Farquharson Building, Rm.G111, or Petrie Building, Rm. 030F).

7.5 Solid Radioactive Wastes

All solid radioactive wastes are to be stored in garbage containers lined with poly bags. Hypodermic needles and other sharp objects, including contaminated glassware, are to be stored separately from other waste in puncture-proof containers and clearly marked.

7.6 Animals

Animal Carcasses and animal wastes for disposal must be placed in poly bags and stored in cold room or in freezers, ready for collection. Each bag is to be labeled as to name of permit holder, radionuclide, activity, type of animal and date of sacrifice. Contact the Radiation Safety Officer to arrange for removal of animal wastes containing radioactivity.

7.7 Sealed Radioactive Sources

All sealed radioactive sources which are no longer used or required must be disposed of through the Radiation Safety Officer.

7.8 Disposal of Gaseous Radioactive Waste

Radioactive gases must not be discharged to the environment unless the activity is less than the maximum release concentration appropriate to the particular radionuclide involved. In all cases, reference should be made to the Radiation Safety Officer for approval of the proposed procedures.

8. *Spill Clean Up/Decontamination Procedure*

8.1 Routine Spill Clean Up Procedure

Preamble
Personnel cleaning up spill must be

1. previously monitored to ensure that he/she is free from contamination (including the sole of shoes);
2. monitored again after clean up.

Procedure

1. Delineate and isolate spill area.
2. Obtain spill kit from 128 Farquharson or 112 Lumbers.
3. Contain spill immediately:
    a. Liquid Spills:
        - Wear protective gloves.
        - Drop dry absorbent paper (or absorbent from spill kit) on spill.
        - Do not spread contamination.
        - Clean spills inwards (towards centre of spill).
        - Use tongs from spill kit when cleaning up spills involving P-32 or Cl-36.

    b. Dry Spills:
        - Wear protective gloves.
        - Dampen spilled material thoroughly with water (use fine mist).
        - Cover with damp absorbent paper (generally water may be used, except, where a chemical reacts with water which may cause airborne contamination, use oil).
        - Clean spills inwards (towards centre of spill).
        - Use tongs when cleaning up spills involving P-32 or Cl-36.
4. Discard spilled materials as radioactive waste at Farquharson G111 or Petrie Science Building, Rm.030F (inside volatile storage room 030D).
5. Decontaminate area with soap and water.
6. Perform wipe test to ensure complete decontamination.
7. Clean equipment and replenish if necessary.

8.2 Treatment of Skin Contamination

It is very important that skin contamination is removed immediately. Local skin contamination can provide high radiation dose rates to the skin. Early, effective removal of the contamination can help to reduce radiation exposure.

For skin decontamination, proceed from mild treatments to harsher ones only if necessary. Abrasion or any other breaks of the skin must be avoided as these will allow rapid penetration of radioactive material. Therefore, hard scrubbing is discouraged.

Procedure:

If the skin is intact:

- Flush contaminated area with copious amounts of warm water.
- Wet hands and apply neutral soap or neutral detergent. Lather well with plenty of water.
- Wash lather into the contaminated area for 2-3 minutes. Rinse thoroughly. Do not spread contamination to other areas of the body.
- Monitor effectiveness of removal by use of appropriate survey techniques.
- Repeat wash/rinse procedure three times more if necessary. If further washing does not remove the contamination, contact the RSO.

In case of minor wounds (not requiring hospitalization):

- Clean the affected area with swabs.
- Wash the contaminated wound with copious amounts of warm water. Encourage minor bleeding.
- In case of contaminated facial wounds, ensure that contamination does not spread to mouth, ears, eyes or nasal passages.
- After decontamination, apply first aid dressing.
- Notify Permit Holder and RSO immediately.

In case of serious injuries:

- Give immediate first aid (do not let the possibility of radioactive contamination hinder first aid efforts).
- Call 911 and Security Services at ext.33333 (or 416-736-5333). Security Services will inform RSO. State: location of incident, what happened, amount of material and chemical form.
- Advise emergency personnel of the nature of radioactive material.
- Minimize probability of contamination of emergency medical personnel and further contamination of victim.
- Notify Permit Holder.

8.3 Treatment of Contaminated Clothing

In the event that personal clothing becomes contaminated by radioactive material:

- Remove contaminated clothing quickly to reduce the exposure to radioactive material.

- Place contaminated clothing in plastic bag and seal.
- Label bag with owner's name, the isotope, the suspected amount of activity and date of contamination.
- Contact Radiation Safety Officer

8.4 Release of Radioactive Material

In the event of any release, greater than specified in these regulations, to the environment, the Radiation Safety Officer shall be informed immediately.
The Chair of the Radiation Safety Committee shall inform the Canadian Nuclear Safety Commission and the Ministry of Environment & Energy of such release within 24 hours.

9. *Radiation Devices : Portable Gauges, Gas Chromatograph Detectors, Scintillation Counters*

9.1. Users of any device containing a nuclear substance must comply with the Nuclear Substances and Radiation Devices Regulations. When a device containing a nuclear substance is purchased, the Radiation Safety Officer (RSO) must be informed.

9.2. Devices containing radioactive material and exceeding 10 times its exemption quantity (see Appendix VIIb) require a radioiosotope permit and the model of the device must be certified. The device shall be clearly and durably labeled with a radiation warning sign and the nature and activity of the radioisotope involved.

9.3. Where a radiation device is transported or transferred, the RSO should be informed of its new location prior to transport of the device.

9.4. The source holder, shielding or safety interlocks shall not be modified in any way without the prior approval of the RSO.

9.5. Any equipment malfunction, which could adversely affect radiation safety, shall be reported immediately to the RSO.

9.6. Physical contact with the radioactive source(s) shall be avoided.

9.7. Radiation devices containing a sealed source of 50 MBq or more (except if the nuclear substance contained in the device is less than 10 times the exempted quantity) must be leak tested every 12 months. Where the sealed source is being stored, leak test must be performed every 24 months or immediately before using it. The test shall be capable of detecting the presence of 0.2 kilobecquerel of radioactive material, and records shall be maintained for at least 3 years. If removable contamination in excess of 0.2 kilobecquerel is detected, the device shall be immediately removed from service and the Radiation Safety Officer shall be notified. Leak testing will be conducted by the RSO.

9.8. Where a radiation device is used in field operations, the device must be labeled indicating the name or job title and the telephone number (24 hour contact) of an emergency contact person.

Portable Gauges e.g., roof moisture meter

Persons using portable gauges shall comply with sec. 9.1-9.8 above, in addition,

9.9. The individual permits do not authorize the servicing of gauges where it is necessary to gain access to, remove, or in any way handle the radioactive source or sources.

9.10. For transportation, the device shall be placed inside an appropriate shipping container and located in an unoccupied part of the vehicle. The Packaging and Transport of Nuclear Substances Regulations must be complied with.

9.11. When not in use, the radioactive material shall be stored in a locked fire resistant container. Signs indicating the name or job title and the telephone number of an emergency contact person must be posted at the location where the device is stored.

9.12. Only persons instructed in the operation of the equipment and informed of the radiation hazards involved shall be authorized by the permit holder to use the equipment without direct supervision.

9.13. Procedures shall be established in advance to cope with situations in which the source might be involved in an accident or fire. If this happens, the source shall not be used again until it has been established that it is not damaged.

9.14. Contractors who are using portable gauges should provide the organization's CNSC License to the project coordinator prior to beginning the project. A copy of the license should be forwarded to Health, Safety and Employee Well-Being.

Gas Chromatograph Detectors

Persons using gas chromatograph detectors must comply with sec. 9.1-9.8 above, in addition,

9.14 If the sealed source is removed from the device and the sealed source contains more than 50 MBq, the source shall be leak tested at least once every year. If the source is in storage, the source must be leak tested at least once every 24 months.

9.15 Cleaning of the gas chromatograph source shall only be performed according to the manufacturer's instruction.

9.16 The manufacturer's recommended maximum operating temperature for the gas chromatograph source(s) in use shall not be exceeded.

9.17 Vapour emissions from chromatographs containing tritium shall not be vented to occupied areas.

Scintillation Counters

Persons using scintillation counters must comply with sec. 9.1-9.8, in addition,

9.18 Wipe tests shall be performed by the permit holder or his/her designate weekly on the week when the counter is being used.

10. X-Ray Installations and Other Radiation Emitting Devices

All x-ray emitting devices used for teaching or research must be registered through Health, Safety, and Employee Well-Being and will be included in the regular monitoring program by the Radiation Safety Officer. As with all radiation work, all unnecessary exposure to radiation should be avoided. Apart from observing the safety rules, operators should bear in mind that they have duties to protect both themselves and their colleagues from any hazards arising from their experimental or teaching work and they must not expose themselves or their colleagues to ionizing radiation to a greater extent than is absolutely necessary for the pursuit of their experimental research. THERE IS ALWAYS A SAFE WAY OF CARRYING OUT A PARTICULAR OPERATION.

10.1 Legislation

All individuals operating x-ray equipment must be familiar with the relevant legislative requirements under:

1. Regulation respecting X-Ray Safety – made under the Occupational Health and Safety Act, R.R.O. 1990, Reg. 861, enforced by the Ontario Ministry of Labour (outlines requirements for industrial radiography, x-ray machine used for diagnostic examination of animals, cabinet x-ray and analytic x-ray machine)
2. Healing Arts Radiation Protection Act enforced by the Ministry of Health and Long-Term Care (for the use of x-ray machine for irradiation of human)
3. Radiation Emitting Devices Regulations under Radiation Emitting Devices Act (outlines e.g., signage, construction standards etc. of the X-ray equipment or device)

Inventory and Permits

Principal Investigators (P.I.), who use x-ray equipment, must register their x-ray equipment with the Radiation Safety Officer (RSO) and obtain a permit for its use.

The RSO will keep an inventory of all x-ray equipment (type, model, location and permit holder contact information) based on the information collected through the permit process.

Training

Principal Investigators are responsible to ensure that every worker using x-ray equipment has received: (1) x-ray safety training and (2) training on the standard operating procedure prior to use. Record of training should be maintained by the P.I.

X-ray safety training is provided by the RSO. The training includes:

- Radiation Safety Program at York University
- Regulations
- Radiation Basics

- X-ray: properties and Production Units
- Health Effects of X-rays
- Maximum Permissible Radiation Limit
- Radiation Protection (monitoring and control)
- Types of X-ray Equipment and Legislative Requirements
- X-ray Emergencies

10.4 Safety Requirements

The safety requirements for each x-ray facility and the equipment are specific to the type of x-ray equipment and its use (e.g., analytic x-ray equipment, cabinet x-ray source, diagnostic x-ray equipment etc.). The Principal Investigator is responsible to be familiar with the relevant legislative requirements and the manufacturer's safety guideline. In general,

10.4.1 Care must be taken to avoid personal exposure to the primary x-ray beam. Exposure in areas where radiation scatter is possible should be kept to a minimum.

10.4.2 No interlock or other safety device shall be deliberately defeated. No live adjustments or alignments shall be made if any safety cover is removed except where the procedure has been specifically checked for safety and the methods documented.

10.4.3 Prior to making a modification to an x-ray source, either permanent or temporary, in operating technique, equipment arrangement or in ancillary equipment, the modification shall be checked for safety and all changes documented and communicated to the RSO.

10.4.4 Any defect in x-ray equipment resulting in possible radiation hazard shall be reported to the grant or contract holder who will inform the RSO.

The RSO will inspect all x-ray machines and facilities in his/her inventory annually.

11. Precautions to be followed in Operation of Lasers

For the registration and the safe operation of lasers, refer to the York University Laser Safety Program. The Laser Safety Program is available from the Health, Safety, and Employee Well-Being (http://www.yorku.ca/dohs/programs.html). Any enquiries on the safe use of lasers should be directed to the Laser Safety Officer in the Health, Safety, and Employee Well-Being.

12. *Precautions on the Use of Open Ultraviolet Radiation Sources*

Ultraviolet (UV) lamps are used as radiation sources in photophysical and photochemical studies in a number of laboratories. These range in power output from 50 to 1000 watts. Exposure of the eye to UV radiation causes severe corneal and retinal damage similar to the effects caused by lasers. These may result from seemingly short exposures. A few details on the operation of these light sources, which may be of value to the inexperienced person, will be considered here. In the use of UV lamps one should never look directly at unshielded, operating lamp unless protective wraparound safety glasses are worn. These glasses should have certified UV filtering lenses. Ordinary tinted sunglasses or shades are not recommended for this purpose. Prolonged exposure of the skin to intense UV radiation should be avoided as well. The photolysis apparatus, when in use, should be shielded with opaque screens preventing unnecessary leaking of light (direct or reflected) to the rest of the work area. General precautionary measures listed under the use of lasers should be exercised in the handling of UV radiation sources.

13. Rules for Teaching Laboratories Using Radioisotopes

For all teaching laboratories using radioisotopes (opened or sealed sources), it is the responsibility of the radioisotope permit holder and the course director to ensure that radiation exposure to individuals are being kept to an "As Low As Reasonably Achievable" level. It is essential that students performing the experiments are supervised by an individual trained in Radiation Safety.

For laboratories using open sources (i.e. sources that are not encapsulated or sealed, and which can be spilled or cause contamination under normal use):

Prior to start of the laboratory session:
1. Notification Form (Appendix XIII) completed by the Course Director and sent to the Radiation Safety Officer (RSO).
2. Checklist (Appendix XIV) completed by the Laboratory Instructor and returned to the RSO.

At the end of the laboratory session:
1. Except for tritium, monitor each student's hands prior to leaving the room, using a portable contamination meter.
2. Monitor all areas and equipment to ensure that radioactivity is only limited to the active areas, and that all 'hot' equipment is being placed in labeled containers.
3. For all noticeable contamination or spills, follow the Emergency Response Procedure for Spills of Radioactive Materials (York Emergency Phone No. 416-736-5333). Notify the RSO, Course Director and Permit Holder.

Appendix I *Radiation Safety Committee*

Radiation Safety Committee Membership

K. Hudak (Chair)
L. O'brien or P. Lindsay (Committee Secretary)
C. Shew (Radiation Safety Officer)
M. Bayfield
R. Ceddia
T. Hodgson
M. Mazzurco
B. Sheeller
C. Storry

As of December 2015

Appendix II Terms Of Reference

Terms of Reference

(Ref. CNSC. Regulatory Guide G-121 Radiation Safety in Educational, Medical and Research Institutions)

The Committee shall be responsible for:

- establishing the criteria for radioisotope use in any department of the University within the licensing conditions designated by the Canadian Nuclear Safety Commission from time to time and oversee the University's radiation safety program;
- reviewing all applications for use of radioactive material and approve those meeting the required standards for transmittal to the Canadian Nuclear Safety Commission;
- monitoring the operations of users granted permission to use such material. In addition to this routine monitoring of operations, the Committee shall make at least one annual inspection of all areas where radioactive isotopes are used or stored. If it should be of the opinion, at any time, that the criteria laid down in its operations manual, or specified in the conditions required in any radioisotope license are not being followed, or that any operations are potentially unsafe, the Committee shall require such operations to cease forthwith until such time as it is satisfied that the conditions can be met and that guarantees, satisfactory to the Committee, are received that the conditions will be met in the future.
- Reviewing reports concerning any incidents or unusual occurrences at the institution that involved radioactive materials;
- Recommending measures or improvements to prevent recurrences of any incidents that exposed persons to unnecessary radiation, or to prevent recurrence of any other unusual incidents involving radioactive materials;
- Advising management of any need for additional resources to establish, maintain or improve radiation protection programs.

For other radiation sources, e.g., lasers, ultraviolet radiation sources, the Committee may establish a working group with expertise in the use of these sources to establish and maintain policies and standards for the safe use of these sources.

Membership

The Committee shall be composed of at least three members who are experienced users of radioactive material together with the Radiation Safety Officer. Members will be appointed by the Dean(s) of the relevant Faculties which uses nuclear substances. The Dean of the Faculty of Science will appoint: three members representing the Departments of Biology, Chemistry and Physics respectively; one representing the technical staff and one representing the Dean's office (e.g., the Executive officer or his/her designate). The Faculty of Health will appoint: at least one faculty member representing the Department of Kinesiology and Health Science, and one representing the Dean's Office.

Quorum

A committee meeting must have a quorum of (50%+1) of its members and must include the chair.

Operating Procedures

The RSO, in consultation with the Committee, shall prepare an annual report to be sent to the CNSC. The Radiation Safety Committee shall meet at least quarterly.

Appendix III Application for Radioisotope Permit

York University Radiation Safety Committee

RADIOISOTOPE PERMIT APPLICATION

Date of Application: ______________________________
Name of Applicant: ______________________________
Department: ____________________________________
Room: ________ Building: _____________ Tel: __________

ISOTOPE	AMOUNT TO BE HANDLED ON THE OPEN BENCH	AMOUNT TO BE HANDLED IN CONTAINMENT**	CHEMICAL FORM*

Total Anticipated Usage in 2 years:

Proposed Experimental Procedures:

Name of Authorized Users:

Laboratories in which isotopes will be used:

* In case of sealed sources, state: the type of equipment (e.g. gas chromatograph), brand name and model no.
** Containment, e.g. fumehood

Appendix IV Purchasing Requisition

A copy of the form is available from:

http://www.yorku.ca/procurement/forms.html

PC-FR-2000-0005
v.22032005

PURCHASING REQUISITION

Date:
Requisition No.:

Mail OR Fax One Copy With Supporting Documents To: Procurement Services, EOB • Fax: (416) 736-5630

Suggested Supplier	
Name:	
Address:	
Address (cont'd):	
Phone:	Fax:
Contact:	
Email:	
Supplier Quote No:	

Ship To Information
Contact:
Extension:
Email:
Dept. Name:
Room No.:
Building:

Other Information
P.O. Type:
End Use:
Date Goods Are Required (MM/DD/YYYY):
Change Order:
Existing P.O. No.:
Radioactive:
Radioisotope Permit No.:

Quantity	UOM	Supplier Part No. / Description of Item	Account	Fund	Cost Centre	Activity (optional)	Time (optional)	Location (optional)	Unit Price	Extended Price

Subtotal:	
Freight:	
Other:	
G.S.T.:	
P.S.T.:	
Total Price:	

Procurement Services Use Only
P.O. No.:
Approval:

Additional Requirements for this Order

Department Authorization

I hereby certify that I am authorized to sign on the cost centres above and all the expenditures are valid, in compliance with the policies of the University, and sufficient funds are available to cover this expenditure.

Printed Name　　　　Signature

YORK U redefine THE POSSIBLE

THIS IS NOT A PURCHASE ORDER

Appendix V Annual Inventory Of Radioisotopes

Note: an online fillable copy of this form can be found on the HSEWB Website: https://dohs.apps01.yorku.ca/machform/view.php?id=35996

YORK UNIVERSITY
RADIATION SAFETY COMMITTEE

ANNUAL INVENTORY OF RADIOISOTOPES

for the period of: January 1, 2016- December 31, 2016

Date of Inventory: ______________________

Name of Permit Holder: ______________________

Radioisotopes currently in your lab:

ISOTOPE	ACTIVITY (uCi or mCi)	CHEMICAL FORM	STORAGE LOCATION (building, Rm.No.)

Isotope purchased between: January 1, 2016- December 31, 2016

ISOTOPE	ACTIVITY (mCi or uCi)	CHEMICAL FORM	STORAGE LOCATION (Rm.No.)	DATE REC'D (mm/dd/yy)

Isotopes disposed of between: : January 1, 2016- December 31, 2016

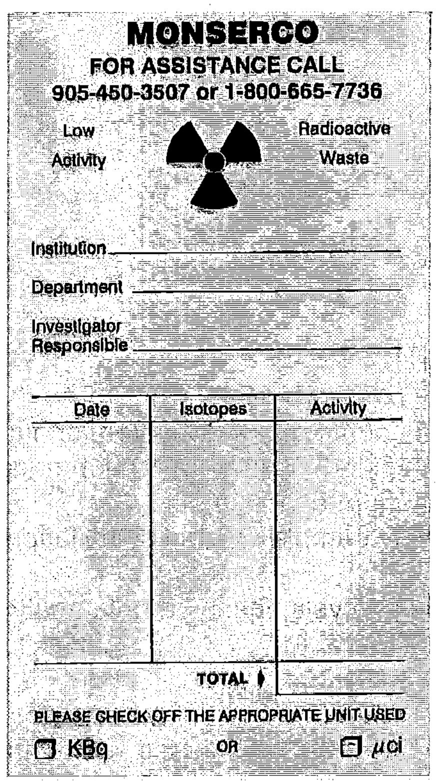
ISOTOPE	QUANTITY	CHEMICAL FORM (Solid, liquid, scint. vials)	DISPOSAL DATE

Signature of Permit Holder ______________________

PLEASE RETURN TO : Radiation Safety Officer, Health, Safety, and Employee Well-Being, Kinsmen Building.

Appendix VI York University Certificate of Disposal of Radioisotope

All radioactive waste must be labeled directly on the bag, jar, or container to be disposed. Waste disposal forms can be obtained from the Stores (Rm. 128 Farquharson). An example of a waste disposal form is shown below.



MONSERCO
FOR ASSISTANCE CALL
905-450-3507 or 1-800-665-7736

Low Activity Radioactive Waste

Institution ____________________

Department ____________________

Investigator Responsible ____________________

Date	Isotopes	Activity
	TOTAL ▶	

PLEASE CHECK OFF THE APPROPRIATE UNIT USED

☐ KBq OR ☐ μci

Copies:

Top Copy: Left with Stores for RSO
Middle Copy: Permit Holder
Bottom Copy: Attach to Waste Container

Appendix VIIa Safety Information For Some Commonly Used Radionuclide

CARBON-14 (C-14)

PHYSICAL CHARACTERISTICS:

Half-life:
- Physical1: 5730 years
- Biological2: 12 days
- Effective3: 12 days

Radiation Emitted: Beta

Energy of Radiation: 0.156 MeV (max)

Maximum Range in Air: 22 cm (max)

RADIOBIOLOGICAL CHARACTERISTICS:
Radiotoxicity: Moderate

Critical Organ: Whole Body

MEASUREMENT METHODS:
External:
- Beta-gamma counting and detection techniques. Start all monitoring with detector unshielded. Special attention necessary to select appropriate low-energy monitoring techniques.
- Smear or swipe sample. Liquid scintillation counting.

Internal:
- Urine sample analysis; feces sample analysis or breath analysis for carbon dioxide gas

SPECIAL CONSIDERATIONS:
C-14 labeled nucleic acids must be handled with extra caution. To avoid intake by ingestion or absorption, gloves and protective clothing should be worn. Volatile C-14 gases and dusty compounds should be handled in a fume hood or glove box.

---

[1] Physical half-life: The characteristic time taken for the activity of a particular radioactive substance to decay to half of its original value; that is, for half the atoms present to disintegrate.
[2] Biological half-life: The characteristic time required for the amount of radioactive substance to decay to half of its original value due to elimination by biological processes alone. The biological half-life is not dependent on the radioisotope but does depend on the organ or body system in which the material is deposited and the chemical properties of the material.
[3] Effective half-life: The characteristic time required for a radioactive material to be eliminated from a biological system through a combination of the physical and biological removal processes. The effective half-life is a mathematical combination of the physical and biological half-lives of the particular radioisotope.

IODINE-125 (I-125)

PHYSICAL CHARACTERISTICS:

Half-life:
- Physical1: 60.2 days
- Biological2: 138 days
- Effective3: 41.9 days

Radiation Emitted: Gamma and X-rays

Energy of Radiation:
- Gamma: 0.035 MeV
- X-rays: 0.027 MeV

Dose Rate at 1 meter from 1mCi Point:
Source: 0.275 mR/hr

RADIOBIOLOGICAL CHARACTERISTICS:
Radiotoxicity: Moderate

Critical Organ: Thyroid

MEASUREMENT METHODS:
External:
- Beta-gamma counting and detection techniques. Start all monitoring with detector unshielded.
- Smear or swipe sample counted in laboratory.

Internal:
- Whole body count (standard gamma detection methods), including nuclear medicine counters.

SPECIAL CONSIDERATIONS:
Soluble I-125 accumulates in the thyroid gland. It will appear in the thyroid within a few hours of an accidental intake. Volatilization is a most significant problem. Simple opening a vial of sodium iodine can cause significant airborne release. Solutions should not be made acidic or stored frozen. Double gloving is strongly recommended. Neutralize all spills with sodium thiosulfate before starting clean up. All work is normally to be done in an approved hood.

---

[1] Physical half-life: The characteristic time taken for the activity of a particular radioactive substance to decay to half of its original value; that is, for half the atoms present to disintegrate.
[2] Biological half-life: The characteristic time required for the amount of radioactive substance to decay to half of its original value due to elimination by biological processes alone. The biological half-life is not dependent on the radioisotope but does depend on the organ or body system in which the material is deposited and the chemical properties of the material.
[3] Effective half-life: The characteristic time required for a radioactive material to be eliminated from a biological system through a combination of the physical and biological removal processes. The effective half-life is a mathematical combination of the physical and biological half-lives of the particular radioisotope.

PHOSPHORUS-32 (P-32)

PHYSICAL CHARACTERISTICS:

Half-life:
- Physical1: 14.28 days
- Biological2: 257 days
- Effective3: 13.5 days

Radiation Emitted: Beta

Energy of Radiation: 1.170 MeV (max)

Maximum Range in Air: 610 cm

RADIOBIOLOGICAL CHARACTERISTICS:
Radiotoxicity: Moderate

Critical Organ: Bone

MEASUREMENT METHODS:
External:
- Beta-gamma counting and detection techniques. Start all monitoring with detector unshielded.
- Smear or swipe sample counted in laboratory.

Internal:
- Whole body count (standard gamma detection methods), including nuclear medicine counters.
- Urine sample analysis.

SPECIAL CONSIDERATIONS:
P-32 is the highest energy radionuclide commonly used in research labs. The surface dose rate from an open source is quite large at short range and is not attenuated appreciably by a few centimeters of air. Exposure to the hands and fingers can be reduced by wearing heavy gloves and by using remote handling techniques. Safety glasses should be worn. Use of low-density 0.75 cm plexiglass shielding is recommended.
Every individual working with P-32 is required to survey himself/herself and the workplace with an appropriate survey instrument immediately at the end of work and to record the results of the survey.

---

[1] Physical half-life: The characteristic time taken for the activity of a particular radioactive substance to decay to half of its original value; that is, for half the atoms present to disintegrate.

[2] Biological half-life: The characteristic time required for the amount of radioactive substance to decay to half of its original value due to elimination by biological processes alone. The biological half-life is not dependent on the radioisotope but does depend on the organ or body system in which the material is deposited and the chemical properties of the material.

[3] Effective half-life: The characteristic time required for a radioactive material to be eliminated from a biological system through a combination of the physical and biological removal processes. The effective half-life is a mathematical combination of the physical and biological half-lives of the particular radioisotope.

APPENDIX VIIa (continued)

PHOSPHORUS-33 (P-33)

PHYSICAL CHARACTERISTICS:

Half-life:
Physical1: 25.4 days
Biological2: 257 days
Effective3: 23 days

Radiation Emitted: Beta

Energy of Radiation: 0.249 MeV (max)
88mR/hr @ surface of 1uCi/ml solution

Maximum Range in Air: 46 cm

RADIOBIOLOGICAL CHARACTERISTICS:
Radiotoxicity:

Critical Organ: Bone and whole body

MEASUREMENT METHODS:
External:
- Liquid scintillation counter (efficiency ~85%)
- Thin-window Geiger miller counter (efficiency ~20%)

Internal:
- Urine sample analysis (not routinely done)

SPECIAL CONSIDERATIONS:
Millicurie quantities of P-33 do not present a significant external exposure hazard because the low energy betas emitted barely penetrate gloves and the outer dead layer of skin. Handle P-33 compounds that are potentially volatile or in powder form in ventilated enclosures.
Plexiglass shielding for stock solutions

[1] Physical half-life: The characteristic time taken for the activity of a particular radioactive substance to decay to half of its original value; that is, for half the atoms present to disintegrate.
[2] Biological half-life: The characteristic time required for the amount of radioactive substance to decay to half of its original value due to elimination by biological processes alone. The biological half-life is not dependent on the radioisotope but does depend on the organ or body system in which the material is deposited and the chemical properties of the material.
[3] Effective half-life: The characteristic time required for a radioactive material to be eliminated from a biological system through a combination of the physical and biological removal processes. The effective half-life is a mathematical combination of the physical and biological half-lives of the particular radioisotope.

SULPHUR-35 (S-35)

PHYSICAL CHARACTERISTICS:

Half-life:
- Physical[1]: 87.9 days
- Biological[2]: 90 days
- Effective[3]: 44.3 days

Radiation Emitted: Beta

Energy of Radiation: 0.167 MeV (max) ...100%

Maximum Range in Air: 24 cm

RADIOBIOLOGICAL CHARACTERISTICS:

Radiotoxicity: Moderate

Critical Organ: Testis

MEASUREMENT METHODS:

External:
- Beta-gamma counting and detection techniques. Start all monitoring with detector unshielded. Special attention necessary to select appropriate low-energy monitoring techniques.
- Smear or swipe sample. Liquid scintillation counting.

Internal:
- Urine or feces sample analysis.

SPECIAL CONSIDERATIONS:

S-35 is a soft beta-emitter and has an end-point energy similar to that of C-14. In certain applications, sulphur-35 may be preferable to carbon-14 as the appropriate tracer because it has a relatively short half-life.

---

[1] Physical half-life: The characteristic time taken for the activity of a particular radioactive substance to decay to half of its original value; that is, for half the atoms present to disintegrate.

[2] Biological half-life: The characteristic time required for the amount of radioactive substance to decay to half of its original value due to elimination by biological processes alone. The biological half-life is not dependent on the radioisotope but does depend on the organ or body system in which the material is deposited and the chemical properties of the material.

[3] Effective half-life: The characteristic time required for a radioactive material to be eliminated from a biological system through a combination of the physical and biological removal processes. The effective half-life is a mathematical combination of the physical and biological half-lives of the particular radioisotope.

TRITIUM (H-3)

PHYSICAL CHARACTERISTICS:

Half-life:
Physical1: 12.26 years
Biological2: 10 days
Effective3: 10 days

Radiation Emitted: Beta

Energy of Radiation: 0.018 MeV (max) ...100%

Maximum Range in Air: 5 mm

RADIOBIOLOGICAL CHARACTERISTICS:
Radiotoxicity: Low

Critical Organ: Whole Body

MEASUREMENT METHODS:
External:
- Beta-gamma counting and detection techniques. Start all monitoring with detector unshielded. Special attention necessary to select appropriate low-energy monitoring techniques.
- Smear or swipe sample. Liquid scintillation counting.

Internal:
- Urine sample analysis.

SPECIAL CONSIDERATIONS:
Tritium emits very low energy beta particles. The particles have negligible range in air. Although tritium is considered only slightly radiotoxic, precautions are required to prevent internal exposure.
Intake of tritium gas gives rise to dose to the lung and may give rise to soft tissue doses from tritiated water, due to the conversion to tritiated water within the body.

[1] Physical half-life: The characteristic time taken for the activity of a particular radioactive substance to decay to half of its original value; that is, for half the atoms present to disintegrate.
[2] Biological half-life: The characteristic time required for the amount of radioactive substance to decay to half of its original value due to elimination by biological processes alone. The biological half-life is not dependent on the radioisotope but does depend on the organ or body system in which the material is deposited and the chemical properties of the material.
[3] Effective half-life: The characteristic time required for a radioactive material to be eliminated from a biological system through a combination of the physical and biological removal processes. The effective half-life is a mathematical combination of the physical and biological half-lives of the particular radioisotope.

Appendix VIIb Exemption Quantities and Annual Limits on Intake (ALI) of Common Nuclear Substances used at York University

References: -Nuclear Substances and Radiation Devices Regulations(SOR/2000-207). Sch.1

-GD-52 Design Guide for Nuclear Substance laboratories and Nuclear Medicine Rooms. Appendix A.

Radioactive Nuclear Substance	Exemption Quantity (in kBq)	ALI (ingestion) MBq/yr
Americium 241	10	0.1
Barium 133	1000	20
Carbon 14	10000	34
Hydrogen 3	1000000	1000
Iodine 125	1000	1.3
Iron 55	1000	61
Nickel 63	100000	130
Phosphorous 32	100	8.3
Phosphorous 33	100000	83
Polonium 210	10	0.083
Radium 226	10	0.071
Sodium 22	1000	6.3
Sulphur 35	100000	26 (organic) 110 (inorganic)
Uranium (natural)	1	2.1

**"ALI" or "annual limit on intake" means the activity, 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 of a person 18 years old or older or during the period beginning at intake and ending at age 70 after it is taken into the body of a person less than 18 years old.

Appendix VIII Notification of Nuclear Energy Worker (NEW) Status and Dose Levels

1. Notification of NEW Status

Worker: ____ Sex: M F
Date of Birth: ____
SIN Number: ____

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

As required by the Radiation Protection Regulations (RPR, sec.7(1-3)), I have been informed in writing:

a) that I am a Nuclear Energy Worker (NEW),
b) of the risks associated with radiation to which I may be exposed during the course of my work, including the risk associated with the exposure of an embryos and fetuses;
c) the applicable dose limits as specified in the RPR;
d) that I will be informed of my radiation dose levels;
e) for females, my rights and obligations should I become pregnant (i.e. (1) Every NEW who becomes aware that she is pregnant shall immediately inform the university (via the permit holder and RSO in writing, (2) the university shall make any reasonable accommodation and/or respect the right to refuse work that involves radioisotopes.)

I understand the risk, my obligations, and the radiation dose limits and levels that are associated with being designated a NEW.

Signature of Worker: ____
Name of Permit Holder: ____
Signature of Radiation Safety Officer: ______________________________
Date: ____

2. Notification of NEW Dose Levels
(note: this notification will be sent to each NEW by the RSO via email)

Name of Nuclear Energy Worker: ____________________________

Department: ____

Name of Permit Holder: _____________________________________

Dosimetry Exposure Report for period: ____________________________ (see attached)

Effective Dose Limits (Ref. Radiation Protection Regulations sec.13(1), sec.14(1)):

Item	Person	Period	Effective Dose (mSv)
1	Nuclear energy worker, Including a pregnant Nuclear energy worker	c. One-year dosimetry period d. Five-year dosimetry period	50 100
2	Pregnant Nuclear Energy Worker	Balance of the pregnancy	4
3	A person who is not a Nuclear Energy Worker	One calendar year	1

Ref.: Radiation Protection Regulation, sec.13(1)

"Effective Dose" means the sum of the products, in sievert, obtained by multiplying the equivalent dose of radiation received by and committed to each organ or tissue by its weighting factor. The weighting factor for the whole body is 1. The weighting factors for specific organs are listed in the Radiation Protection Regulation sec. 25, schedule 1 and 2.

Equivalent Dose Limits (Ref.Radiation Protection Regulations sec. 14(1)):

	Organ or Tissue	Person	Period	Equivalent Dose (mSv)
1.	Lens of an eye	(a) NEW	One-yr dosimetry period	150
		(b) Any other person	One calendar year	15
2.	Skin	(a) NEW	One-yr dosimetry period	500
		(b) Any other person	One calendar year	50
3.	Hands and feet	(a) NEW	One-yr dosimetry period	500
		(b) Any other person	One calendar year	50

Appendix IX Phosphorous-32 Waste Disposal Procedure

Introduction

The purpose of establishing a special phosphorous-32 waste disposal procedure is to minimize the volume of radioactive waste and thus to reduce the cost to the users for the transportation and disposal of radioactive wastes.
Phosphorous-32 is a short half-life radioactive material in which its waste can be stored for decay to background levels and then be disposed as 'normal' garbage rather than being shipped for burial as radioactive waste. The following are the characteristics of phosphorous-32:

PHOSPHOROUS-32

Physical Characteristics:

Physical Half-Life:	14.28 days
Radiation: Beta	1.710 MeV (max.) 100
Range in Air:	610 cm (max.)
Source Strength:	2100 mrem/hr at 10 cm per uCi
(Unshielded point source)	

Radiobiological Characteristics:

Radiotoxicity:	Moderate
Critical Organ:	Bone
Biological Half-Life:	257 days
Effective Half-Life:	13.5 days

The Beta radiation from phosphorous-32 is extremely penetrating. The surface dose rate from an open source is quite large at short range and is not attenuated appreciably by a few centimeters of air. Any direct skin contact with phosphorus-32 must be avoided and measures to control contamination are essential.

In accordance with the conditions for disposal as listed in York's radioisotope license, phosphorus-32 can be disposed of:

In Solid Form:
By release through the municipal garbage system if concentration is less than 10uCi/kg of P-32 waste material and is uniformly distributed, or

In Liquid Form:
By release through the municipal sewage system provided the substance is water soluble and the concentration in the sewer at the property line for the facility is less than 1 MBq/year/building (Ref.: CNSC Licence condition for P-32) of effluent based upon a yearly average.

DISPOSAL PROCEDURES:

ACTION	RESPONSIBLE
1. Segregate phosphorus-32 (P-32) waste from other radioactive wastes.	User
2. Separate (P-32 waste) into liquid and solid.	User
a. For solid P-32 waste:	
I. Place into plastic bag.	User
II. Stick on a radioactive waste label, and check off "solid" on the label	User
III. Before taking to the radioactive waste storage area, complete all information on the label e.g. date of disposal, name of disposer, activity, etc...	User
IV. Wipe the outside of the container, take to radioactive waste storage area.	Disposer
V. Store in the appropriate cabinet or shelf.	Disposer
b. For liquid P-32 waste:	
1. Pour waste into plastic container containing Gel absorbent (identified by bottles containing a small amount of white powder). If the solution does not solidify, pour celite (from bottles containing a large amount of grey sandy powder) into the solution until it is above the top of the liquid.	User
2. Stick on radioactive waste label, and check off on label "liquid".	User
3. Before bringing to the radioactive waste storage area, complete all information on the label.	User
4. Wipe the outside of the container and take to radioactive waste storage area*.	Disposer
5. Store in the appropriate cabinet or shelf.	Disposer

*For large amount of waste, during transportation, use a trolley and shield the container with plexiglass or acrylic

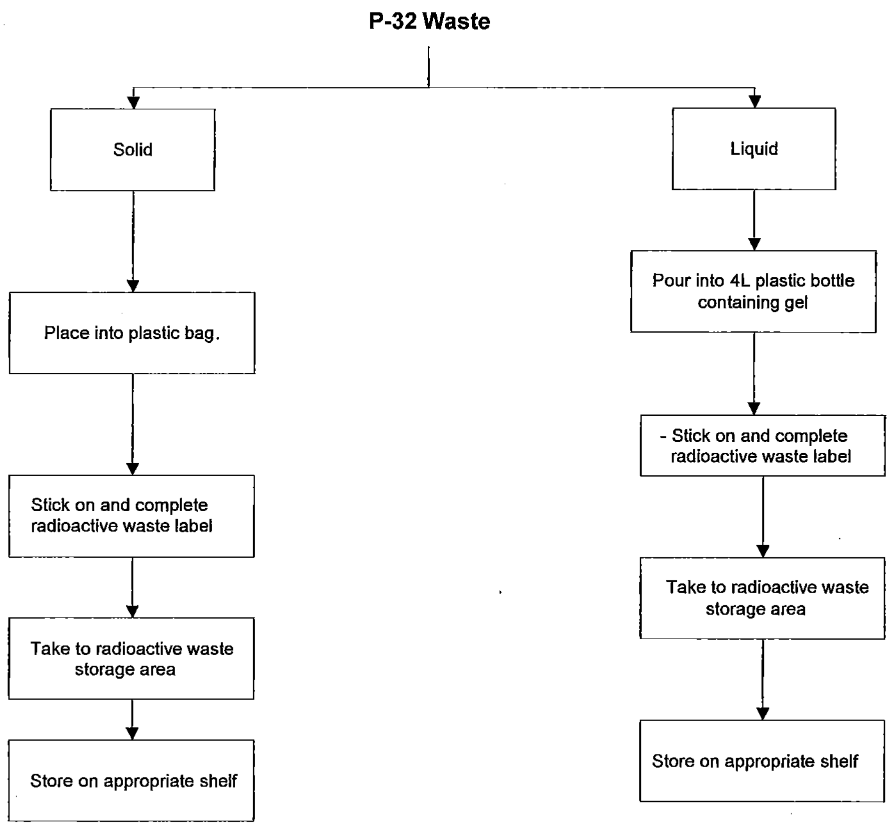
Appendix IX Phosphorous-32 Waste Disposal System Maintenance

P-32 users and disposers are to follow the "P-32 Waste Disposal Procedure" and the Radiation Safety Officer (RSO) or designate will be responsible to maintain and monitor the system.

ACTION	RESPONSIBLE
1. On a monthly basis (or as often as required based on usage), check all materials left on shelves or in cabinets. Record details onto waste inventory sheet.	RSO or Designate
1.2 For materials with activity greater than 10 uCi/kg, keep in storage for decay	RSO or Designate
1.3 For material with activity less than 10 uCi/kg remove all radioactive labels and dispose of as normal waste.	RSO or Designate
1.4 For organic or water insoluble liquid, contact permit holder for disposal.	RSO or Designate
2. Contamination monitoring of shelves: (Approximately once every six months) – Coordinate shelves monitoring with removal of materials so that the shelves are empty during wipe testing. – Monitor and wipe test shelves – If contamination is detected, clean shelf and re-monitor until count is less than 3x background. If decontamination is not successful, remove shelf from service until contamination clears. Consider replacing shelf surface if necessary.	RSO or Designate
3. If the above (#1-2) are conducted by another person other than the RSO, check wipe test records, disposal room, and the disposal system occasionally.	RSO

Date of Revision: December 2015

P-32 WASTE DISPOSAL PROCEDURE



Appendix X Radiation Quantities and Units

For work with radiation it is necessary to understand the various units used for measuring different quantities and to understand the inter-relationships that exist. Definitions of all the units are given in the Glossary of Technical Terms. In what follows, the more important ones will be discussed.

I. Units for Measuring Radioactivity

Since radioactive isotopes decay with their own characteristic half lives a given amount of material which decays fast will be more radioactive than a similar quantity of material, which is decaying slowly. Therefore, the quantity in weight or volume is not a measure of its radioactivity. The unit (curie) of radioactivity was initially established as that amount of activity corresponding to one gram of radium or more precisely that quantity of radioactive nuclide which is disintegrating at the rate of 3.7 X 10^{10} atoms per second. Smaller units used are the millicurie (mCi) and microcurie (uCi) which are 3.7 X 10^{7} dps and 3.7 X 10^{4} dps. respectively.

II. Units of Radiation Energy

A. While the curie gives information about the number of disintegrations it does not indicate the energy of the radiations being emitted. The unit used for this purpose is the electron volt, abbreviated as eV. One electron volt is equal to energy gained by an electron in passing through a potential difference of one volt. The charge of the electron being very small, the electron volt represents a very tiny amount of energy. The energy of the radiations used in radiography is expressed in million electron volts abbreviated as MeV.

B. The energy of X-radiations is often expressed in terms of kVp. This is an abbreviation of kilovoltage peak and refers to the peak potential of the high voltage in the X-ray machine. It is not a direct measure of the energy of the radiation but since energy and tube voltage are related, it gives an indication of the quality of the radiations. The quality of an X-ray beam can also be described by its half-value layer (HVL). The HVL is that thickness of some specified material, (usually Al or Cu) which will attenuate the beam to one-half of its original intensity. The HVL of a beam is a function of its effective energy. The effective energy in KeV units is approximately 1/3 of the applied potential, being influenced somewhat by the nature of the power supply, and increasing as filtration is added.

III. Units of Radiation Dose

The most important characteristic of g- and X-rays is their ability to ionize the atoms and molecules of the material through which they pass. The unit for measuring intensity of X- or gamma-radiation is based upon its ability to produce ionization. The unit chosen is the roentgen.

A. The Roentgen

The Roentgen is defined as an exposure dose of X- or gamma-radiation such that the associated corpuscular emission per 0.001293 gm of air produces, in air, ions carrying one electrostatic unit of quantity of electricity of either sign.

More simply it is that quantity of radiation, which creates 208 X 10^9 ion pairs per cc of air at S.T.P. By definition the Roentgen is a unit of exposure dose, which is based upon ionization of air. It is not a unit of ionization, nor is it an absorbed dose in air. Finally it applies to X- and gamma-radiations only.

It can be shown that the Roentgen is equivalent to the deposition of 83 ergs of energy per gm of air. Since absorption is higher in water and human tissue, the deposition of energy in these media is approximately 93 ergs.

B. RAD

Since the Roentgen is not easily applicable to all systems, a new unit of absorbed dose is used when considering radiation damage in living tissue. This unit is called the rad and is equal to that amount of ionizing radiation, which imparts 100 ergs/gm of energy. The SI unit for absorbed dose is the Gray (Gy). It is seen that the Roentgen and the rad are really not very different in value; however, the rad is a unit of absorbed dose and can be applied to all types of radiation. (1mGy = 100mRad)

C. RWF

RWF stands for Radiation Weighting Factor.

Different ionizing radiations can cause different amounts of biological damage for the same rad dose delivered. Examples of this are alpha-radiation and fast neutrons both of which cause more damage than commonly used X- and g-radiations. The RWF for X- and gamma-radiations used in radiography is equal to 1.

D. REM

The rem is an abbreviation of Roentgen-equivalent-man and is related to the rad by the equation:

REM = RAD X RWF

The Sv is an abbreviation of Sievert and is related to the Gray by the equation:

Sv = Gy x RWF

For X-gamma and beta-radiations the RWF is one, therefore, the Sv dose and the Gy dose are the same. For expressing radiation doses the correct unit is Sievert. A smaller unit of this: MilliSievert (mSv) = Sv/1000

Since the Roentgen and the rad are not very different in many occasions the symbol “r” is used instead of rem, and “mr” instead of mrem.

E. Working Level (WL) or Working Level Month (WLM)

WL and WLM are units for measuring exposure to radon daughters.

WL means the amount of any combination of radon daughters in one litre of air that will release 1.3 X 103 mega electron volts of alpha particle energy during their radioactive decay to lead-210.

WLM mans the exposure resulting from the inhalation of air containing one working level of radon daughters for one working month, where one working month equals 170 working hours.

Radiation Quantities And Units

Quantity	Old (Imperial Unit)		S.I. Unit		Relationship
	Name	Abbreviation	Name	Abbreviation	
Activity	Curie	Ci	Becquerel	Bq	1 Bq = 1 disintergration per sec. 1 Ci = 3.7 X 10^{10} Bq 1 Bq = 2.7 X 10^{-11} Ci
Exposure (ionization in air)	Roentgen	R	-	-	1 Coulomb/kg = 3876R
Absorbed Dose	rad	Rad	Gray	Gy	1Gy=1J/kg=100 rad
Dose Equivalent	rem	rem	Sievert	Sv	1 Sv = 100 rem

Abbreviations:
J = Joule
Kg = kilogram

Appendix XI Wipe Test Method

Equipment:
1. 10 ml pipette
2. #1 filter paper (4.25 cm) or Q-tips
3. Scintillation vials (20 ml size recommended)
4. Pipettor

Reagent:
1. Ecoscint LS-271

Procedure:

1. Pipette 5-10 ml (sample must be homogenous and not cloudy) scintillation fluid into each scintillation vial (note: for miniature vials, a calibration standard with the same vial size must be used). Whichever volume of fluid is chosen should be consistent for all vials being tested.
2. Moisten one filter paper or Q-tip with water and place into one of the vials. This serves as the control.
3. Mark on the floor plan the locations that are to be tested. Number the locations (locations may include door knobs, fridge handles, taps, pipettor handles, etc...).
4. With a moistened filter paper, wipe a representative area of approximately 100 cm2 in each of the designated locations. Use one wipe per location and make sure the wipe is identified.
5. Insert the paper into the vial. Label the vial (mark on the lid of the vial).
6. Gently shake the bottle so that the filter paper is completely immersed into the solution. Keep samples in the dark and wait for two hours before reading the samples with the liquid scintillation counter.
7. Set the channel of the counter within the energy range capable to detect the radioisotope of interest.
8. If there is a significant radioactivity (3 times background) on any of the wipes, clean the area with dilute detergent or DECON 75 (take care not to spread the contamination over a large area), and repeat the wipe test until contamination is non-detectable.
9. Check against contamination Criteria.
10. Keep records of results.

York University Contamination Criteria (all radionuclides):

5 Bq/cm2 for active areas (except for alpha emitter)
0.3 Bq/cm2 for other areas
And As Low As Reasonably Achievable (ALARA)

Conversion from counts per minute (cpm) to Bq/cm2 on wipe test results

Detection Efficiencies for Radionuclides using Tri-Carb 1600 TR scintillation counter in Farq.Rm.133 (note: for other scintillation counter, refer to counter's operational manual to determine counting efficiency).

Nuclide	Counting Efficiency	Conversion Factor
H-3	60%	0.00278
I-125	78%	0.0021
C-14, S-35, P-33	95%	0.00175
P-32	98%	0.00170
Unknown or for more than one isotope	55%	0.00303

Method:

1. After subtracting the blank, multiply the net count rate (cpm) by the conversion factor for the nuclide of interest to convert to Bq/cm2
2. Compare net count (Bq/cm2) to contamination criteria for compliance.

(If the source of contamination is not known or more than one isotope is being used, assume an efficiency of 55%)

Appendix XII Sample Log For Radioisotopes Use

Location	Source	Shipment
Building and Room #: Supervisor:	Isotope: Chemical Form: Activity: Activity reference date: Volume:	Date Received: Supplier: Catalog #: Vial ID:

Date (dd/mm/yy)	User	Procedure	Volume used	Volume remaining in stock	Activity used (uCi)	Activity remaining in stock (µCi)	Amount in waste (µCi)	Waste form (see below)	Date of transfer to disposal room

Waste form	Disposal Date of Stock Vial
L = Aqueous liquid (pour into celite or gel bottle) LSV = Aqueous liquid in scintillation vials O = Organic solvent S = Solid G = Glass/Sharps For Biohazard/infectious or animal carcass, contact the Radiation Safety Officer at ext.55491	

XIII Teaching Laboratories Using Radioisotopes Notification Form

(To be completed by the Course Director)

Please send a copy of the completed form together with the laboratory procedure to: Radiation Safety Officer, Health Safety and Employee Well-Being, Kinsmen Building, prior to the start of the laboratory session.

Course Name and No. ____

Name of Course Director and Permit Holder: __________________________

Name of Laboratory Instructor: ____________________________________

Name of Teaching Assistants: ____________________________________

Types of radioisotope: ____

Amount (Curie/Becqueral) of Radioisotope to be used: ___________________

Chemical Form: ____

Lab Location: ____

Building   Room No.

Location (floor plan to be included) inside the laboratory where radioisotope will be used (for decontamination purpose):

____

Dates when radioisotopes will be used: ___________________________

____

Number of students that will be present in this laboratory:

No. of Students: ____

No. of Groups: ____

XIV Teaching Laboratories Using Radioisotopes For Laboratory Instructor *Checklist*

(This is a guide for the laboratory instructor. Items on the list should be discussed with the course director before the start of the lab, and the completed form should be returned to the RSO within HSEWB at Kinsmen Building).

		NO	YES
1.	Notification form sent to the Radiation Safety Officer.	☐	☐
2.	Radiation warning sign and radioisotope permit posted.	☐	☐
3.	Provide safety information to users on the type of radioisotope that will be handled.	☐	☐
4.	Radiation Safety video* to be shown to students prior to start of the lab.	☐	☐
5.	Monitoring equipment, e.g. Geiger counter, obtained.	☐	☐
6.	Active area labeled with warning tape.	☐	☐
7.	Specific radioactive waste container clearly labeled with warning tape.	☐	☐
8.	Shielding materials (for P-32), including plexiglass shield, Safety goggles, obtained.	☐	☐

*Video: "The Key to Contamination Control", University of Calgary or other suitable video

XV Revoking and Reinstatement of Permits

This procedure allows for the enforcement of the requirements of the Canadian Nuclear Safety Commission and the York University Radiation Safety Program.
The Radiation Safety Officer (RSO) or any member of the Radiation Safety Committee (RSC) lab inspection team has the authority to initiate the procedure for revoking a permit when there is an actual or perceived threat to health, safety or security involving radioactive materials.

Procedure for revoking and reinstatement of permits:

1. On the occurrence*, the permit holder will be notified in writing (in a memo) by the RSO or RSC of the infractions or violations of that were noted. The permit holder will be informed that a follow-up visit will be conducted by the RSO or RSC lab inspection team to review compliance and the consequence should a re-occurrence happen within one year.

2. On the second occurrence (within one year), the RSO or RSC will send a letter to the permit holder, with a copy to the Department Chair and the Dean, outlining the infractions, the responsibilities of the permit holder in that respect and the consequences of further infractions. The permit holder will be informed that a follow-up visit will be conducted by the RSO or RSC lab inspection team to review compliance.

3. On the third occurrence (within one year), the permit will be revoked. All radioisotopes will be removed from the lab. All purchase requisitions denied.

*occurrence may include minor infractions which have been noted numerous times in regular inspections

Notes:
1. For step 3, at least two members of the RSC shall approve the action.
2. Any violations greater than one year old will not be considered in further actions.
3. The RSO or RSC lab inspection team reserves the right to bypass any one or more of the above noted steps if a serious, immediate risk to health, safety or security violation occurs.

Reinstatement of Permit:

In order for a revoked radioisotope permit to be reinstated, the permit holder must convince the RSO and at least two members of the RSC (including the Committee Chair) that all required remedial actions have been taken.