UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title:	**Contact Numbers**		
Number:	Not Applicable		Page 1 of 2
Issued by:	Environmental Health and Safety	Date issued:	June 23, 2017
Approved by:	Radiation Protection Committee	Date Approved:	June 29, 2017

University Emergency Phone Numbers

24 Hour Fire, Medical **911**

24 Hour Radiation Safety Officer → Contact University of Manitoba Security Services (includes access to a radiation survey meter or a contamination meter)

From University phones, dial direct.....555

Cell Phones (MTS, Roger Wireless) .....#555

From all other phones ..... 204 474-9341 or 911

Environmental Health and Safety

Website: http://umanitoba.ca/admin/vp_admin/risk_management/ehso/

Bannatyne Office, P310 Pathology Building

Radiation Safety Officer..... 204 789-3613

Cellular 204 298-3769

Radiation Safety Specialist..... 204 789-3654

Cellular 204 451-0994

Laboratory Safety Technologist..... 204 789-3359

Email .....radsafe@umanitoba.ca

Fax..... 204 789-3906

Fort Garry Office, 191 Extended Education Complex

General Office..... 204 474-6633

Fax..... 204 474-7629

UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title: **Table of Contents**

Number: Not Applicable

Issued by:	Environmental Health and Safety	Date issued:	June 23, 2017
Approved by:	Radiation Safety Committee	Date last updated:	December 4, 2017

UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title:	**Emergency Procedure for Areas where Radioactive Materials are Used or Stored**		
Number:	RSP-1		Page 1 of 4
Issued by:	Environmental Health and Safety	Date issued:	June 23, 2017
Approved by:	Radiation Protection Committee	Date Approved:	June 29, 2017

Emergency Phone Number for Fire, Police, Ambulance, Hazardous Materials Call 911

24 Hour access to Radiation Safety Officer and or a contamination meter: **Access to a radiation dose survey meter Contact University of Manitoba Security**

From University phones, dial direct.....555
Cell Phones (MTS, Roger Wireless) .....#555
From other phones 204 474-9341

Quick Steps

If there is fire, smoke or other signs of danger

Remove yourself and others from immediate danger.

Exit the building via nearest Emergency Exit.

Activate the nearest manual pull station as you exit the building, if alarm has not been automatically activated.

Close doors behind you (do not lock) as you leave areas. When you have reached the outside, move away from the building.

Telephone 4-911 or 555 from a landline or 911 or #555 from a cellphone to report the fire location once you are outside the building; do not assume that this has been done.

If there is an alarm (and no other signs of danger)

Stop work.

If possible, securely close containers of radioactive material and return radioactive material to shielding.

Remove gloves.

Remove lab coat.

R.E.A.C.T. (Evacuate).

If there is a medical emergency – call 911. At the University of Manitoba, *First Aid takes precedence over radioactive contamination control.*

1. Policy

The University of Manitoba shall have procedures in place to respond effectively to an emergency that occurs in an area where radioactive materials are used or stored in order to ensure:

- Exposures to radioactive materials to staff members and the public are As Low As Reasonably Achievable (ALARA), taking into consideration economic and social factors, and
- The highest standard of radiological safety and security of radioactive material is maintained under the emergency conditions as appropriate.

2. Procedures

2.1 Fire or Explosion

In the event fire or explosion occurs in an area where radioactive materials are used or stored, the building occupants will follow the local building fire plan.

2.1.1 Fire Plans

Buildings that are permitted to use or store radioactive material at levels above the Basic Level (for Open Source Permits) or have Sealed Sources with potential radiation field greater than 25 microsieverts per hour will be identified in the local building fire plan along with site-specific radiation considerations related to emergency situations.

2.1.2 Radiation Hazards

Keep in mind the potential hazards associated with fire or explosion and the direct impact on locations where radioactive material are used or stored. These hazards are:

- Radioactive material may be released from its containers and give rise to a radioactive contamination in the area local to the incident.
- Such contamination could spread to other parts of the facility if uncontrolled access is permitted to these areas prior to assessment of the radiological hazard.

2.1.3 Responsibilities of the Radiation Safety Officer

In the event of a fire or explosion in areas where radioactive materials are used or stored, when radioactive contamination or exposure to ionizing radiation is suspected, the Radiation Safety Officer has the responsibility to:

- Assess or arrange for the assessment of worker exposure to ionizing radiation.
- Revise or remove restrictions on access to the area in terms of radiological hazard.
- Supervise the monitoring of areas for radioactive contamination and the decontamination process.
- Report incidents as required by regulations.

2.2 Serious Personal Injury

In the event of a serious personal injury requiring emergency medical attention, immediately call 911.

1. Request Emergency Medical Service and state the nature of the injury as well as that the injured people might be contaminated with radioactive material.

- Provide the patients name and the type of injury or medical condition.
- Provide the exact location.
- If known, collect information on the radioactive material, total activity involved, the nature of the radioactive material (solid, liquid, gas and chemical form), and the extent of the contamination to provide to emergency responders when they arrive.

2. Trained First Aiders should respond to anyone that is critically injured. At the University of Manitoba, First Aid takes precedence over radioactive contamination control. Care should be taken to protect the First Aider from potential hazardous exposure to chemical, biological or radioactive materials. When possible, care should be taken to not spread chemical, biological or radioactive contamination.

3. Contact the Radiation Safety Officer to report the situation as soon as possible. Radiation Safety Officer has the responsibility to:
   - Assess or arrange for the assessment of worker exposure to ionizing radiation.
   - Revise or remove restrictions on access to the area in terms of radiological hazard.
   - Supervise the monitoring of areas for radioactive contamination and the decontamination process.
   - Report incidents as required by regulations.

UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title:	**Radiation Safety Program Administrative Structure and Permit Process**		
Number:	RSP-2		Page 1 of 12
Issued by:	Environmental Health and Safety	Date issued:	June 23, 2017
Approved by:	Radiation Protection Committee	Date approved:	June 29, 2017

1. Background

Ionizing radiation refers to electromagnetic waves or particles that have a size and energy capable of interacting with atoms causing the atoms to become charged (ions). Although people are exposed to ionizing radiation from natural and from medical procedures throughout their lives, there is a potential for harm if sources of ionizing radiation are used improperly. At high exposures, health effects could be immediate (cataracts, radiation burns and radiation sickness). Fortunately, at the University of Manitoba the use of sources of ionizing radiation are systematically controlled making the possibility of high exposure very unlikely.

In 1977, the University created a committee to oversee the implementation and maintenance of a radiation safety program and over the decades the mandate has focused on the use of radioactive materials, Radiation Devices and X-ray equipment used in research projects or for academic purposes. The Radiation Protection Committee, as it is now known, oversees the current radiation safety program specific to the use of ionizing radiation in locations that the University controls (either the University owns the building or an agreement is in place for the University to administer the radiation safety program in the considered space).

At the University, a worker may be exposed to ionizing radiation from radioactive material or Radiation Devices or from X-ray Equipment. An internal permit system was developed to ensure the hazards are appropriately identified and mitigated by engineering controls or work practices. The internal permit system is managed by the University Radiation Safety Officer. The Radiation Safety Officer and alternate are available full time to provide technical expertise, systematic assessment, training and inspections.

The University authorizes the Radiation Protection Committee and the X-ray Sub-Committee in the governing documents called Radiation Safety Policy and Radiation Safety Procedure. The University Radiation Safety Policy and Procedure are included at the end of this manual as Appendix A and Appendix B, respectively. Details on the form and functions of the Radiation Protection Committee, X-ray Sub-Committee and Radiation Safety Officer are documented in the Terms of Reference (Appendix C at the end of this manual).

The Radiation Protection Committee is authorized to approve Radiation Standard Procedures (RSPs) that are documented in the University Radiation Safety Manual.

1.1 Authorization to Use Radioactive Material

The use of radioactive material is controlled federally by the Canadian Nuclear Safety Commission (CNSC). The University holds a licence issued by the CNSC to use radioactive materials for

research and educational purposes. The radioactive materials used at the University fall under two categories: 'Open Source' and 'Sealed Source".

'Open Source' radioactive material is used in the form of radioactive chemicals (radiotracers), radioactive rocks (ore) or irradiated materials. Since Open Source materials can be spread about, work with Open Sources must be done very carefully to avoid contamination. Radioactive contamination can make its way into the human body and increase the potential harm. Procedures specific to Internal Radioisotope Permits for Open Sources are outlined in RSP-3 of this manual.

'Sealed Source' radioactive material may be encapsulated into sealed sources limiting the potential for contamination while allowing the source to be used for its radioactive properties. Such sources are licensed as Sealed Source radioactive material. When a Sealed Source is incorporated into equipment in a manner that allows the use of the ionizing radiation, the equipment is called a Radiation Device. Procedures specific to Internal Radioisotope Permits for Sealed Sources and Radiation Devices are outlined in RSP-4 of this manual.

1.2 Authorization to Use X-ray Equipment

Unlike radioactive material or Radiation Devices, X-ray equipment is energized by electricity to create X-rays. When unplugged or 'turned off', X-ray equipment is not a source for ionizing radiation. X-ray equipment is regulated provincially under the Manitoba Health Act. The specific regulation is titled the Manitoba X-ray Safety Regulation. The X-ray Safety Regulation authorizes health care professionals (Medical Doctors, Dentists, Veterinarians and Certified X-ray Technologists) to operate X-ray equipment in Manitoba for purposes of providing health care or while training health care professionals. However, the regulation does not allow researchers to use X-ray Equipment unless authorized by the Minister of Health. Since 2011, the University has ministerial authorization to issue Internal Permits to researchers. Procedures specific to Internal X-ray Permits are outlined in RSP-5 of this manual.

1.3 Controlling Radiation Exposure

Following the procedures in this manual will keep exposure to staff and students as low as reasonably achievable (ALARA) taking into consideration economic and social factors. Specific information on monitoring worker exposure to ionizing radiation, economic and social factors taken into account, are described in RSP-6 at the end of this manual.

2. Purpose

RSP-2 outlines the common procedures related to obtaining, amending and maintaining an Internal Permit to use radioactive materials, Radiation Devices and X-ray equipment in areas controlled by the University. This RSP also covers responsibilities for each type of worker authorized by Internal Permits and the training and oversight needed for ancillary workers or lab staff that work in the vicinity of sources of ionizing radiation.

3. Definitions

Action Level is defined as a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee's radiation protection program and triggers a requirement for specific action to be taken.

Clinical X-ray equipment, for the purposes of this manual, shall refer to X-ray equipment that is used on human subjects to provide medical or dental care. The safe use of dental X-ray equipment is additionally guided by the Health Canada "Recommended Safety procedures for the Use of Dental X-ray Equipment- Safety Code 30".

CNSC means the Canadian Nuclear Safety Commission

Decommissioning is the process of releasing equipment or a room from the conditions on the Internal Permit. Decommissioning requires documentation to record that all radioactive material has been removed and no radioactive contamination is present in excess of legal limits or that the permitted X-ray Device is removed or locked out of service. See Section 5.3 of this RSP for more detail. The current forms for decommissioning permits or equipment will be on the Environmental Health and Safety website.

EHS means Environmental Health and Safety

Laboratory Hazard Clearance is the University process to communicate the mitigation of lab hazards to non-designated workers that will be working in a radioisotope permitted room.

Major Radiological Incident is a spill or unplanned release involving more than 10 megabecquerel (10 MBq), (270 microcurie) or 100 Exemption Quantities (EQs) whichever is more restrictive. See Appendix D – third column for a list of 100 EQs at the end of this manual.

Radiation Device, for the purpose of this manual shall refer to a device that contains more than the exemption quantity of a nuclear substance and that enables the nuclear substance to be used for its radiation properties.

Radiation Safety Officer (RSO) means the University employee Environmental Health and Safety designated as the Radiation Safety Officer pursuant from the Radiation Safety Policy.

Radioactive material, for the purposes of this manual, the term "radioactive material" shall be limited to materials used for their radioactive properties in the course of research or teaching. Further, "radioactive material" means an unstable isotope of an element that decays, or disintegrates spontaneously, emitting radiation of sufficient energy to create charged particles by adding or removing an electron or breaking chemical bonds.

Radioisotope means radioactive material as defined above. Historically, the Internal Permits issued to control the use of radioactive material and radiation devices are called 'Internal Radioisotope Permits'.

Research X-ray equipment, for the purposes of this manual, shall refer to X-ray equipment that may include:

- Any X-ray equipment that is not used on humans subjects or
- Any X-ray equipment when it is used to irradiate humans under a research study protocol.

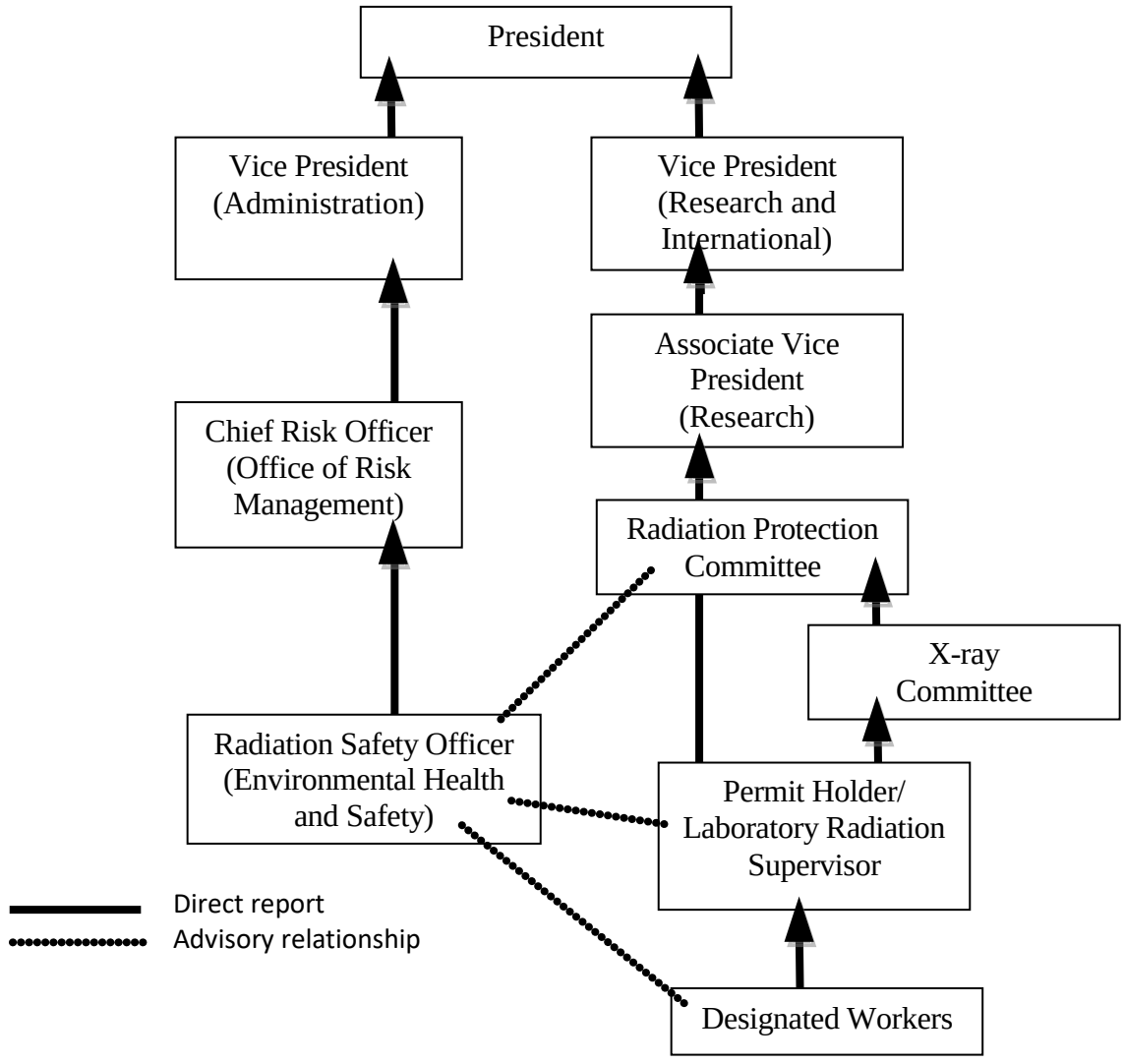
RSP means Radiation Standard Procedures that are approved by the University Radiation Protection Committee and documented in the University of Manitoba Radiation Safety Manual.

X-ray means artificially produced electromagnetic radiation of wave-length shorter than 0.000 000 25 mm (0.25 nanometers).

X-ray equipment or X-ray machine means an operable device, the principle purpose and function of which is the production of X-rays, together with such ancillary apparatus as may be necessary for this purpose. For locations in the province of Manitoba, X-ray equipment is governed by the Manitoba Provincial Regulations.

4. Administrative Structure

The University Radiation Safety Policy and Procedure are included at the end of this manual as Appendix A and Appendix B. Details on the functions of Radiation Protection Committee, X-ray Sub-Committee and Radiation Safety Officer are documented in the Radiation Protection Committee and Terms of Reference (Appendix C at the end of this manual). Below is a organization chart. All roles are with the University of Manitoba.



4.1 Radiation Protection Committee

The University has a Radiation Protection Committee comprising members of the University community and stakeholders knowledgeable in the safe use of radioactive material, radiation devices and X-ray equipment. This Committee oversees the use of sources of ionizing radiation in areas controlled by the University of Manitoba.

4.1.1 X-ray Committee

The University has an X-ray Committee which is a subcommittee to the Radiation Protection Committee comprising of members of the University community and stakeholders knowledgeable in the safe use of X-ray equipment. This Committee oversees the use of X-ray Equipment including an Internal X-ray Permit system to control the research use of X-ray equipment in areas controlled by the University of Manitoba.

4.2. Radiation Safety Officer

The University Environmental Health and Safety is responsible for the provision of the function of the Radiation Safety Officer. The Radiation Safety Officer administers the Radiation Safety Program, acting in consultation with the Radiation Protection and X-ray Committees. At least one individual shall be available to fulfill these duties on a full time basis. The duties of the Radiation Safety Officer are to provide advice, guidance, and technical support; ensure Permit Holders and Designated Workers are aware of their responsibilities to comply with the Radiation Safety Policy and Procedures and conduct routine compliance inspections of all laboratories and storage areas listed on Internal Permits at least annually. Verify radiation dose rates for all areas storing Open Source radioactive material at least annually.

Radiation Safety Officer has the responsibility to:

- Assess or arrange for the assessment of worker exposure to ionizing radiation.
- Revise or remove restrictions on access to the area in terms of radiological hazard.
- Report incidents as required by regulations.

5. Internal Permits

Internal Permits are issued to clearly designate responsibilities pertaining to the use of radioactive material, radiation devices and the research use of X-ray Equipment.

5.1 Permit Parameters

The Radiation Protection Committee issues Internal Radioisotope Permits to control all procurement, use, storage, transfer and disposal of all radioactive materials and radiation devices. The X-Ray Committee issues Internal X-ray Permits to control the procurement, use, storage, transfer and disposal of all X-ray equipment used for research purposes in all areas under the control of the University.

The Internal Permit will specify:

- The Permit Holder
- Designated Workers
- Laboratory Radiation Supervisor (LRS), if an Laboratory Radiation Supervisor is not named, the Permit Holder will be specified as the Laboratory Radiation Supervisor
- Permitted radioactive material and possession limits; radiation devices or X-ray equipment
- Approved locations

- Approved usage
- An approved disposal procedure
- Other conditions of use as appropriate

To use radioactive materials, radiation devices and Research X-ray equipment one must be:
- A Designated Worker
- In the case of X-ray equipment that is enclosed and interlocked by the manufacturer and has passed an X-ray leakage test, a person acting under the supervision of a Designated Worker listed on the related Internal Permit

5.1.1 Permit is Conditional

The Permit is conditional on the strict adherence to all terms, conditions and parameters listed on the Permit. Compliance with the conditions of the Permit will be enforced by the Radiation Protection Committee and the Radiation Safety Officer (details related to the enforcement procedure are in Appendix B at the end of this manual).

5.1.2 Non-Compliance

Once identified, issues of non-compliance must be resolved as soon as practicable.
- Any issues not resolved within a maximum of 15 working days will be considered a second (or subsequent) occurrence.
- If in the opinion of the Radiation Safety Officer, the non-compliance is a safety risk, a shorter deadline maybe communicated to the Permit Holder and if the deadline is passed, the situation would also be considered a second (or subsequent) offence.
- At the sole discretion of the Radiation Safety Officer, the deadline may be extended if there are extenuating circumstances that affect the resolution of the non-compliance.

5.2 Approval of Permit Applications and Amendments

Processing an application for a Permit involves many considerations. Issues related to security, room design and doses within or adjacent need to considered. It may take up to four weeks for the Radiation Safety Officer to assess an amendment or application. If CNSC approval of a licence amendment, design approval form, or a project approval is required, processing the Permit (or amendment) may take longer.
- Permit applications must be completed by the Permit Holder/ Responsible User and submitted to University Environmental Health and Safety.
- The Radiation Safety Officer shall assess the application and forward it to the Chair of the appropriate Committee for approval.

5.2.1 Exposure Control

Where practicable, radioactive material or radiation devices are to be stored and used in a way that ensures that any person will not be exposed to a radiation field in excess of 25 microsieverts per hour at a distance greater than 0.3 meter from any object or shield. X-ray Equipment will be used in such a way to ensure workers are not exposed to a radiation field in excess of 25 microsieverts per hour.

When a laboratory has a radiation field that a person may be exposed to that is in excess of 25 microsieverts per hour at a distance beyond 0.3 meter from any object or shield, access controls shall be implemented as described in Section 7.1 of this RSP.

5.2.2 Security Requirements

Radioactive material, radiation devices and X-ray equipment listed on an Internal Permit must be maintained secure from theft and unauthorized use.

5.2.3 Project Approvals

Projects involving more than 10 000 exemption quantities (EQs) shall be pre-approved by the CNSC. See Appendix D – second column lists single Exemption Quantities at the end of this manual.

5.2.4 Not for use on Humans

Permits will not authorize the use of radioactive materials or radiation devices, containing radioactive material, on humans.

5.2.5 Renewal

Each Internal Permit will have an expiry date. The Radiation Safety Officer will initiate procedures for permit renewal approximately one month prior to this date, by sending permit applications to the Permit Holders. The application is to be completed and returned to the Radiation Safety Officer by the date specified to allow for assessment and processing.

5.2.6 Cancellation

If the Permit Holder cancels the Internal Permit, allows the Permit to expire without renewal or leaves the University, all records required by the conditions of the Permit and the Radiation Safety Records binder must be returned to Environmental Health and Safety with a completed Radioisotope Permit Decommissioning form. See Section 5.3 Decommissioning below.

Whenever possible, the Radiation Safety Officer must be informed about the intention of cancellation of an Internal Permit in writing at least two weeks in advance.

5.2.7 Inventories of Radiation Detection Equipment

Environmental Health & Safety maintains an inventory of all scintillation counters, gamma counters, contamination meters and survey meters.

- Inform Environmental Health and Safety of all radiation detection equipment in your department whether they are in use or not. Environmental Health and Safety should be informed of newly acquired equipment as well as equipment that will leave the department. Environmental Health and Safety can assist you in making the proper arrangements for discard or transport.
- Certain liquid scintillation counters may contain radioactive Sealed Sources greater than one exemption quantity and may require the owner having an Internal Radioisotope Permit.
- Rooms where liquid scintillation counters are in use shall be monitored for contamination at least annually and therefore listed on at least one Open Source Internal Radioisotope Permit.

5.3 Decommissioning

Decommissioning is the process of releasing equipment or a room from the conditions detailed on the Internal Permit. Decommissioning requires documentation to record that all radioactive material has been removed and where open source work with radioactive material had been permitted, no radioactive contamination is present in excess of legal limits (listed under ‘other conditions of use on the related Internal Permit) or that the permitted X-ray Device is removed or locked out of service. For brief service work like unclogging a drain in a lab, the Laboratory Hazard Clearance (a form outlining the process is on the University Environmental Health and

Safety Office web page) would usually suffice. Removing a room from a Permit or terminating a Permit would require documentation of the actions taken on a Radioisotope Permit Decommissioning Form or X-ray Permit Decommissioning Form (found on the Environmental Health and Safety Radiation Safety website).

5.3.1 Laboratory Hazard Clearance

Laboratory Hazard Clearance is the University process to communicate the mitigation of laboratory hazards to non-permitted workers that will be entering or working in a lab. The Laboratory Hazard Clearance process for a room listed on an Internal Radioisotope Permit has the following requirements:

- Radioactive material (Sealed and Open Source) must be secured from the non-Designated Workers.
- The non-Designated Workers must not be exposed to a radiation field above background. This may require relocating waste or radioactive material. The Radiation Safety Officer can offer advice and assistance in determining what actions are required.
- For rooms permitted for Open Source use, confirm and document is no radioactive contamination above the Decontamination Level of the area or equipment where the non-Designated Worker will be working. See RSP-3, section 10.6 for more information on Decontamination Levels.
- Non-Designated Workers are not allowed to touch any surface or equipment labeled with the radiation warning symbol or striped tape.
- Forms are available on the Environmental Health and Safety website to document the process of Laboratory Hazard Clearance.

5.3.2 Removing a Location from Permit

- Use the Radioisotope Permit Decommissioning form or the X-ray Permit Decommissioning Form (found on the Environmental Health and Safety Radiation Safety website) and follow the steps on the form.
- DO NOT remove the Permit and all other required postings posted (they will be removed by Environmental Health and Safety staff only).

For Open Source Permits:

- Remove all radioactive stock vials, working solutions, samples and specimens recording actions on corresponding radioisotope inventory forms.
- Remove all waste generated by use of radioactive materials.
- Monitor all areas and equipment within the room where radioactive materials have been used or stored. Remove all contamination above the Decontamination Action Level (see RSP-3, Section 10.6 for details of the Decontamination Level).
- Deface or remove all Radioactive Warning Symbols and striped tape from all areas and equipment that are ensured to be below the Decontamination Action Level.

For Sealed Sources or Radiation Devices Permits:

- Make arrangements with Environmental Health and Safety to transfer or dispose of all Sealed Sources or Radiation Devices.
- Deface or remove all Radioactive Warning Symbols.

5.4 Mandatory Decommissioning for Radioactive Materials

Since a permitted space is controlled and requires effort (from the Permit Holder, Designated Worker and Environmental Health and Safety staff) to meet the conditions of the Permit, only locations in use or soon to be in use should be permitted. Mandatory decommissioning is intended to keep the list of 'approved' locations controlled by Internal Radioisotope Permits up-to-date.

5.4.1 Inactive Permitted Locations

When a radiation safety inspection identifies no documented use of radioactive material (no usage records or monitoring) in a location during the previous twelve months:

1. The Radiation Safety Officer (RSO) shall notify the Permit Holder(s) of this situation and give the Permit Holder a 6-month notice of mandatory decommissioning.
2. At the end of this time, if no use has occurred in the previous 18 months, one of the following mandatory steps shall be implemented:
   - There is no radioactive material being stored, then the permit shall be terminated. The Permit Holder shall be responsible for decommissioning as described above (Section 5.3).
   - If radioactive material is being stored, it is highly recommended to dispose of radioactive material that the permit holder has no plan to use by transferring to Environmental Health and Safety, and only materials believe to be useful should be kept. Then,
     - The permit will be amended to 'storage only', and
     - The working areas in the storage location(s) and all other Locations Approved for Use listed on the permit will be decommissioned.
     - The period that a permit may be 'storage only' will not exceed 4 times the half-life of the longest-lived radioisotope being stored.
3. If during the 6-month period of notice given in step 1, there has been documented use of radioactive material, or there are firm plans to recommence use of radioactive materials, the Permit Holder shall inform the Radiation Safety Officer in writing (email) and the Radiation Safety Officer may cancel room decommissioning.

It is the sole decision of the Radiation Safety Officer if mandatory decommissioning will proceed or will be cancelled.

6. Permit Roles and Related Responsibilities

6.1 Permit Holder/Responsible User

The Permit Holder is responsible to:

1. Be aware of and comply with all conditions on the Internal Permit and safety rules and the applicable procedures as identified in the Radiation Safety Manual.
2. Ensure the following duties are addressed:
   a. Required postings and labels are clearly visible.
   b. The Laboratory Radiation Supervisor, identified on the Internal Permit, has maintained the Radiation Safety Manual up to date and it is available to all Designated Workers.
   c. All changes to information found on the Internal Permit are promptly reported to the Radiation Safety Officer.
   d. Records of inventory including shipping, purchase, use and disposal, and records of required monitoring, testing or servicing related to radioactive material, radiation devices and X-ray equipment are maintained readily available for inspection for a period of 8 years.

3. Ensure the potential hazard of all new procedures involving radioactive material, Radiation Devices or X-ray equipment are evaluated.
   a. Develop site-specific procedures to mitigate the hazards.
   b. Ensure Designated Workers are trained to follow site-specific work procedures.
4. Supervise all Designated Workers and visitors to ensure the safe conduct of work performed in approved locations.
5. Regularly assess their permitted areas for compliance and ensure resources are available to meet with the requirements as specified in the Radiation Safety Manual.
6. Ensure that any incidents that occur in their area are promptly reported to Environmental Health and Safety, including reporting to the Radiation Safety Officer, any incident in which they believe there may be:
   a. A significant increase in the risk to the environment or the health and safety of persons;
   b. A threat to the maintenance of security or an incident with respect to security;
   c. A failure to comply with the conditions of the Internal Permit;
   d. An act of sabotage, theft, loss or illegal use of possession of radioactive materials or X-ray equipment;
   e. A release to the environment above the quantities of radioactive material authorized by the Internal Permit; or
   f. A known or suspected radiation exposure or contamination that may exceed established limits.
7. Must identify a Laboratory Radiation Supervisor (LRS) to act as an alternate. If a Laboratory Radiation Supervisor is not identified, the Permit Holder will be identified as Laboratory Radiation Supervisor.

6.2 Laboratory Radiation Supervisor

The Laboratory Radiation Supervisor must be a Designated Worker. Designated Workers are personnel listed on the Internal Permit as approved to work with radioactive material, Radiation Devices or X-ray equipment. The Laboratory Radiation Supervisor shall:

1. Assist the Permit Holder to carry out duties as specified above.
2. Ensure the Radiation Safety Manual is up to date and available to all Designated Workers.
3. Keep records that Designated Workers have been informed of changes to the Radiation Safety Manual.

6.3 Designated Worker

Every Designated Worker shall:

1. Observe and obey all conditions on the Internal Permit, applicable in the Radiation Safety Manual and other site-specific safe work procedures.
2. Take all reasonable precautions to ensure their own safety, and the safety of other persons, the protection of the environment, and the maintenance of security. Perform work in a manner that will minimize radiation exposure (ALARA), including:
   a. Participate and follow direction as provided in radiation safety training.
   b. Use equipment, devices, facilities and clothing for protecting the environment or the health and safety of persons, or for determining doses of radiation, dose rates or concentrations of radioactive materials in a responsible and reasonable manner and in accordance with the University procedures.
   c. Provide feedback to their supervisor if a procedure is inappropriate, impractical or unsafe.
   d. Not initiate or participate in any activity that may endanger the health and safety of anyone.
3. Report to the Radiation Safety Officer any incident in which they believe there may be:

a. A significant increase in the risk to the environment or the health and safety of persons.
b. A threat to the maintenance of security or an incident with respect to security.
c. A failure to comply with the conditions of the Internal Permit.
d. An act of sabotage, theft, loss or illegal use of possession of radioactive materials or X-ray equipment.
e. A release to the environment above the quantities of radioactive material authorized by the Internal Permit.
f. A known or suspected radiation exposure or contamination that may exceed established limits.

7. Ancillary Workers and Non-Permitted Laboratory Personnel

At the University there are personnel that work in the vicinity of permitted work that are not permitted to work with radioactive materials. To support the workers and their supervisors to have the information needed to work safely, permitted areas are identified at the entrance, radiation awareness training is provided and some areas have restricted access controls in place.

7.1 Laboratory Signage

All locations listed on an Internal Permit are marked at the entrance to clearly identify the Permit Holder and an alternate Designated Worker.

Areas where a person may be exposed to a radiation fields greater than 25 microsieverts per hour at a distance greater than 0.3 meter from any object or shield must:

- have a 24 hour emergency entrance safe work procedure approved by the Radiation Safety Officer that is filed with Security Services and Physical Plant, and
- be signed at the entrance " Restricted Entrance – must be accompanied by Lab Personnel".

7.2 Safe Work Procedures

Manitoba Workplace Safety and Health regulations require supervisors to ensure their workers have a safe work procedures describing their regular duties to identify the risks and how to work safely. At the University, anyone that supervises workers that may work in areas where radioactive material use is permitted shall ensure the workers are trained in Radiation Safety Awareness.

7.3 Radiation Awareness Training

Environmental Health and Safety provides training materials outlining how to:

- Identify the radiation warning symbol and striped tape used at the University.
- Contact the appropriate Permit Holder or permitted alternate to do a risk assessment and minimize the possibility of radiation exposure for non-regular tasks. (See Lab Hazard Clearance).
- Minimize radiation exposure with shielding, limiting time and increasing distance as well as the need to control contamination (ALARA) and maintain security.
- Be safe by prohibiting contact with anything or any area marked with the radiation warning symbol or striped tape and by limiting the time they spend closer than 1 meter from items marked with the radiation warning symbols or striped tape.

- Contact the Radiation Safety Office (including after hours) in case of inadvertently touching or coming in contact with items labelled with the radiation warning symbol or striped tape.

7.4 Laboratory Training Standard

All new lab personnel (including students) are required by the University of Manitoba Laboratory Training Standard to complete training in Basic Lab Safety that includes Radiation Awareness Training (described in 7.3 above).

7.5 Ancillary Workers

At the University, supervisors of ancillary functions that allow staff access to permitted areas for caretaking, or other support roles, must provide safe work procedures that include rules to keep the workers safe in the permitted space. Ancillary staff services with access to permitted space may be Physical Plant, Information Technology, Security Services and Administrative Support Staff. The Supervisors of ancillary staff that are expected to work in permitted areas must ensure staff have received Radiation Awareness Training (described in Section 7.3 above).

UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title:	**Radiation Standard Procedures – Open Source**		
Number:	RSP-3		Page 1 of 30
Issued by:	Environmental Health and Safety	Date issued:	June 23, 2017
Approved by:	Radiation Protection Committee	Date approved:	June 29, 2017

1. Introduction

Open Sources are radioactive materials such as a radioactive liquid, powder or gas that can be absorbed, ingested or inhaled into the body, presenting both an internal and an external radiation hazard.

At the University Open Sources are typically low activity radiotracers or material used for research imaging of animals. RSP-3 outlines the minimum procedures required to ensure the safe use of Open Source radioactive material in order to minimize the radiation exposure of all staff, students, the public and the environment as well as comply with all applicable regulations.

RSP-3 covers hazard identification, records keeping, how to obtain Open Sources, opening shipments, rules, *in vivo* use, contamination monitoring, spill clean-up procedure, waste and training.

2. Definitions

ALI "Annual Limit of Intake"

CNSC means the Canadian Nuclear Safety Commission.

Contamination refers to radioactive contamination and is the presence of radioactive materials in any place where it is not desired, in particular where its presence may be harmful. Contamination may present a risk to a person's health or the environment. Contamination has also been determined to be the cause of failed experiments. Control of contamination is one of the key concerns whenever radioactive materials are used.

Contamination Meter, for the purposes of this RSP, refers to a portable instrument used for measuring ionizing radiation for the purpose of detecting contamination and explicitly excludes a 'radiation survey meter' as defined by the Canadian Nuclear Substance and Radiation Devices Regulations as an "instrument that is capable of measuring radiation dose rates".

CNSC Surface Contamination Limit are levels of removable beta, gamma and alpha radioactive contamination found on normally accessible working surfaces in radioisotope laboratory. Limits shall vary with the isotope. The regulatory limits are listed in the ninth column of Appendix D at the end of this manual. The contamination level may be averaged over an

area not exceeding 100 square centimeters. The maximum permissible levels of removable alpha should be one tenth those specified for beta and gamma emitting isotopes.

Decommissioning is the process of releasing equipment or a room from the conditions on the Internal Permit. Decommissioning requires documentation to record that all radioactive material has been removed and no radioactive contamination is present in excess of legal limits or that the permitted X-ray equipment is removed or locked out of service. See RSP-2, Section 5.3. The current forms for decommissioning Permits or equipment will be on the EHS website.

Decontamination Level, at the University of Manitoba, the Decontamination Level for removable radioactive contamination for most radioactive materials in use is 0.5 becquerel per square centimeter. Different Levels for certain radioisotopes may be required (or allowed) and will be listed in the conditions of the Internal Radioisotope Permit. The contamination level may be averaged over an area not exceeding 100 square centimeters.

Designated Worker means an individual listed on the Permit as working under the authority of the Permit Holder.

EHS refers to Environmental Health and Safety. Acronym formally used was EHSO.

Exemption Quantity (EQ) is an isotope specific quantity defined by regulations. Exemption Quantities are listed in the second column of Appendix D at the end of this manual.

Laboratory Radiation Supervisor (LRS) is a Designated Worker nominated by a Permit Holder to assist the Permit Holder to carry out the duties as specified in this manual. The LRS is responsible to ensure the Radiation Safety Manual is up to date and available to all Designated Workers. The LRS shall keep records that Designated Workers have been informed of changes to the Radiation Safety Manual.

Nuclear Energy Worker (NEW) means a person who is required in the course of their work at the University 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.

Open Source Permits are Internal Radioisotope Permits specifically authorizing the use of Open Source radioactive materials and the conditions of that use. Open Source Permits are those beginning with the designations F-2-, F-3-, F-4- or F-5- (for Fort Garry Campus) or B-2-, B-3-, B-4 or B-5- (for Bannatyne Campus).

Open Source Radioactive Material (Open Source) is a radioactive liquid, powder or gas that can be absorbed, ingested or inhaled into the body presenting both an internal and an external radiation hazard.

Permit means the Internal Permit issued by the Committee to control all procurement, use, storage, transfer and disposal of all radioactive materials, radiation devices, X-ray equipment and other sources of ionizing radiation in all areas under the control of the University.

Permit Holder/Responsible User means the individual issued the Permit by the Committee who is required to be a faculty member or report to a Dean, Director or Department Head or who is supervised by a Dean, Director or Department Head.

Radiation Safety Records Binders are provided by Environmental Health and Safety (EHS) for the storage of all records that are required by the conditions of the Permit. The Radiation Safety Records binder and the records inside of it are the property of EHS and shall be returned to the Radiation Safety Officer when the room is decommissioned.

Radiation Safety Officer (RSO) means the University employee Environmental Health and Safety designated as the Radiation Safety Officer pursuant from the Radiation Safety Policy.

Radiation survey meter means an instrument that is capable of measuring radiation dose rates.

Radiation Warning Symbol (trefoil) shall be used as outlined in this procedure to identify all areas where radioactive materials are used or stored.

Radioactive material, for the purposes of this manual, the term "radioactive material" shall be limited to materials used for their radioactive properties in the course of research or teaching. Further, "radioactive material" means an unstable isotope of an element that decays, or disintegrates spontaneously, emitting radiation of sufficient energy to create charged particles by adding or removing an electron or breaking chemical bonds.

Radioisotope means radioactive material as defined above. Historically, the Internal Permits issued to control the use of radioactive material and radiation devices are called 'Internal Radioisotope Permits.

RSP means Radiation Standard Procedures that are approved by the University Radiation Protection Committee and documented in the University of Manitoba Radiation Safety Manual.

Striped Tape is magenta and yellow striped tape shall be used as outlined in this procedure (RSP) to identify all areas or equipment designated for use with radioactive material.

The University is the University of Manitoba.

3. Policy Related to the Use of Open Source Radioactive Material

Open Source Radioactive Material will be used in a manner to minimize the radiation exposure of all staff, students, the public and the environment and comply with all applicable regulations. To limit the risks associated with Open Source radioactive material, permitted spaces are classified according to the list below.

3.1 Laboratory Classifications

The Classification of a Laboratory is based on the Annual Limit of Intake (ALIs). See columns 4-8 in Appendix D at the end of this manual for a table of ALIs.

- **Basic Level Laboratory** where no more than 5 ALI in any single container may be used at a single time or stored in a Basic Level Laboratory. At the University, Permits with a permit number beginning with F-2 or B-2 are Basic Level.
- **Intermediate Level Laboratory** where no more than 50 ALI of radioactive material may be used at a single time or stored in an Intermediate Level Laboratory. At the University, Permits with a permit number beginning with F-3 or B-3 are Intermediate Level.
- **High Level Laboratory** where no more than 500 ALI of radioactive material may be used at a single time or stored in a High Level Laboratory. At the University, Permits with a permit number beginning with F-4 or B-4 are High Level.
- **Containment Level Laboratory** where more than 500 ALI of radioactive material may be used or stored in a Containment Level Laboratory. At the University, Permits with a permit number beginning with F-5 or B-5 are Containment Level.

4. Posting and Labelling

At the University, a consistent approach is required to identify the presence of radioactive material, possible radioactive contamination and the classification of areas where Open Sources are used or stored. Lab workers and ancillary staff rely on Designated Workers to identify potential hazards with posted information (postings) and labels as described in this section.

4.1 Internal Radioisotope Permit

A copy of the most recent version of the Internal Radioisotope Permit shall be posted in a prominent place in each location listed on the Permit as approved for manipulation or storage of radioactive material.

4.2 Waste Chart

Each room listed on the Internal Radioisotope Permit shall have a current "Waste Disposal Chart for Radioisotope Laboratories" posted. Proper disposal related to the use of radioactive material is KEY to protecting caretakers and the environment. A posted waste chart is a reminder to follow the rules related to segregation, packaging and labelling of wastes generated from the use of radioactive materials.

4.3 CNSC Use of Unsealed Nuclear Substances Poster

The CNSC Use of Unsealed Nuclear Substances Poster corresponding to the highest Classification Level (See Section 3 above) of Open Source Permit shall be posted prominently in each room listed on the Permit.

- The Poster will be 'filled in' with the 24 Hour Contact information for the University Radiation Safety Officer, the 24-hour phone number for Security and the Room Identification (room number and name of building).
- The Notes Section shall include a reference to following the procedures in this manual and conditions on the Permits posted in the room.
- The poster shall only be removed by Radiation Safety Staff after the room is decommissioned.

4.4 Contact Information at Entrance

At the entrance of every location listed on an Open Source Internal Radioisotope Permit, there shall be posted:

- The name of at least one Permit Holder including information on how to reach during the workday.
  - The first contact shall be a Permit Holder for the room and
  - The second contact shall be currently listed on an Internal Radioisotope Permit for the room and
  - Contact information for the University Radiation Safety Officer and alternate.
- After Hours Emergency Contact Information for the University Security Services to initiate emergency procedures related to the Radiation Safety Program.

4.5 Radiation Warning Symbol

4.5.1 Posted at Entrance

The Radiation Warning Symbol and the words "RAYONNEMENT-DANGER-RADIATION" shall be posted at the entrance of a room when:

- The room contains radioactive material in excess of one hundred exemption quantities (EQ), and/or
- Within the room, a person could be exposed to a radiation field in excess of 25 microsieverts per hour at a distance greater than 0.3 meter from any object or shield. In this case:
  - The room shall be posted as "Restricted ENTRANCE" and "Must be accompanied by lab personnel".
  - The entrance is restricted to lab personnel that are Designated Workers listed on the current Internal Radioisotope Permit.
  - There must be a 24 hour 'unaccompanied entrance' Safe Work Procedure (SWP) approved by EHS and provided to Security Services and Physical Plant to allow for unaccompanied entrance for life or building saving scenarios.

4.5.2 Labelling within the Room

All areas and equipment used to manipulate or store radioactive material within the Open Source permitted space must be labelled with, either:

- Striped Tape (magenta and yellow) may be used whenever any amount of radioactive material is involved and may be used to identify space or items designated for working with radioactive materials, or
- Radiation Warning Symbols are required to indicate the presence of Open Source radioactive material greater than one exemption quantity (1 EQ) and may be used whenever any amount of radioactive material is present. Radiation Warning Symbols must be removed within seven days of removing the radioactive material, but only after confirming there is no removable contamination above the Decontamination Level.

4.5.3 Label means 'follow the rules'

When the Radiation Warning Symbol or striped tape is in place, the work in the area or with the equipment shall follow the rules in section 8 of this RSP.

4.5.4 Labels on 'Vessels'

Vessels (eg: labelled samples in microcentrifuge tubes, aliquoted contents of stock vials) containing radioactive materials in excess of one exemption quantity (1 EQ) are to be labelled

with the Radiation Warning Symbol, the name of the radioisotope, activity and the corresponding date and the name (or initials) of the Permit Holder.

4.5.5 Labels on Waste

Receptacles designated for radioactive waste must be clearly marked with the University Radioisotope Waste Tag with the upper portion filled in. Alternately, if the tag is not present, the information provided by filling the upper portion of the waste tag must be labelled on the waste receptacle. Refer to section 12 in this RSP. A temporary waste container may be designated with only striped tape and kept in an area designated for use with radioactive material (not the on the floor). These temporary waste receptacles do not require a waste tag and should be emptied daily into a waste container with a waste tag.

4.5.6 Labels on Cages

Cages housing animals injected with radioactive materials shall be labelled with a cage card, Radiation Warning Symbol, the name of the radioisotope, activity at a given time and the name of the Permit Holder. Refer to section 9 in this RSP.

4.5.7 Remove Labels after Decommissioning

The Radiation Warning Symbol and striped tape shall be removed when decommissioning equipment and areas for use other than with radioactive material – only after contamination monitoring has confirmed there is no removable radioactive contamination in excess of the Decontamination Level.

4.5.8 Unwarranted Labels are Prohibited

Radiation Warning Symbols shall only be used as outlined in this Radiation Safety Manual. Unwarranted Radiation Warning Symbols shall be removed.

5. Radiation Safety Records Binder

To facilitate inspections, all records required by the conditions of the Internal Radioisotope Permit are kept accessible in Radiation Safety Records binders provided by Environmental Health and Safety (EHS).

- One Radiation Safety Records binder will be issued by EHS for each room that is permitted to store or manipulate radioactive materials. Normally, only one binder shall be issued per room regardless of the number of Permits on the room.
- All records required by the conditions of the Internal Radioisotope Permit shall be kept readily available for inspection. Records may be visibly posted or kept in the Radiation Safety Records binder. Records required to be in the lab:
  - Contamination Monitoring Records
  - Radioisotope Inventory Form (gold sheets or copies on white paper of the disposed items)
  - Copies of TDG certificates (receiving class 7 Radioactives) for lab personnel
  - All lab site specific training related to Radiation Safety, such as:
    - Radiological-Biological Waste Approval (RBWA),
    - Alternate methods of detection

- Safe Work Procedures listed as a condition on the Internal Permit
- A copy of the Lab Assignment (effective September 14, 2016)

o Copies of any incidents, malfunctions, security breaches related to radioactive materials (listed on the Permit).
o Keep all records for a minimum of 8 years and do not discard until authorized by EHS (usually at time of annual reconciliation).

6. Ordering/ Obtaining Radioisotopes and Inventory (Forms)

The University is licensed by the Canadian Nuclear Safety Commission to use specific radioisotopes at specified limits. Under the consolidated licence, the Radiation Protection Committee issues Internal Permits. To ensure the University does not exceed the licence limits, all orders and transfers to and from the University must be pre-approved by EHS.

6.1 Environmental Health and Safety Responsibilities

Environmental Health and Safety (EHS) is responsible to pre-approve every transfer or order of radioactive material. EHS will:

- Provide radiation safety pre-approval of every transfer or order of radioactive material.
  - o The pre-approval process will ensure the University is licensed to receive the order.
  - o An assessment is made to ensure the possession, use and storage of this item in the permitted facility will control radiation dose ensuing ALARA.
- Generate a unique Radioisotope Inventory Form (Gold Sheet) for every radioactive stock vial or kit. Radioisotope Inventory Forms will be prepared based on information from the transfer or purchase request. The Radioisotope Inventory Form will serve as the only required inventory record to log usage and the ultimate disposal of individual radioactive stock vial or kit.
- Maintain an inventory of all scintillation counters, gamma counters, radiation survey and contamination meters.

6.2 Permit Holder Responsibilities

The Permit Holder is responsible to ensure:

- Every transfer or purchase of radioactive material has radiation safety pre-approval from EHS.
- Orders are placed only for radioisotopes listed as approved on the current Radioisotope Permit and the approved container/item and possession limits must not be exceeded.
- All transfers of radioactive stock vials or kits to another Permit (within the University) are pre-approved by EHS and are recorded on the Radioisotope Inventory Form including the date and the Permit Number of the receiving Permit.
- Every radioactive stock vial or kit in the possession of the lab has its own unique Radioisotope Inventory form as generated by EHS.
- EHS is immediately informed of any radioactive stock vials or kits in the lab that do not have a unique EHS generated Radioisotope Inventory Sheet on gold colored paper.
  - o The Serial Number on the Radioisotope Inventory Form is copied onto the corresponding stock vial or kit.
  - o The required information is accurately recorded on the Radioisotope Inventory Form. Discrepancies between the original order information and the item as received shall be recorded in the space provided on the Form. Significant discrepancies (>10%) should be promptly reported to EHS.

  - An accurate record of each withdrawal shall be maintained on the Radioisotope Inventory Form (date, person and activity). When the form includes the activity / unit of volume, the volume withdrawn can be recorded instead of the activity withdrawn.
  - Radioisotope Inventory Forms are kept either posted or in the Radiation Safety Records binder in the room where the radioactive material is stored. Records must be up-to date and readily available in the lab for inspection.
  - The Radioisotope Inventory Form is completed (with the date transferred to EHS) and returned to EHS with the stock vial or kit. The only accepted method of disposal for unwanted vials or kits is to transfer the vial or kit to EHS along with the corresponding Radioisotope Inventory Form. A copy on white paper of the Radioisotope Inventory Form should be kept in the Radiation Safety Records Binder (for 8 years past the discard date).
- An annual verification of inventory (Annual Reconciliation Form) is completed and returned to EHS. At the time of annual reconciliation, a physical inventory shall be taken including stock vials in long-term storage. Contamination monitoring of the storage location is required at this time.
- Radioactive stock vials shall be stored in a locked cupboard, locked refrigerator, or the equivalent to ensure that they are not accessible to anyone entering the laboratory except Permit Holders or Designated Workers. When non permitted workers have access to the locked cupboard or refrigerator, radioactive stock vials shall be stored in a dedicated locked storage box which is secured (by a locking device) to the inside of the refrigerator, or cupboard and the keys shall only be accessible to Designated Workers.
- EHS is informed of all scintillation counters, gamma counters, radiation survey and contamination meters in your department whether they are in use or not. EHS should be informed of newly acquired equipment as well as equipment that is leaving the department. EHS will assist in making the proper arrangements for discard or transport.

6.3 Open Source Radioisotope Purchasing Procedure

Orders for radioactive stock vials or kits may be placed online using the University of Manitoba's e-procurement system (e.g. EPIC). The current e-procurement procedure is available on the EHS web page.

6.4 Non – EPIC order/ transfers to (or from) other Licenses

All movement of radioactive material to and from the University is coordinated in advance with EHS.

7. How to Receive a Shipment of Radioactive Material

Depending on the amount of activity, radioactive material may be potentially dangerous. Transportation of Dangerous Goods is controlled by Federal regulations invoking stringent federal and provincial reporting requirements. There are nine classes of Dangerous Goods. Radioactive materials are categorized as Class 7. The following procedure is required to be followed when opening a shipment of radioactive material.

7.1 Receiving Procedure

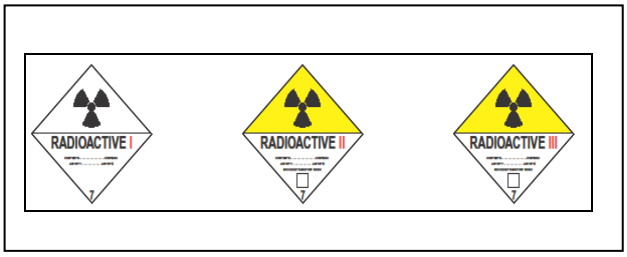
1. Immediately report any anomalies (tampering, contamination, leakage, missing, short or wrong shipment) to the Permit Holder and/or Laboratory Radiation Supervisor and to the

Radiation Safety Officer (RSO). The contact information for the RSO is on the first page of this manual.

- The RSO must make a preliminary verbal report to the Canadian Nuclear Safety Commission and Manitoba Department of Environment.
- Lab staff must inform the consignor (vendor) immediately.

2. Before you open a package of Radioactive Material, make sure:
   a. Packages of Radioactive Material are never left unsecured.
   b. Shipments of radioactive materials labelled with one of the Transport of Dangerous Goods (TDG) symbols (Figure 1) are only to be received and opened by persons that have been certified (trained) in receiving Class 7 Radioactive Materials.

Figure 1: Transportation of Dangerous Goods symbols



Non-certified personnel may only receive packages of radioactive materials that are shipped and labelled as “Excepted Packages”. See Figure 2.

Figure 2: Excepted Package label

RADIOACTIVE MATERIAL,
EXCEPTED PACKAGE –
LIMITED QUANTITY OF MATERIAL
UN 2911

   c. Confirm the package is addressed to your lab. If not, STOP & report to RSO.

   d. Before you sign for a package, be sure to take off any gloves you may be wearing.

   e. Upon receipt, unopened packages of radioactive material should be promptly delivered to an approved location listed on the Internal Radioisotope Permit.

   f. If appropriate, use a cart when transporting radioactive packages to increase the distance between people and the package and minimize radiation exposure.

3. To open a Radioactive Shipment, assume the package may be contaminated until you have proven otherwise.

   a. Unpack urgently! The package contains a dangerous good, it is important to check to make certain there is no damage from the transport.

   b. Wear a lab coat and disposable gloves to handle the package.

c. Place package behind appropriate shielding if applicable.

d. If receiving potentially volatile material (for example, unbound iodine or S-35 labelled proteins), place the package in a fume hood behind appropriate shielding.

e. Remove the packing slip from the exterior of the package and review to ensure the information corresponds with what was ordered. If not, STOP & report to RSO.

f. Check the exterior and then the interior of the package for possible damage or visible leakage.
   - If the package is damaged or leakage is obvious STOP & report to RSO:
     - Isolate the package to limit the spread of any contamination.
     - Remove your gloves, wash your hands and monitor your hands and clothing (detail of how to monitor personnel are outlined in section 10.5 of this RSP).

   - If no visible leakage or damage:
     - Remove the container of radioactive material from the packaging. Typically, the radioactive material is in an inner vial inside this secondary container.
     - While avoiding unnecessary direct contact with the unshielded inner vial, wipe test the inner vial and verify the vial appears intact and appears to contain the ordered radioactive material (wipe test procedure is outlined in section 10 of this RSP).
     - If the inner vial is empty, STOP & report to RSO.

g. If there is no visible damage and the inner vial appears intact, place the inner vial back into the secondary container vial. Place in a beaker or plastic bag in the secured storage location and keep packaging isolated until the results of the wipe test verify no removable contamination.

h. If removable contamination is not detected, verify the radioisotope, the activity, and other details on the primary container with the information on the packing slip and Radioisotope Inventory Form (gold sheet). If there is a discrepancy in the information or activity of more than 10%, STOP & report to RSO.

i. Write the serial number from the gold sheet on the primary container. The serial number is located in the upper part of the radioisotope inventory form.

j. Record the pertinent information on your Radioisotope Inventory Form (activity received, assay date, radioactive concentration, total volume and the lot number) and the results of the wipe test from the vial and background.

k. If the packaging is free of contamination, remove or deface all Radiation Warning Symbols and/or wording before discarding into the regular garbage.

7.2 Contacting the Radiation Safety Officer to report anomalies

Contact the Radiation Safety Officer to report the situation as soon as possible. Radiation Safety Officer has the responsibility to:

- Assess or arrange for the assessment of worker exposure to ionizing radiation.

- Revise or remove restrictions on access to the area in terms of radiological hazard.
- Supervise the monitoring of areas for radioactive contamination and the decontamination process.
- Report incidents as required by regulations.

8. Rules for Working with Radioactive Chemicals

To minimize the potential hazards of working with radioactive materials, before each experiment, workers are required to consider the potential for hazard with the value from the experiment.

- Optimize and justify every use of radioactive material.
- Consider using the lowest energy radioisotope and the least amount of activity.

In addition to conforming to the University of Manitoba Chemical Safety Guideline, the following basic rules must be followed when working with Open Sources of radioactive material:

1. Food, beverages or cigarettes must not be taken into or stored in Radioisotope Laboratories. Food items that are intended for research must be clearly marked as “not for human consumption”.

2. It is recommended that personal clothing and bags are not stored in rooms permitted for the manipulation of Open Source radioactive materials.

3. Radioactive Work Areas:
   - Locate the Radioactive Work Area in a remote part of the lab, where people are less likely to walk by or work beside.
   - Prior to starting work with Open Source radioactive material one sink, a bench area and any other equipment that is necessary shall be designated as Radioactive Work Areas.
   - The surfaces of the Radioactive Work Areas should be clean and free of unnecessary items.
   - Cover the counter with plastic backed absorbent paper with the absorbent side up.
   - Clearly identify and label with the Radiation Warning Symbol or striped tape when the radioactive material is present. All equipment (including pipettes, racks, pens, etc) used in the designated radiation area should be labeled with the striped tape.
   - If the volume of radioactive liquid is not readily absorbed into the absorbent paper, trays lined with absorbent paper shall be used.
   - Consider if shielding is appropriate (including shielding waste containers).
   - Consider placing timers in Ziploc bags and covering vortexes with plastic wrap as appropriate.

4. Store large volumes (more than one liter), or containing more than one exemption quantity (1 EQ), in secondary containment vessel. The secondary containment must be capable of holding the total volume of waste or sample.

5. Prepare waste containers for all types of waste anticipated.

6. An appropriate contamination meter shall be available when working with radioactive material.

7. For new or higher risk procedures:
   - Consider working in pairs.
   - A “dry run” will allow a practice of the technique and will help to identify steps when contamination is a risk. Plan when to de-glove. Practice until the worker is sure of the technique and all the required items are assembled. For high risk procedures –document a safe work procedure.

8. Plan and use secondary containment when transporting radioactive materials away from the bench.

9. Take extra care to control contamination when performing procedures that may produce radioactive aerosols. Example of procedures that may produce aerosols are: pipetting, blending, grinding, dissecting, vortex mixing, centrifuging, operating ultrasonic disintegrators, drying, freeze drying, heating/boiling, shaking, adding liquid to powders, reconstituting in a vacuum vial; opening test tubes, flasks or bottles; or using in a syringe.

10. Wear disposable gloves and a clean laboratory coat fully buttoned, or a back closing hospital gown, over street clothes when working with radioactive materials. Arms should be covered. Shoes should cover the whole foot. Legs should be covered (long pants or long skirts are preferred).

11. Remove gloves before touching such objects as telephones, doorknobs, keys, faucets, computer keyboards, contamination meter, pens or lab books.

12. Check for contamination during and at the end of work. Decontaminate as required. Remove gloves and dispose of as radioactive waste. Wash hands.

13. Except for work using H-3 or C-14, use a contamination meter to monitor personnel for contamination at the completion of procedures.

14. Prior to entering designated office/food areas, workers must remove lab coats, remove gloves and wash hands.

15. All stock vials and kits shall be attended by a Designated Worker or must be locked (secure) when not attended by a person listed on the Internal Radioisotope Permit.

16. Report all incidents to Environmental Health and Safety as outlined in RSP-2, section 6.3, item

9. *In Vivo* Use of Radioactive Materials

In vivo use of radioactive materials in animals is permitted under the Consolidated Radioisotope Licence. (Use in HUMANS is NOT!)

- The approval of in vivo radioactive material use in animals will be listed under Approved Usage on the Internal Radioisotope Permit.
- Radiological- Biological Waste Approval is required and will be listed under Approved Usage on the Permit.
- The Radiation Safety Officer shall be informed of the schedule each time a project involving in vivo use is started.

9.1 Approval listed on Permit

The Permit Holder shall indicate the in vivo use of radioactive material at the time of application of the Permit or by requesting an amendment to an existing Permit as stated in RSP-2.

Protocols which generate carcasses containing a radioactive material with a half-life greater than 90 days or resulting in animals containing more than one exempt quantity per kilogram may not be approved.

The Permit Holder shall notify the Radiation Safety Officer of changes in the protocol including:

- Change of radioisotope or activity administered
- Changes which may affect waste disposal or handling precautions
- Change of species

9.2 Approval to Work in Animal Care Facilities

Advance approval from the director of the animal facility is required to use radioactive materials within any University animal facility.

- In consultation with the Radiation Safety Officer, the Permit Holder shall ensure the animal care staff are aware of the potential hazards and required precautions.
- A copy of the Internal Radioisotope Permit and appropriate radiation warning signs (Door signs and Radiation Warning Symbols) shall be posted outside any room that is used during the experiment, including animal holding rooms.
- In case contamination does occur, an appropriate spill kit shall be accessible wherever the animals are located and ready for use.

10. Contamination Monitoring

Keeping the level of radioactive contamination as low as reasonably achievable (ALARA) is required by law and it also protects the safety and health of staff, students and the environment. Contamination monitoring is important for the reproducibility of experimental results.

An effective contamination monitoring program is like a well-designed experiment. Monitoring must include periodic checks of work surface, personnel and items used while handling radioactive material. To monitor effectively, there are different methods used to quantify the different radioisotopes and regulations may require certain Decontamination Levels for specific radioisotopes. *Part of the process of approving a permit is that the Radiation Safety Officer makes*

sure the workers have access to the appropriate detection method for the radioisotopes listed on the permit.

Liquid Scintillation Counting and using a Decontamination Level equivalent to 0.5 becquerel per square centimeter (Bq/cm^2) is the University standard. For radioisotopes with very short half-lives, the Permit may also indicate a less restrictive Decontamination Level and for certain radioisotopes we are required by regulation to ensure a lower Decontamination Level of 0.3 becquerel per square centimeter (Bq/cm^2).

- Lower energy emitters like H-3, C-14 and S-35 need to be quantified by liquid scintillation counting (see section 10.4.2 below for more detail).
- P-32, Tc-99m or other higher energy emitters may be measured directly with a contamination meter BUT only if the meter that has a sticker indicating the calibration of the meter and probe combination has been verified for the radioisotope in use (see section 10.4.1 below for more detail).
  - The sticker must indicate the University Decontamination Level for the radioisotope.
  - The verification is only valid for 36 months.
- To use any other method to quantify, there must be an approved alternate method of detection listed in the approved usage of the Internal Radioisotope Permit and filed in the Radiation Safety Records binder. Gamma well counters and other non-liquid scintillation counter type devices will have the Decontamination Level specified on the approved alternate method of detection.

At the University we practice 'twice background' as a Decontamination Level (requires decontamination and re-monitoring). If you use liquid scintillation counting or the approved method of detection listed on the Permit, and decontaminate and re-monitor whenever the wipe is more than twice the background reading, then you will meet the legal requirements without having to calculate the Bq/cm^2!*

* The background measurement must be made in an area without high ambient radiation.

Section 10 covers:

- Section 10.1 covers the responsibilities of the Permit Holder that may be delegated to a Designated Worker. The Permit Holder remains however accountable to ensure all responsibilities have been achieved.
- Section 10.2 outlines the Basic Contamination Monitoring Procedure, that must be followed regardless of the radioisotopes in use or the measuring method. It includes the equations to calculate the level of contamination for reference.
- Sections 10.3 to 10.5 cover the additional steps to quantify contamination either directly with a contamination meter, or indirectly with a contamination meter or liquid scintillation counter.
- Section 10.6 covers the course of actions needed to be taken when contamination is found.
- Items useful in a Decontamination or Spill Kit are listed in Section 10.7.

10.1 Permit Holder Responsibilities

The following responsibilities may be delegated to a Designated Worker. The Permit Holder remains however accountable to ensure the responsibilities have been met. The Permit Holder is responsible to ensure that:

- A well-planned contamination monitoring program is established and maintained. The program shall include preplanning, periodic review and be designed to detect contamination

in radiation work areas. It should ensure that periodic check areas less likely to be contaminated are included.

- All rooms where Open Sources are used have access to a Decontamination/ Spill Kit (section 10.7).
- Every Designated Worker has ready access to a scintillation counter and/ or a contamination meter equipped with an appropriate probe for the radioisotope in use. Access must continue during the period the radioactive material is being used.
- Storage areas where Open Sources are stored for longer than six months are monitored for contamination at least annually.
- Contamination in excess of the permissible levels (see column 9 of Appendix D at the end of this manual) are be reported to the Radiation Safety Officer.

10.2 Frequency of Contamination Monitoring

Contamination Monitoring is required:

- Whenever contamination is suspected, such as after a spill.
- Within seven (7) days of each use of any amount of radioactive material, and
- Immediately (at least - daily) after each use of more than (18.5 megabecquerel) (500 microcurie) of any radioisotope with a half-life of greater than 2 hours other than H-3 and C-14.
- Storage areas where radioisotopes are stored for longer than six months shall be monitored at least annually.
- Prior to decommissioning or 'releasing' a room or equipment that has been used to work with or store radioactive material.

Decontamination procedures shall be initiated when the contamination level exceeds the Decontamination Level as outlined in Section 10.6 below.

10.3 Basic Laboratory Contamination Monitoring Procedure

1. Prepare a Record to include the following required information:
   - Permit Holder and Permit Number
   - Date monitored, person doing the monitoring and monitoring equipment used
   - Locations monitored (use numbers on a map/floor plan of the room or write descriptions)
   - Operational checks according to manufacturer's instructions and the outcome of the checks
   - A measurement of background or a blank
   - The results of monitoring each location
   - Clear indication if the results do not exceed the decontamination level

2. In general, for an average sized lab, ten locations should be satisfactory. The number of locations monitored may be reduced, by limiting the number of locations used for radioactive work.

3. Monitor within one week of the first use of radioactive material.

4. Continue to monitor at least weekly during periods of use of radioactive material. Be sure to record reasons for delays in counting wipes on weekly record (i.e. Statutory holiday, therefore no radioactive work was done).

5. Record the actual readings and include the units of measurement.

6. If the result is greater than twice background, decontaminate and re-monitor. Repeat until a result of less than twice background is documented. *Results greater than 6 times background should be reported the Radiation Safety Officer as (depending on the radioisotope) it may indicate removable contamination at levels greater than the CNSC reporting criteria (see column 9 of Appendix D at the end of this manual).*

10.4 Measuring Contamination

10.4.1 Contamination Meter - Direct Method

1. Use a contamination meter that has a sticker indicating the calibration of the meter and probe combination has been verified for the radioisotope in use. The verification is only valid for 36 months.

2. Before monitoring, follow manufacturer's operational checks (battery check, measure a check source i.e. source of known activity, if available). Document the checks made.

3. Measure and record the background with the meter set on slow.

4. Monitor areas with the meter, switched on “fast”, by passing the detector slowly (less than one inch per second) with the detector face towards the surface. Keep the distance between the detector and the surface as small as possible without touching. If contamination (reading greater than twice the background measurement) is detected, stop and obtain a measurement with the meter set on slow.

5. You will need to decontaminate and re-monitor if the reading (minus the background) exceeds:
   - The Decontamination Level as listed on the Approved Alternate Method of Detection for the radioisotope in use. (Alternate Method of Detections within the Approved Usage on the Permit).
   - The ‘Decontamination Level’ listed on the ‘Contamination Monitor’ sticker on the contamination meter.
   - If you detect more than twice background, or use the equation provided in figure 1 on the following page and calculate to determine if you have more than 0.5Bq/cm^2 (or 0.3 Bq/cm^2 if indicated on the Permit under other conditions of use).
   - *Results greater than 6 times background should be reported the Radiation Safety Officer as (depending on the radioisotope) it may indicate removable contamination at levels greater than the CNSC reporting criteria (see column 9 of Appendix D at the end of this manual).*

Figure 1: Calculating Contamination Level – Direct Monitoring

For Direct Contamination Meters:

$$\text{Surface Contamination } (Bq/cm^2) = \text{Net Count* (cps)} \times \frac{100}{\text{detector efficiency (\%)}} \times \frac{1}{\text{operational area of detector } (cm^2)}$$

$$\text{*Net Count (counts/second)} = \text{Measured Count (cps)} - \text{Background Count (cps)}$$

For example, if you were working with P-32, using a Ludlum -3 meter and the Ludlum 44-9 probe, you measure a background of 50 cpm (or 0.83 cps) and an area on an under-pad of 320 cpm (or 5.3 cps) then

$$\text{Net Count (counts/second)} = \text{Measured Count (cps)} - \text{Background Count (cps)}$$

$$\text{Net Count (counts/second)} = 5.3 \text{ cps} - 0.83 \text{ cps}$$

$$\text{Net Count} = 4.5 \text{ cps}$$

Then using a manufacturer's supplied counting efficiency of 32 % and a detector area of 10cm^2

$$\text{Surface Contamination } (Bq/cm^2) = \text{Net Count* (cps)} \times \frac{100}{\text{detector efficiency (\%)}} \times \frac{1}{\text{operational area of detector } (cm^2)}$$

$$\text{Surface Contamination } (Bq/cm^2) = 4.5 \text{ cps} \times \frac{100}{32} \times \frac{1}{10 \text{ cm}^2}$$

Surface Contamination = 1.4 Bq/cm^2 Since this is greater than 0.5 Bq/cm^2 (and greater than twice the Background), DECONTAMINATE and re-monitor).

10.4.2 Wipe Test – Indirect Method

1. Select an absorbent grade of filter paper or another suitable material. Consider wetting the paper with water or 50% alcohol. Hold the moistened filter paper on the edge with thumb and index finger and rub lightly but firmly over the surface, using the pads of the other fingers to apply light pressure, try to pick up any removable contamination on center of the paper. Wipe an area of approximately 100 cm^2. A larger area may be wiped but the counts obtained cannot be averaged over more than 100 cm^2. A zigzag pattern may be used to sample a large area.

2. Include a blank or background count using an unused wipe.

3. Wipes may be measured directly with a contamination meter in an area of low background with a meter that has a sticker indicating the calibration of the meter and probe combination has been verified for the radioisotope in use and the verification is only valid for 36 months. An area of low background is one were the meter reading is not increased by local radioactive material such as radioactive waste or radioactive samples. Or,

4. Measure with Liquid Scintillation Counting by:
   a. Allow the paper to dry (as required by capabilities of scintillation fluid), and place each wipe in a vial. Add scintillation fluid, seal and shake each vial.

   b. It is recommended to store vials in the dark overnight after sealing and shaking them (to minimize activation of the scintillation fluid by ultraviolet light).

   c. Program the Liquid Scintillation Counter to report counts in disintegrations per minute (DPM) whenever available.

   d. Following the manufacturer's instructions, count for the radioisotopes in use. Include a standard of known activity or calibrate with a standard as per manufacturer instructions. It is recommended to count each sample for a minimum of 5 minutes.

   e. Record results in contamination monitoring records or attach the print out with the locations indicated on it for each measurement.

5. You will need to decontaminate and re-monitor if:
   - You detect more than twice background, or use the equations in Figure 2 on the next page and calculate more than 0.5 Bq/cm^2 (0.3 Bq/cm^2 if indicated on the permit under other conditions of use).
   - You have exceeded the Decontamination Level for the radioisotope in use with the lowest counting efficiency in in section 10.6, Figure 3.

Figure 2: Calculating Contamination Level – Indirect Monitoring

For indirect monitoring – wipe testing (Measured with Liquid Scintillation or Gamma Counters)

$$\text{Surface Contamination (Bq/cm}^2\text{)} = \text{Net Count* (cps)} \times \frac{100}{\text{detector efficiency (\%)}} \times \frac{100}{\text{area wiped (cm}^2\text{)} \times \text{wipe efficiency (\%)}}$$

$$\text{*Net Count (counts/second)} = \text{Measured Count (cps)} - \text{Background Count (cps)}$$

When swiping area of 100 cm^2 and assuming wipe efficiency 10% use formula:

$$\text{Surface contamination (Bq/cm}^2\text{)} = \text{Net count (cps)} \times \frac{100}{\text{Detector efficiency (\%) specific for isotope}} \times \frac{100}{100\ \text{cm}^2 \times 10\%}$$

For example, if you were working with H-3, using a Liquid Scintillation Counter, you measure a background of 50 cpm (or 0.83 cps) and an area on the floor 100 cpm (or 1.6 cps) then

$$\text{Net Count (counts/second)} = \text{Measured Count (cps)} - \text{Background Count (cps)}$$

$$\text{Net Count (counts/second)} = 1.6\ \text{cps} - 0.83\ \text{cps}$$

$$\text{Net Count} = 0.77\ \text{cps}$$

Then using a manufacturer's supplied counting efficiency of 20 %

$$\text{Surface Contamination (Bq/cm}^2\text{)} = \text{Net Count* (cps)} \times \frac{100}{\text{detector efficiency (\%)}} \times \frac{100}{\text{area wiped x wipe efficiency (cm2)}}$$

$$\text{Surface Contamination (Bq/cm}^2\text{)} = 0.77\ \text{cps} \times \frac{100}{20} \times \frac{100}{100\ \text{cm}^2 \times 10\ \%}$$

Surface Contamination = 0.38 Bq/cm^2 Since this is less than 0.5 Bq/cm^2 (and less than twice the Background), no further action is needed.

10.5 Personnel Monitoring

For safety and to control the possible spread of contamination periodic personnel monitoring must be considered while working with radioactive materials. Except for work using H-3 or C-14, use a contamination meter to monitor personnel for contamination at the completion of procedures. Follow the steps in 10.4.1 Contamination Meter - Direct Method when the personnel are in an area of low background.

10.6 Decontamination Level

- At the University, decontamination is recommended whenever readings are above twice the background.

- Decontamination is required when measured removable contamination exceeds the Decontamination Level. The decontamination level will be specified on the Internal Radioisotope Permit under
  - 'Approved Usage' if there is an Approved Alternate Method of Detection, or
  - "other conditions of use".
- At the University, the decontamination level for most radioactive material is 0.5 Bq/cm^2 and the corresponding net measurement (gross- background) is listed in (Figure 3).

Figure 3: University Decontamination Levels corresponding to 0.5 Becquerel per cm^2

Method of Detection	Radioisotope	Manufacturers' Supplied Efficiency of counting	Decontamination Level Net measurement (Gross measurement minus Background measurement)
Wipe tests	All	N/Ap	300 DPM (5 DPS)
(Ew=10%)	H-3	20 - 60%	60 - 180 CPM (1 - 30 cps)
Liquid Scintillation Techniques	C-14, S-35,	80 - 97%	240 - 290 CPM (4 - 5 cps)
	Cr-51	35%	100 CPM (2 cps)
	I-131	70%	210 CPM (3.5 cps)
	I-125, Co-57	78%	230 CPM (4 cps)
	P-32, Na-22, P-33, Ca-45, Sr-90	~100%	300 CPM (5 cps)
Direct Ludlum 44-9	P-32	32% (2 pi, contact)	96 CPM (1.6 cps)
Alternate Method Approved by EHS			

Contamination Level (Bq/cm^2) = $\frac{(CPMm - CPMb) \quad x100\%}{Ec \times Ew \times 60 \times A}$

Where:

CPMb= Measurement of background in CPM

Ec= Efficiency of counting

Ew= Efficiency of wiping (10% for wipes or 100% direct readings)

A= Area wiped or Active area of detector

10.7 Actions Required when Decontamination Level is Exceeded

- Detected contamination levels higher than the limits specified in column 10 of Appendix D at the end of this manual shall be immediately decontaminated, re-monitored and documented to demonstrate compliance.
- If the contamination detected exceeds the level in column 9 of Appendix D, report the situation urgently the Radiation Safety Officer.
- If the half-life is less than 24 hours, an alternate strategy, if appropriate, is to isolate and secure the area and allow time for decay.
- Where decontamination is not possible, consider isolation (e.g. place contaminated bench coverings in radioactive waste or seal contaminated items and store for decay).
- Store all records of contamination monitoring in the Radiation Safety Records binder.

10.8 Decontamination / Spill Kit

In case contamination does occur, the following items should be accessible and ready for use:

- Wax pencil/felt pen to delineate spill area(s).
- Warning labels or signs to post around the area.
- Large and small plastic bags to consolidate waste.
- Shoe covers or plastic backed under-pads to walk on if appropriate.
- Disposable gloves for hand protection.
- String to fasten plastic bags and Radiation Warning Labels.
- Paper towels or absorbent materials for blotting and drying.
- Soap or detergent to help decontaminate.
- Tags for identification of waste.
- Swipes or filter papers to check for loose contamination.
- A note pad to diagram the area and document the spill and clean up.
- A copy of the Spill Procedures (Section 11 of this RSP).

10.9 Contacting the Radiation Safety Officer to report Contamination

Contact the Radiation Safety Officer to report the situation as soon as possible. The Radiation Safety Officer has the responsibility to:

- Assess or arrange for the assessment of worker exposure to ionizing radiation.
- Revise or remove restrictions on access to the area in terms of radiological hazard.
- Supervise the monitoring of areas for radioactive contamination and the decontamination process.
- Report incidents as required by regulations.

11. Spill or Unplanned Release Procedure

11.1 Release of Radioactive Mists, Fumes, Vapors and Gases

Notify all persons in the area of the incident. Ask them to hold their breath and leave the area as soon as possible and

1. If the fume hood is not already on, hold your breath and switch on fume hood.

2. Leave the area as soon as possible and close doors behind you.

3. Wait in an area that would not be contaminated and immediately call the Radiation Safety Officer (RSO). The contact information for the RSO is on the first page of this manual.

11.2 Personal Contamination

If you know or suspect a person's body (eyes, skin, hair) or clothing is contaminated, immediately:

1. Stop work immediately!

2. Remove contaminated clothing including contaminated gloves or lab coat. Keep the contaminated items separate within the radiation work area.

3. Take action to decontaminate, in this order:

- eyes
- skin
- hair

4. As soon as possible, inform your supervisor and call the Radiation Safety Officer (RSO) for assistance in safe decontamination techniques.

5. MONITOR
   For isotopes other than H-3, locate the contamination using appropriate contamination meter (for procedure see section 10.4.1 of this RSP). Ask a colleague for assistance to summon help if you are contaminated. Monitor slowly (one centimeter per second) with setting on fast response. Monitor hands and your feet carefully to ensure they are not contaminated to reduce the chance of spreading the contamination.

   When contamination with H-3 (tritium) is suspected, it is safest to assume that contamination has not been removed. Take all reasonable steps to limit the spread until you have confirmed the absence of contamination with wipe testing and use of the Liquid Scintillation Counting Technique (see Section 10.4.2 of this RSP).

6. Report the incident to the Radiation Safety Officer as soon as reasonably possible.

11.2.1 Eye decontamination

1. Use local eyewash as soon as possible. If your fingers are contaminated, ask for assistance to hold your eyelids open.

2. Flush eye(s) for at least 15 minutes.

3. MONITOR (see 11.2 5. above) for contamination and, if necessary, repeat the flush.

4. Immediately call the Radiation Safety Officer (RSO). The contact information for the RSO is on the first page of this manual.

11.2.2 Body (skin) decontamination

Body contamination includes when you have a cut.

1. Flush contaminated skin or body parts taking care not to spread contamination to non-contaminated body parts. Use warm (not hot) water. Rinse. Do not scrub as this could promote deeper tissue penetration or increased local blood flow that could subsequently spread the contamination throughout the body.

2. MONITOR (see 11.2 5. above) the area where possible skin contamination occurred

3. Immediately call the Radiation Safety Officer (RSO). The contact information for the RSO is on the first page of this manual.

11.2.3 Hair decontamination

1. Flush contaminated hair under warm running water for at least 10 minutes taking care not to spread contamination to non-contaminated body parts.

2. MONITOR (see 11.2 5. above) and if necessary repeat the procedure.

3. If the contamination persists it might be necessary to clip the contaminated hair. Do not discard contaminated hair. Keep clipped hair in radiation work area.

4. Immediately call the Radiation Safety Officer (RSO). The contact information for the RSO is on the first page of this manual.

11.3 Contaminated Personal Protective Clothing (gloves or lab coat)

1. Immediately remove contaminated item.

2. Placed contaminated item on an under-pad or in a plastic bag to control contamination. Do not discard contaminated item. Keep the contaminated item separate within the radiation work area.

3. MONITOR (see 11.2 5. above) yourself with an appropriate contamination method to confirm you are not personally contaminated.

5. Immediately call the Radiation Safety Officer (RSO). The contact information for the RSO is on the first page of this manual.

11.4 Internal or External Radiation Exposure

In the event of suspected (or known) exposure to any person, immediately call the Radiation Safety Officer (RSO). The contact information for the RSO is on the first page of this manual.

11.5 Radioactive Spill or Radioactive Contamination (Non-Personal)

In the event of radioactive contamination or spill, which does not involve injury or personal contamination, immediate action must be taken to limit the spread of contamination.

1. Ensure your own safety and the safety of others. Do not do anything to contaminate yourself or others.
   - Immediately inform co-workers in the area. Keep unnecessary personnel away from the area.
   - Leave fume hood fan on.
   - Do not do anything to cause increased spread of contamination.
   - Step back 1 or 2 meters – preferably onto a clean disposable absorbent pad.
   - If appropriate, check people in immediate area for radioactive contamination before proceeding.
   - If possible, inform supervisor of the situation and ask for their assistance.

2. Cordon off the area to keep unnecessary persons from entering the contaminated area.

3. If you are not trained to cope with the severity of incident, or the spill is a Major Radiological Incident (involves more than 10MBq (270uCi) or 100 EQ whichever is more restrictive) (See the third column of Appendix D at the end of this manual for a list of 100 EQ):

- Immediately call the Radiation Safety Officer (RSO). The contact information for the RSO is on the first page of this manual.
- Wait outside the contaminated area in the immediate vicinity for the RSO. Remain available to help with decontamination and provide assistance as directed by the RSO.

4. If you know it is a Minor Radiological Incident involving less than 10MBq (270uCi) or 100EQ, whichever is more restrictive, non-volatile and no personal contamination:
   - Get the Spill Kit and contamination meter (for radioisotopes H-3 or C-14 plan to use Liquid Scintillation Counting).
   - Wear a clean lab coat and gloves to prevent personal contamination.
   - Wear protective shoe covers, or, alternatively, the floor may be covered with absorbent pads (absorbent side down) and only walk on the pads.

5. MONITOR (see 11.2 5. above) the area to determine the extent of contamination with a suitable contamination meter. For H-3 and C-14, use liquid scintillation techniques.

6. For spills: Surround the spill with absorbent material. Cover liquid spills with absorbent material. Use wetted absorbent material for dry spills. Allow the absorbent material at least 10 minutes in contact with the spill.

7. While you are waiting, prepare waste containers and tags for waste created during the decontamination procedures. All wastes are to be disposed of in accordance with Section 12 on Waste Disposal. Remember to keep higher level and lower level waste separate.

8. Wearing clean disposable gloves, lift the absorbent material and place into appropriate waste container(s).

9. Check for radioactive contamination: MONITOR (see 11.2 5. above) and if necessary, continue to decontaminate using more of the absorbent material. The initial approach should be scrubbing with small quantities of warm water containing soap or detergent. Use no more liquid than necessary in order to minimize the spread of contamination.

10. Re- MONITOR for contamination and repeat until removable contamination is below 0.5Bq/cm^2 or whatever limit is specified on the Permit for the involved radioisotope. There are reporting requirements if CNSC Contamination Limits (see column 9 of Appendix D at the end of this manual) are exceeded.

11. Package and tag all waste generated.

12. Write a report.
    - Provide a written record of decontamination procedure and results of subsequent monitoring.
    - Analyze the contributing factors to the incident and take action to reduce the possibility of a re-occurrence.
    - File the Report in the Radiation Safety Records binder in the room where the incident occurred.
    - Send a copy to the Radiation Safety Officer.

11.6 Contacting the Radiation Safety Officer to Report

Contact the Radiation Safety Officer to report the situation as soon as possible. Radiation Safety Officer has the responsibility to:

- Assess or arrange for the assessment of worker exposure to ionizing radiation.
- Revise or remove restrictions on access to the area in terms of radiological hazard.
- Supervise the monitoring of areas for radioactive contamination and the decontamination process.
- Report incidents as required by regulations.

12. Radioactive Waste

Careful handling and disposal of waste is critical to controlling contamination in the laboratory and protecting ancillary staff and the environment.

12.1 Radioactive Waste Policy Statement

Radioactive waste disposal by the lab personnel to the regular garbage is strictly prohibited.

All wastes generated from the use of radioactive materials shall be handled in a manner to ensure:

- Exposures from radioactive materials to the public and environment are As Low As Reasonably Achievable (ALARA), economical and social factors considered.
- Waste is disposed of in accordance with University hazardous waste disposal guidelines as described in in this section (12).
- Radioactive waste is stored securely.

All wastes generated by the use of radioactive materials shall be transferred by Designated Workers to Environmental Health and Safety staff. EHS will ensure wastes are disposed of in compliance with regulatory limits.

12.2 Permit Holder Responsibilities

The Permit Holder is ultimately responsible to ensure:

- Safe and secure storage of radioactive waste in the lab.
- Proper waste labeling and sorting.
- Timely transfer of radioactive waste into the EHS radiation waste facility.
- The waste disposal procedures described in this section are followed.
- Local procedures may be developed subject to EHS approval.

12.3 Basic Waste Procedures

1. Before using radioactive materials, consider your planned experiments and prepare waste containers for all potential waste types.

2. Water used to wash hands or glassware or equipment may be flushed down the designated lab sink indicated with Striped Tape. (Striped Tape as defined on page 3 of this RSP).

3. Liquid scintillation fluid must be poured into a waste container for liquids and the emptied vials disposed into a wet solid waste container.

4. At the University, never use red or orange biohazard bags.

12.4 Waste Types and Acceptable Containers

A waste container should be selected to contain the waste intended.

1. Stock vials, shielded vials and 'kits' are all given to EHS in the original packaging 'as is' with their corresponding 'gold' Radioisotope Inventory Form. Do not empty contents into another waste container!

2. Lead: Remove labels and plastic if possible and package in a 'small box' if appropriate.

3. Liquid waste should be collected in a wide-mouth high-density polyethylene containers or barrier-pack containers. No Glass. Do not fill container more than 85% full.

4. Keep the following materials in separate containers:
   - Liquid Scintillation Fluid
   - Flammable Liquids: a solution containing more than 20% flammable component (Ethanol, Methanol) is considered a flammable liquid. Do not fill container more than 75% full.
   - Containing Bleach
   - All other liquids should be separated by WHMIS class

5. Wet solids such as emptied vials and spill clean–up must be double-bagged (clear bags only) and secured in a box or packed in a closed pail. Transfer to EHS promptly.

6. Dry solids (e.g. gloves, paper, underpads, plastics) should be collected in a clear bag and secured in a box or packed in a closed pail. Remove or deface any radiation warning labels prior to placing in waste container.

7. Sharps must be collected in a puncture proof container (high density plastic or metal). DO NOT COLLECT in Biohazard Sharps Containers!

12.5 Disposal of Mixed Radiological and Biological Waste

Autoclaving radioactive waste is prohibited at the University. Autoclaving radioactive waste could result in radioactive contamination.

Working with radioactive materials in whole animals requires a Radiological-Biological Waste Approval (RBWA) to be listed on the Permit under 'Approved Usage'.

Unless the RBWA listed on the Permit is followed, waste generated while working with radioactive and biological material must follow the procedures listed below. This general approval is limited to work with Biological Agents that are Risk Groups 1 or Risk Group 2 and not for experiments involving whole animals.

1. Biologically hazardous liquid samples (Risk Group 1 and Risk Group 2) mixed with Liquid Scintillation Fluid are effectively disinfected and disposed as described in item 12.4 above. Never add bleach to Liquid Scintillation Fluid as adding bleach to Liquid Scintillation Fluid may create other hazards.

2. Liquids with cells, bacteria, blood and body fluids – add 20% household bleach (approximately 1 part household bleach to 4 parts liquid waste, final concentration 1.05% of NaOCl) unless there are other chemical hazards. For example, do not add bleach to radioiodine waste. Dispose as a liquid containing bleach (item as described in item 12.4 above).

3. Solids
   a. Gloves or paper towels that are incidentally contaminated with biological and radioactive agents may be bagged and boxed as Dry Solid Radioactive Waste.
   b. Syringes and needles: Draw freshly prepared 20% household bleach into the syringe and needle, and soak for 20 minutes. Discard the rinsing fluid (see item 12.5 2) then place syringe and needle in a puncture proof container (not a biohazard sharp container) and dispose as radioactive sharps waste.
   c. Pipettes, pipette tips and empty assay vials (flasks, petri dishes) formerly in contact with radiological-biological liquid will be soaked in freshly prepared 20% household bleach (rinsing fluid) for 20 min. Discard the rinsing fluid as incidental waste (see item 12.5 2) and dispose of the solids as wet solid radioactive waste.

12.6 Waste Labelling

All waste containers must be labelled with the University radioactive waste tag unless located on a radioisotope work area labeled with trefoil or Striped Tape. (Striped Tape as defined on page 3 of this RSP).

1. Complete the upper part of the tag and attach the tag to the container. The required information is: radioisotope, permit number, responsible user, date started collecting the waste, type of waste and chemical name in full; or, biological components and decontamination method (e.g. bleach).

2. Prior to transfer to EHS radioactive waste facility, wipe test the outside of the container and complete the bottom part of the tag. This includes the information on volume or weight, isotope, the activity in megabecquerel (MBq) of each isotope in the container and the date the activity was measured. The activity can be either measured directly or estimated based on original activity used and type of waste generated. Remember to correct for decay.

13. Radiation Safety Training and Consent

Provincial and Federal regulations require that workers are informed of risks in the workplace and trained to identify potential hazards and how to work safely. Regulations require that documentation of radiation safety training must be kept for three years past the end of ‘employment’.

To ensure workers are aware of the risks, have the necessary knowledge to work safely and are able to perform the needed work practices competently in the lab, the following training program must be completed.

13.1 Registration of Personnel with the University Radiation Safety Program

- All personnel shall submit a form to record their consent to their role on a Permit to work with radioactive materials and establish their past training and experience (Radiation Safety Program - Personnel Registration and Consent Form - found on the Environmental Health and Safety (EHS) webpage).
- EHS radiation safety training must be completed prior to being listed as a Designated Worker or Laboratory Radiation Supervisor.
- EHS will keep documentation (attendance, content, tests) of all radiation safety training provided by EHS.

13.2 Training for Permit Holder

- Upon the issuance of a Permit to a new permit holder, Radiation Safety staff will conduct a New Permit orientation session with the Permit Holder to communicate the basics of the University Radiation Safety Program as per a checklist. Time limit: 2 weeks from issuance of the Permit and prior to the first use of radioactive material.
- Permit Holders are strongly encouraged to participate in the Designated Worker training including the Radiation Safety Workshop.
- New Permit Holders who do not meet the training requirements of a Designated Worker will not be permitted work with radioactive materials.

13.3 Training for Designated Workers and Laboratory Radiation Supervisors

Designated Workers (DW), including Laboratory Radiation Supervisor (LRS)

- Within four months of being listed on an Internal Permit, all DW /LRS shall participate in the Radiation Safety Workshop (or they will be removed from the Permit).
- Until the workshop is completed, a DW will be physically supervised by a fully trained DW/LRS while manipulating radioactive material. Additionally, the Permit Holder shall ensure that all DW/LRS are properly trained in site-specific procedures.

13.3.1 Self study

Prior to being listed on an Internal Permit, all Designated Workers/Laboratory Radiation Supervisors will complete a self-study as directed by the Radiation Safety Officer and complete a take home assignment. Self-study topics include:

- Theory of Radiation
- Radiation Exposure
- Legal Requirements
- Contamination Monitoring
- Ordering, Receiving, Inventory Control
- Working with Radioactive Material
- Radioactive Waste

13.3.2 Lab assignment

The lab assignment should be completed with a mentor in the prospective radioisotope lab. Mentor is preferably an experienced Designated Worker from the same lab. If one is not available, the Radiation Safety Officer may appoint an alternate.

13.3.3 Radiation Safety Workshop

Permit Holders and Laboratory Radiation Supervisor are notified of course dates on a periodic basis. Registration is on a first come basis. Workshops are provided by EHS and include hands-on activities in a training lab setting. Topics include:

- Lab set-up and security
- Using contamination meters
- Shielding, Time and Distance
- Receiving a shipment of radioactive material
- Contamination monitoring
- Emergency procedures and spill exercise

13.3.4 A challenge exam

A challenge exam may be administered on an individual basis.

If an individual chooses to sit the challenge exam, only one opportunity will be granted. If the individual does not successfully complete the exam, he or she shall participate in the specified training.

- Summer students listed on Permits using Open Source radioactive material are not given the option of the challenge exam.
- The Permit Holder shall ensure that at least one Designated Worker on a Permit for Open Source radioactive material has taken the workshop rather than the challenge exam.

13.3.5 Past Training Exemption

The Radiation Safety Officer may grant a 'past training exemption' for the workshop if satisfied that appropriate formal training has occurred in the last three years. Appeal to the Radiation Protection Committee may be requested. The decision of the Radiation Protection Committee is final.

13.3.6 Refresher

Every three years, the Radiation Safety Officer shall audit each Permit with a prescribed checklist. This process will include the Permit Holder and all available Designated Workers as listed on the Permit. The completed checklist will be kept by EHS as a record of the review session. Refresher training must be completed by each Designated Worker within 36 months of the previous workshop or refresher or they will be removed from the Permit.

13.3.7 Site Specific Training Records

When there exists a radiation risk in the lab that is not mitigated by the procedures in this manual, Manitoba Workplace Health and Safety regulations require:

- Safe work procedures that reduce the risk as much as reasonably practicable,
- Workers must be trained in these site-specific procedures and
- Permit Holders must ensure the procedures are followed.

Documents of the site-specific training should be kept in the Radiation Safety Records Binder.

UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title:	**Radiation Standard Procedures – Sealed Source**		
Number:	RSP-4		Page 1 of 12
Issued by:	Environmental Health and Safety	Date issued:	June 23, 2017
Approved by:	Radiation Protection Committee	Date approved:	June 29, 2017

1. Introduction

Sealed Sources are radioactive materials encapsulated or encased in such a way that it is extremely unlikely the radioactive material would be absorbed into a worker's body. Sealed Sources, therefore, only present an external radiation hazard. At the University, Sealed Sources are typically low activity check sources, calibration sources or larger activity Mossbauer spectroscopy sources. When a Sealed Source is incorporated into equipment in such a way that the device can make use of the properties of the ionizing radiation, the equipment is called a Radiation Device. At the University, Radiation Devices are often electron capture detectors (used for gas chromatography), soil moisture meters or liquid scintillation counters. RSP-4 outlines the (minimum) procedures required to ensure the safe use of Sealed Sources and Radiation Devices in order to minimize the radiation exposure of all staff, students, the public and the environment and comply with all applicable regulations.

RSP-4 covers hazard identification, records keeping, how to obtain Sealed Sources, opening shipments, rules, leak testing and training.

2. Definitions

CNSC means the Canadian Nuclear Safety Commission.

Committee means the Radiation Protection Committee.

Decommissioning is the process of releasing equipment or a room from the conditions on the Internal Permit. Decommissioning requires documentation to record that all radioactive material has been removed and no radioactive contamination is present in excess of legal limits or that the permitted X-ray Device is removed or locked out of service. See Section 5.3 of RSP-2 and the current forms for decommissioning Permits or equipment will be on the Environmental Health and Safety website.

Designated Worker means an individual listed on the Permit as working under the authority of the Permit Holder.

EHS refers to Environmental Health and Safety. Acronym formerly used was EHSO.

Exemption Quantity (EQ) Isotope specific quantity defined by regulations. Exemption Quantities are listed in the second column of Appendix D at the end of this manual.

Laboratory Radiation Supervisor (LRS) is a Designated Worker nominated by a Permit Holder to assist the Permit Holder to carry out the duties as specified in this manual. The LRS is responsible to ensure the Radiation Safety Manual is up to date and available to all Designated Workers. The LRS shall keep records that Designated Workers have been informed of changes to the Radiation Safety Manual.

Permit means the Internal Permit issued by the Committee to control all procurement, use, storage, transfer and disposal of all radioactive materials, radiation devices, X-ray equipment and other sources of ionizing radiation in all areas under the control of the University.

Permit Holder/Responsible User means the individual issued the Permit by the Committee who is required to be a faculty member or report to a Dean, Director or Department Head or who is supervised by a Dean, Director or Department Head.

Radiation Device, for the purpose of this manual shall refer to a device that contains more than the exemption quantity of a nuclear substance and that enables the nuclear substance to be used for its radiation properties.

Radiation Safety Records Binders are provided by Environmental Health and Safety (EHS) for the storage of all records that are required by the conditions of the Permit. The Radiation Safety Records binder and the records inside are the property of EHS and shall be returned when the room is decommissioned.

Radiation Safety Officer means the University employee Environmental Health and Safety designated as the Radiation Safety Officer pursuant from the Radiation Safety Policy.

Radiation Safety Program means the program developed pursuant from the Radiation Safety Policy.

Radiation Warning Symbols (trefoil) shall be used as outlined in this procedure to identify all areas where radioactive materials are used or stored.

Radioactive material, for the purposes of this manual, the term “radioactive material” shall be limited to materials used for their radioactive properties in the course of research or teaching. Further, “radioactive material” means an unstable isotope of an element that decays, or disintegrates spontaneously, emitting radiation of sufficient energy to create charged particles by adding or removing an electron or breaking chemical bonds.

RSP means Radiation Standard Procedures that are approved by the University Radiation Protection Committee and documented in the University of Manitoba Radiation Safety Manual.

Sealed Source Permits are Internal Radioisotope Permits specifically authorizing the use of Sealed Source radioactive materials and the conditions of that use. Sealed Source Permits are those beginning with the designations F-1- (for Fort Garry Campus) or B-1 (for Bannatyne Campus).

Sealed Source Radioactive Material is radioactive material that is encapsulated or encased in such a way that the radioactive material is extremely unlikely to be absorbed into the body and therefore present only an external radiation hazard. An example would be small calibration sources and Mossbauer spectroscopy sources.

Sealed Sources Requiring Leak Testing are all Sealed Sources over 50 megabecquerel (50 MBq) and all Radiation Devices containing Sealed Sources greater than 50 MBq. Gaseous sources or sources of tritium are exempt from leak testing.

The University is the University of Manitoba.

3. Policy Related to the Use of Sealed Sources and Radiation Devices

Sealed Sources and Radiation Devices will be used in a manner to minimize the radiation exposure of all staff, students, the public and the environment and comply with all applicable regulations.

4. Posting and Labelling

At the University, a consistent approach is required to identify Radiation Devices and areas where Sealed Sources are used or stored. Lab workers and ancillary staff rely on Designated Workers to identify potential hazards with posted information (postings) and labels as described in this section.

4.1 Internal Radioisotope Permit

A copy of the most recent Internal Radioisotope Permit shall be posted in a prominent place in each location listed on the Permit as approved for use and storage of radioactive materials or Radiation Devices.

4.2 Contact Information at Entrance

At the entrance of every location listed on a Sealed Source Internal Radioisotope Permit, there shall be posted:

- Name of at least one Permit Holder as well as information on how to reach this person during the workday.
  - The first contact shall be a Permit Holder for the room, and
  - The second contact shall be currently listed on an Internal Radioisotope Permit for the room.
- Contact information for the University Radiation Safety Officer and alternate.
- After Hours Emergency Contact Information for the University Security Services to initiate emergency procedures related to the Radiation Safety Program.

4.3 Radiation Warning Symbol Posted at Entrance

Radiation Warning Symbol and the words “RAYONNEMENT-DANGER-RADIATION” shall be posted at the entrance of a room when:

- The room contains radioactive material in excess of one hundred exemption quantities (EQ), and/or

- A person could be exposed to a radiation field in excess of 25 microsieverts per hour at a distance greater than 0.3 meter from any object or shield. In this case:
  - The room shall be posted as "Restricted ENTRANCE" and "Must be accompanied by lab personnel".
  - The entrance is restricted to lab personnel that are Designated Workers listed on the current Internal Radioisotope Permit.
  - There must be a 24 hour 'unaccompanied entrance' Safe Work Procedure (SWP) approved by Environmental Health and Safety and provided to Security Services and Physical Plant to allow for unaccompanied entrance for life or building saving scenarios.

4.4 Labelling with Radiation Warning Symbol

Within the lab, the Radiation Warning Symbol shall be displayed where Sealed Sources greater than 1 exemption quantity (1 EQ) are stored, or are in use and unattended.

- The Radiation Warning Symbol shall be removed from equipment and areas when the radioactive material is removed.
- Radiation warning symbols shall only be used as described in the Radiation Safety Manual. Unwarranted radiation warning symbols shall be removed.

5. Radiation Safety Records Binder

To facilitate inspections, all records required by the conditions of the Internal Radioisotope Permit are kept accessible for inspection, either visibly posted in the room, or in Radiation Safety Records binders provided by Environmental Health and Safety (EHS).

- One Radiation Safety Records binder will be issued by EHS for each room that is permitted to store or use radioactive materials. Normally, one binder shall be issued per room regardless of the number of permits on the room.
- Records required to be in the lab:
  - Leak test and sampling certificates
  - Radioactive Source Inventory Log Form (green sheets or copies of the green sheet on white paper for items that have been disposed)(Effective January 1, 2018)
  - Copies of TDG certificates (receiving class 7 Radioactives) for lab personnel
  - All in lab site specific training related to Radiation Safety, such as:
    - Safe Work Procedures listed as a condition on the Internal Radioisotope Permit
    - A copy of the Lab Assignment (effective September 14, 2016)
  - Copies of any incidents, malfunctions, security breaches related to Sealed Sources and Radiation Devices (listed on the Permit).
  - Keep all records for a minimum of 8 years and do not discard until authorized by EHS (at time of annual inspection).

6. Ordering/ Obtaining Radioisotopes and Inventory (Forms)

The University is licensed by the Canadian Nuclear Safety Commission to use specified item limits of Sealed Sources and specific Radiation Devices. To ensure the University does not exceed the

licence limits, all orders and transfers to and from the University must be pre-approved by Environmental Health and Safety.

6.1 Environmental Health and Safety Responsibilities related to Ordering Sealed Sources

Environmental Health and Safety (EHS) is responsible to pre-approve every transfer or order of radioactive material. EHS will:

- Provide radiation safety pre-approval of every transfer or order of radioactive material.
  - The pre-approval process will ensure the University is licensed to receive the order.
  - An assessment is made to ensure the possession, use and storage of this item in the permitted facility will control radiation dose ensuring ALARA.
- Effective January 1, 2018, EHS will generate a unique Radioactive Source Inventory Log Form (Inventory Log Form) on green paper for every radioactive Sealed Source or Radiation Device based on information from the transfer or purchase request. By April 1, 2018, EHS will prepare an Inventory Log Form for Sealed Sources and Radiation Devices received prior to January 1, 2018.
- EHS maintains an inventory of all scintillation counters, gamma counters, radiation survey and contamination meters.

6.2 The Permit Holder Responsibilities related to Ordering Sealed Sources

The Permit Holder is responsible to ensure:

- Every transfer or purchase of radioactive material has radiation safety pre-approval from EHS.
- Orders are placed only for radioisotopes listed as approved on the current Internal Radioisotope Permit and the approved item limits are not exceeded. (If the radioisotope is not listed on the Permit or the order is greater than the source activity on the Permit, the Permit will need to be amended prior to placing the order.)
- Effective April 1, 2018, every Sealed Source or Radiation Device in the possession of the lab has its own unique Radioactive Source Inventory Log Form as generated by EHS.
- Radioactive Source Inventory Log Forms are kept in the Radiation Safety Records binder in the room where the Sealed Source or Radiation Device is normally located. Records are up-to date and readily available for inspection.
- When a source decays below one exemption quantity (EQ), it should be removed from the Permit, and this action noted on the Inventory Log Form. The original on green colored paper, is kept in the lab until the Sealed Source or Radiation Device is transferred to EHS for disposal.
- All permitted Sealed Sources and Radiation Devices are stored in a safe and secure manner. Sealed Sources that are not in use are stored in a locked cupboard or lock box to ensure they are only accessible to Permit Holders or Designated Workers.
- EHS is immediately informed of any Sealed Source or Radiation Device that does not have a unique EHS generated Radioactive Source Inventory Log Form.
- The required information is accurately recorded on the Radioactive Source Inventory Log Form. Discrepancies between the original order information and the item as received are recorded in the space provided on the Inventory Log Form. Significant discrepancies (>10%) should be promptly reported to EHS.
- The Serial Number of the Radioactive Source Inventory Log Form is copied onto the corresponding Sealed Source (or equivalently the container, baggie or tag associated with the Sealed Source) or labelled onto the Radiation Device.
- The Radioactive Source Inventory Log Form may be used to record the use of the item or document how / where these records are kept. For example, if the use log of a Radiation

Device (eg Liquid Scintillation Counter) is computerized or kept in a separate document, then this is clearly described on the Radioactive Source Inventory Log Form. Uses would include security checks (further described below), leak tests, installation of a Sealed Source into a device, transferring a source or device to another permitted or licensed location, returning sources to storage, and ultimately, transferring Sealed Sources or Radiation Devices to EHS for disposal.

- For Sealed Sources and Radiation devices containing more than 50 megabecquerels (50 MBq), a log is kept of the date, the name of the person that uses or handles the Sealed Source or Radiation Device and the manner the Sealed Source or Radiation Device was used.
- Effective January 1, 2018, the only accepted method of disposal for Sealed Sources or Radiation Devices is to transfer to EHS along with the corresponding Radioactive Source Inventory Log Form. A copy on white paper of the Radioactive Source Inventory Log Form is kept in the Radiation Safety Records Binder (for 8 years past the discard date).
- All Sealed Sources and Radiation Devices listed on a Permit are physically inventoried at least once per calendar year and this security check is recorded on the corresponding Radioactive Source Inventory Log Form. Physically verifying inventory more often (for Category 4 and Category 5 Sealed Sources) as prescribed by CNSC) and any other security requirements as specified in the Permit conditions.
- All transfers of Sealed Sources or Radiation Devices within the University are recorded on the Inventory Log Form including the date and the Permit Number of the receiving Permit.
- All movement of Sealed Sources or Radiation Devices to and from the University is coordinated in advance with EHS.
- EHS is informed of all scintillation counters, gamma counters, radiation survey and contamination meters in the Permit Holder's department whether they are in use or not. EHS should be informed of newly acquired equipment as well as equipment that is leaving the department. EHS will assist in making the proper arrangements to discard or transport.
- Orders for Sealed Sources or Radiation Devices are placed using the University e-procurement system. The current e-procurement procedure is available on the EHS web page. If the e-procurement procedure cannot be followed (i.e. Radiation Devices may have purchasing requirements or controls that supersede e-procurement), contact EHS (radsafe@umanitoba.ca) to ensure radiation safety pre-approval from EHS PRIOR to placing the order!

7. How to Receive a Shipment

Depending on the amount of activity, radioactive material may be potentially dangerous. Transportation of Dangerous Goods is controlled by Federal regulations invoking stringent federal and provincial reporting requirements. The following procedure is required to be followed when opening a shipment of a Sealed Source or a Radiation Device.

7.1 Receiving Procedure

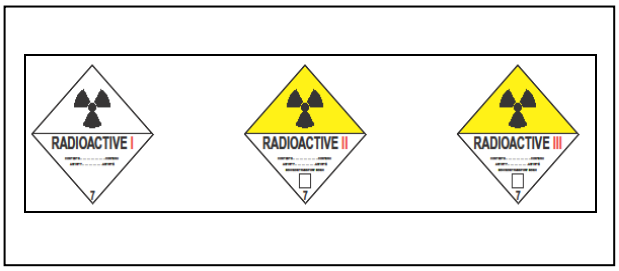
1. Immediately report any anomalies (damage, missing, short or wrong shipment) to the Permit Holder and/or Laboratory Radiation Supervisor and to the Radiation Safety Officer (RSO). The RSO contact information is on the front page of this manual.
    - The RSO must make a preliminary verbal report to the Canadian Nuclear Safety Commission and Manitoba Department of Environment.

- Lab staff must inform the consignor (vendor) immediately.

2. Before opening a package containing radioactive material, make sure:
   a. Packages of radioactive material are never left unsecured.

   b. Shipments of radioactive materials labelled with one of the Transport of Dangerous Goods (TDG) symbols (pictured below) are only received and opened by persons that have been certified (trained) in receiving Class 7 Radioactive Materials.

Figure 1: Transportation of Dangerous Goods symbols



Non-certified personnel may only receive packages of radioactive materials that are shipped and labelled as "Excepted Packages" and do not have a TDG symbol displayed.

Figure 2: Excepted Package label

RADIOACTIVE MATERIAL,
EXCEPTED PACKAGE –
LIMITED QUANTITY OF MATERIAL
UN 2911

   c. Confirm the package is addressed to your lab. If not, STOP & report to RSO.

   d. Upon receipt, unopened packages of radioactive material should be promptly delivered to an approved location listed on the Internal Radioisotope Permit.

   e. If appropriate, use a cart when transporting radioactive packages to increase the distance between people and the package and minimize radiation exposure.

3. To open a Radioactive Shipment:

   a. Unpack urgently! The package contains a dangerous good, it is important to check to make certain there is no damage from the transport.

   b. Place package behind appropriate shielding if applicable.

   c. Remove the packing slip from the exterior of the package and review to ensure the information corresponds to what was ordered. If not, STOP & report to RSO.

d. Check the exterior and then the interior of the package for possible damage or tampering.
   - If the package is damaged or tampering is obvious STOP & report to RSO.
     - Isolate the package to limit the spread of any contamination.
     - Wash your hands. Monitor your hands and clothing. If you do not have access to a contamination meter (not required for a Sealed Source Permit), contact the RSO immediately.
   - If no visible damage, while avoiding or limiting unnecessary direct contact with an unshielded source, continue unpacking to verify the Sealed Source is there. Place the Sealed Source back into the shielding as appropriate.

e. Write the serial number from the Radioactive Source Inventory Log Form on the source, tag, baggie or primary container. The serial number is located in the upper part of the Inventory Log Form.

f. Secure Sealed Sources or portable Radiation Devices in locked storage location.

g. Record the pertinent information on the Inventory Log Form (activity received, assay date, manufacturer's serial and Model). Send this information to radsafe@umanitoba.ca along with your Permit number so Environmental Health and Safety will be able to amend these details onto the Permit and update the University records.

h. If the Sealed Source or Radiation Device has a Leak Test Certificate provided, forward a copy to Environmental Health and Safety and keep the original in the Radiation Safety Records Binder.

i. If the packaging is believed to be free of contamination, remove or deface all radiation warning symbols and/or wording before discarding into the regular garbage.

7.2 Contacting the Radiation Safety Officer to Report Anomalies

Contact the Radiation Safety Officer to report the situation as soon as possible. Radiation Safety Officer has the responsibility to:

- Assess or arrange for the assessment of worker exposure to ionizing radiation.
- Revise or remove restrictions on access to the area in terms of radiological hazard.
- Supervise the monitoring of areas for radioactive contamination and the decontamination process.
- Report incidents as required by regulations.

8. Rules for Working with Sealed Sources or Radiation Devices

To minimize the potential hazards of working with Sealed Sources or Radiation Devices, before each experiment, workers are required to consider the potential for hazard with the value from the experiment.

- Optimize and justify every use of radioactive material.
- Consider using the lowest energy radioisotope and the least amount of activity if applicable.

The following basic rules must be followed when working with Sealed Sources or Radiation Devices:

1. Prior to beginning work, it is important to be familiar with the specific hazards of the radioactive material present.

2. All Sealed Sources and portable Radiation Devices shall be attended by a Designated Worker or must be locked (secure) when not attended by a person listed on the Internal Radioisotope Permit.

3. Sealed Sources or Radiation Devices are to be stored and used in a way that ensures that radiation fields in accessible operating areas do not exceed 25 microsieverts per hour and in areas adjacent to radioactive working areas do not exceed 2.5 microsieverts per hour.

4. Preplan procedures to minimize the time spent in close proximity to the Sealed Source to reduce the time of exposure.

5. Utilize procedures that maximize the distance between people and the Sealed Source.

6. Follow manufacturer's directions for storage, leak testing procedures and manipulation of the Sealed Source. Additional shielding may be required.

7. Report all incidents to Environmental Health and Safety. Contact the Radiation Safety Officer to report the situation as soon as possible. Radiation Safety Officer has the responsibility to:
   - Assess or arrange for the assessment of worker exposure to ionizing radiation.
   - Revise or remove restrictions on access to the area in terms of radiological hazard.
   - Supervise the monitoring of areas for radioactive contamination and the decontamination process.
   - Report incidents as required by regulations.

9. Leak Testing

Sealed Sources and Radiation Devices containing Sealed Sources greater than 50 megabecquerel (50 MBq) must be leak tested to ensure they are still sealed. Leak testing is required at the frequency described below (see 9.2 below) and whenever a source may have been damaged.

9.1 The Permit Holder Responsibilities

The Permit Holder is responsible to ensure:

- When an agency other than Environmental Health and Safety (EHS) is used to measure leak tests, copies of each sampling and leak test certificate are kept. A copy of each is forwarded to EHS. This includes the leak test provided by the vendor at the time of procurement.
- Copies of every leak test sampling certificate and the leak test certificate are kept in the Radiation Safety Records binder for at least the last eight years.
- A written step-by-step procedure for wipe sampling each type of Sealed Source or Radiation Device and a copy of this procedure are kept in the Radiation Safety Records Binder.

- Leak tests are performed at the frequency required by the conditions on the Internal Radioisotope Permit.

9.2 Frequency of leak testing:

9.2.1 Prior to Transport

A leak test and pre-approval from the Radiation Safety Officer is required prior to transferring any source over 50 megabecquerel (50 MBq) to another Licensee.

9.2.3 Sealed Sources (not in Radiation Devices)

Except for gaseous sources or sources of tritium, leak tests shall be performed for all Sealed Sources of more than 50 megabecquerel (50 MBq). The frequency of leak testing shall be:

- Immediately after any incident that may result in source damage.
- Every 24 months, for Sealed Sources that are recorded on the Permit "approved usage" declared as STORAGE ONLY.
- Where the Sealed Source is used after being stored for 12 or more consecutive months, immediately before using it.
- Every six months for all other sources.

9.2.3 Radiation Devices Containing Sealed Sources

Except for gaseous sources or sources of tritium, leak tests shall be performed for all devices containing Sealed Sources of more than 50 megabecquerel (50 MBq). The frequency of leak testing shall be:

- Immediately after any incident that may result in source damage.
- Every 12 months for devices containing Sealed Sources more than 10 times the exemption quantity or
- Every 24 months when the device is declared on the Permit "approved usage" as STORAGE ONLY.
- Every three years for Radiation Devices containing less than 10 times the exemption quantity.

9.2 University Leak Test Procedure

1. When a leak test is required, the Permit Holder will be sent a leak test sampling kit.

2. Follow the direction therein and refer to the written step-by-step procedure for wipe sampling.

3. Keep a photocopy of the filled in leak test kit (sampling certificate) in the Radiation Records binder for the room in which the Sealed Source is stored. Record the leak test on the Radioactive Source Inventory Log Form.

4. When you receive the Leak Test Certificate (the measuring certificate), file it in the Radiation Safety Records binder for the room in which the Sealed Source is stored.

5. If a source or device fails the leak test, EHS will notify the Permit Holder regarding the appropriate action.

6. In the event of any incident that may have caused damage to the source, IMMEDIATELY CONTACT Environmental Health and Safety to request an emergency leak test kit. The possibly damaged source/device shall be immediately taken out of service.

10. Radiation Safety Training and Consent

Provincial and Federal regulations require that workers are informed of risks in the workplace and trained to identify potential hazards and how to work safely. Regulations require that documentation of radiation safety training must be kept for three years past the end of 'employment'.

To ensure workers are aware of the risks, have the necessary knowledge to work safely and are able to perform the needed work practices competently in the lab, the following training program must be completed.

10.1 Registration of Personnel with the Radiation Safety Program

- All personnel shall submit a form to Environmental Health and Safety (EHS) to record their consent to their role on a Permit to work with radioactive materials and to establish their past training and experience (Form on EHS webpage).
- EHS radiation safety training must be completed prior to being listed as a Designated Worker or Laboratory Radiation Supervisor.
- EHS will keep documentation (attendance, content, tests) of all radiation safety training provided by EHS.

10.2 Training for Permit Holders

- Upon the issuance of a Permit to a new Permit Holder, Radiation Safety staff will conduct a New Permit orientation session with the Permit Holder to communicate the basics of the University Radiation Safety Program as per a checklist. Time limit: 2 weeks from issuance of the Permit and prior to the first use of radioactive material.
- Permit Holders are strongly encouraged to participate in the same training that is required to be a Designated Worker.
- New Permit Holders who do not meet the training requirements of a Designated Worker will not be permitted work with radioactive materials.

10.3 Training for Designated Workers (including Laboratory Radiation Supervisors)

10.3.1 Self study

Prior to being listed on an Internal Radioisotope Permit, all Designated Workers/Laboratory Radiation Supervisors will complete a self-study as directed by the Radiation Safety Officer and complete a take home assignment. Topics include:

- Theory of Radiation
- Radiation Exposure
- Legal Requirements

10.3.2 Lab assignment

The lab assignment should be completed with a mentor in the prospective radioisotope lab or, for the portable gauges, in the field. The mentor is preferably an experienced Designated Worker from the same lab. If one is not available, the Radiation Safety Officer may appoint an alternate. Topics include:

- Legal requirements and Security
- Radiation Detection, Shielding, Time and Distance
- Emergency Procedures

10.3.3 A challenge exam

A challenge exam may be administered on an individual basis.
If an individual chooses to sit the challenge exam, only one opportunity will be granted. If the individual does not successfully complete the exam, he or she shall participate in the specified training.

- Summer students are not given the option of the challenge exam.
- The Permit Holder shall ensure that at least one Designated Worker on a Permit has completed the Self Study and Lab Assignment rather than the challenge exam.

10.3.4 Past-Training Exemption

The Radiation Safety Officer may grant a 'past training exemption" if satisfied that appropriate formal training has occurred in the last three years. Appeal to the Radiation Protection Committee may be requested. The decision of the Radiation Protection Committee is final.

10.3.5 Refresher

Every three years, the Radiation Safety Officer shall audit each permit with a prescribed checklist. This process will include the Permit Holder and all available Designated Workers as listed on the Permit. The completed checklist will be kept by EHS as a record of the review session.

A Designated Worker will be removed from the Permit 36 months after the last date of training.

10.3.6 Site Specific Training Records

When there exists a radiation risk in the lab that is not mitigated by the procedures in this manual, Manitoba Workplace Health and Safety regulations require:

- Safe work procedures that reduce the risk as much as reasonably practicable,
- Workers must be trained in these site-specific procedures and
- Permit Holders must ensure the procedures are followed.

Documents of the site-specific training should be kept in the Radiation Safety Records Binder.

UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title:	**Radiation Standard Procedures – X-ray Equipment**		
Number:	RSP-5		Page 1 of 9
Issued by:	Environmental Health and Safety	Date issued:	November 20, 2017
Approved by:	Radiation Protection Committee	Date approved:	December 4, 2017

1. Introduction

The use of X-ray Equipment in Manitoba is subject to regulation in the work place by Manitoba Workplace Safety and must comply with Health regulations and the Manitoba Health X-ray Regulation (expected to soon be superseded by the Ionizing Radiation Protection Act). At the University of Manitoba,

- X-ray equipment, also known as Ionizing Radiation Equipment, may be used (without an Internal Permit) by dental professionals and by students enrolled in Dentistry Education (as directed by their teachers).
- Equipment that contains radioactive material is considered a Radiation Device and is covered in RSP-4 (the preceding section).
- Outside of the College of Dentistry clinics, X-ray equipment is used for research purposes on research samples, animals and occasionally on humans. X-ray equipment that DOES NOT contain radioactive material requires an Internal X-ray Permit to allow use for research projects in locations controlled by the University.

This section of the manual pertains to X-ray equipment powered by electricity and only presents an external radiation hazard. When the power is off, there is no X-ray radiation and no risk of radiation.

- Some of the equipment is 'open beam' as the X-rays leave the equipment and travel though space to interact with the subject. Dental X-ray equipment would be a familiar example of this.
  - At the University, some open beam X-ray equipment has been set up in an interlocked room. Work practices are in place to ensure that persons present in the room when the device is in operation would be protected. These workers must wear personal dosimeters to document their radiation exposure.
  - Dual Energy X-ray Absorption Equipment (DXA) uses low energy X-rays to measure bone density. DXA is used on humans and animals for research projects to gather information related to bone density and lean muscle mass. Operators stay in the room at a safe distance and have no detectable radiation exposure because the radiation is very low energy and the device has an integrated quality control program. Persons that operate DXA must wear dosimeters to document their personal exposure.
- Most of the X-ray equipment at the University is shielded and interlocked in such a manner that radiation exposure only occurs within the device where the subject is placed. If this type of equipment is successfully tested annually (interlocks and leakage tests), then only the persons listed on the Internal X-ray Permit are assigned dosimeters to confirm the lack of exposure. Other workers (not listed on the permit) may use the equipment under the supervision of permitted workers and these persons are not required to wear dosimeters. The

Chief X-ray Safety Officer for Manitoba has accepted this use of dosimetry to satisfy the requirements in Manitoba X-ray Regulation.

RSP-5 outlines the minimum procedures required to ensure the safe use of X-ray equipment in order to minimize the radiation exposure of staff, students, the public and the environment and comply with all applicable regulations.

RSP-5 covers hazard identification, records keeping, how to obtain and register X-ray equipment for use at the University, rules, leakage testing and training.

2. Definitions

Clinical X-ray Equipment, for the purposes of this manual, shall refer to X-ray equipment that is used on human subjects to provide medical or dental care. The safe use of dental X-ray equipment is additionally guided by the Health Canada "Recommended Safety procedures for the Use of Dental X-ray Equipment- Safety Code 30".

Committee means the Radiation Protection Committee.

Decommissioning is the process of releasing equipment or a room from the conditions on the Internal Permit. Decommissioning requires documentation to record that all radioactive material has been removed and no radioactive contamination is present in excess of legal limits or that the permitted X-ray equipment is removed or locked out of service. See Section 5.3 of RSP-2. The current forms for decommissioning Permits or equipment will be on the Environmental Health and Safety website.

Designated Worker means an individual listed on the Permit as working under the authority of the Permit Holder.

EHS refers to Environmental Health and Safety. Acronym formerly used was EHSO.

Internal X-ray Permit means the Permit approved by the chair of the X-ray Committee to control all procurement, use, storage, transfer and disposal of all X-ray equipment used for research purposes in all areas under the control of the University.

Ionizing radiation means electromagnetic radiation that is capable of ionizing atoms.

Laboratory Radiation Supervisor (LRS) is a Designated Worker nominated by a Permit Holder to assist the Permit Holder to carry out the duties as specified in this manual. The LRS is responsible to ensure the Radiation Safety Manual is up to date and available to all Designated Workers. The LRS shall keep records that Designated Workers have been informed of changes to the Radiation Safety Manual.

Permit Holder/Responsible User (for this RSP) means the individual issued the Internal X-ray Permit by the X-ray Committee who is required to be a faculty member or report to a Dean, Director or Department Head or who is supervised by a Dean, Director or Department Head. For X-ray Equipment intended for clinical (not research) use, a permit

is not required, however the Responsible User/ Registered Owner should be authorized under Manitoba Regulations to supervise clinical X-ray Equipment.

Radiation Safety Records Binders are provided by Environmental Health and Safety (EHS) for the storage of all records that are required by the conditions of the Permit. The Radiation Safety Records binder and the records inside are the property of EHS and shall be returned when the room is decommissioned.

Radiation Safety Officer means the University employee Environmental Health and Safety designated as the Radiation Safety Officer pursuant from the Radiation Safety Policy.

Radiation Safety Program means the program developed pursuant from the Radiation Safety Policy.

Research X-ray Equipment, for the purposes of this manual, shall refer to X-ray equipment that may include:

- Any X-ray equipment that is not used on humans subjects or
- Any X-ray equipment that is used to irradiate human subjects under a research study protocol only.

RSP means Radiation Standard Procedures that are approved by the University Radiation Protection Committee and documented in the University of Manitoba Radiation Safety Manual.

The University is the University of Manitoba.

X-ray Equipment or X-ray machine means an operable device, the principle purpose and function of which is the production of X-rays, together with such ancillary apparatus as may be necessary for this purpose. For locations in the province of Manitoba, X-ray equipment is governed by the Manitoba X-ray Safety Regulation 341/88R.

X-ray Warning Symbol is pictured to the right.

3. Policy Related to the Use of X-ray Equipment

X-ray equipment will be used in a manner to minimize the radiation exposure of all staff, students, the public and the environment and comply with all applicable regulations.

4. Posting and Labelling

At the University, a consistent approach is required to identify X-ray equipment and areas where X-ray equipment is used. Lab workers and ancillary staff rely on Designated Workers and X-ray operators to identify potential hazards with posted information and labels as described in this section.

4.1 Internal X-ray Permit

For rooms listed on an Internal X-ray Permit, a copy of the most recent Internal X-ray Permit shall be posted in a prominent place in each location listed on the Permit as approved for use and storage of X-ray equipment.

4.2 Contact Information at Entrance

At the entrance of every location where X-ray equipment is used, there shall be posted:

- Names of at least two persons knowledgeable of the use of the X-ray equipment.
- For rooms listed as approved to use X-ray equipment on an Internal X-ray Permit
  - The first contact shall be a Permit Holder for the room, and
  - The second contact shall be currently listed on an Internal X-ray Permit for the room.
- After Hours Emergency Contact Information for the University Security Services to initiate emergency procedures related to the Radiation Safety Program.

4.3 X-ray Caution Posted at Entrance

X-ray tube symbol and the words “X-ray Caution Rayon-X” shall be posted at the entrance of a room when:

- The room contains X-ray Equipment that is intended for use in that location.

Restricted access would be required for locations listed on an Internal X-ray Permit if:

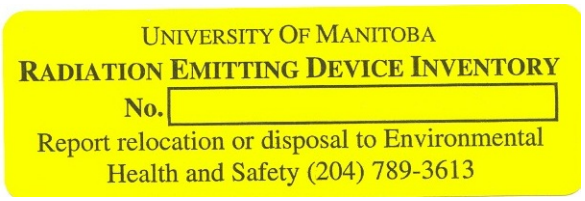
- A worker could be exposed to a radiation field in excess of 25 microsieverts per hour at a distance greater than 0.3 meter from any object or shield and
- The X-ray equipment is energized and is unattended by a permitted worker or an X-ray operator authorized by provincial regulations.

To restrict the access

- The room shall be posted as “Restricted ENTRANCE” and “Must be accompanied by lab personnel”.
- The entrance is restricted to lab personnel that are Designated Workers listed on the current Internal X-ray Permit.
- If the X-ray equipment is energized and unattended, there must be a 24 hour ‘unaccompanied entrance’ Safe Work Procedure (SWP) approved by Environmental Health and Safety and provided to Security Services and Physical Plant to allow for unaccompanied entrance for life or building saving scenarios.

4.4 Registration Stickers

All devices used in areas controlled by the University of Manitoba must be registered with Environmental Health and Safety and a Radiation Emitting Device Inventory Number sticker (pictured to the right) signifying the inventory number must be visible.



Provincial regulations also require that all X-ray equipment used in Manitoba must be registered with CancerCare Manitoba (Radiation Protection) and a registration sticker signifying the registration number must be visible.

Contact EHS if either sticker is faded, damaged, placed where it is not visible or illegible. Neither sticker may be removed or defaced.

If equipment bearing a University Radiation Emitting Device sticker is moved to a new location (for use or storage), EHS must be informed immediately and EHS will inform CancerCare Manitoba.

5. Radiation Safety Records Binder

To facilitate inspections, all records required by the conditions of the Internal X-ray Permit shall be kept accessible for inspection, either visibly posted in the room, or in Radiation Safety Records binders provided by Environmental Health and Safety (EHS).

- One Radiation Safety Records binder will be issued by EHS for each room that is permitted to store or use X-ray equipment for research purposes. Normally, one binder shall be issued per room regardless of the number of permits on the room.
- Records required to be in the lab:
  - Inventory records/log of use of each X-ray equipment and maintenance records shall be kept in the room where the X-ray equipment is located. If these records are not kept in the Radiation Safety Records binder, a description of the location of these records will be kept in the binder.
  - If required by permit conditions, a written record of leakage tests and interlock test for all X-ray equipment shall be kept in the Radiation Safety Records Binder within the room where the X-ray equipment is located. See Section 8 of this RSP.
  - Documentation for each Designated Worker having completed the Generic X-ray safety training provided by EHS.
  - All in lab site specific training related to Radiation Safety, such as:
    - Safe Work Procedures listed as a condition on the Internal X-ray Permit
    - A copy of the Lab Assignment (effective January 1, 2018)
  - For studies involving human subjects, copies of the Physician's Prescription(s):
    - Must be located as prescribed by the Personal Health Information Act.
    - Must be available upon request.
    - A note describing how to get access to these records must be kept in the Radiation Safety Records Binder.
  - Any decommissioning records for areas or X-ray equipment are to be kept in the Radiation Safety Records Binder. See RSP-2, Section 5.
  - Copies of any incidents, malfunctions, or security breaches related to the X-ray equipment.
  - If the Radiation Safety Records Binder is not clearly visible within the lab, a prominently located notice shall be posted in the room indicating the exact location of these records.
  - When the room is decommissioned the binder and its contents must be returned to the Radiation Safety Office.

- Keep workplace monitoring (leakage and incidents related to exposure) records for a minimum of 30 years and training records for a minimum of 5 years.

6. Ordering/ Obtaining and Registering X-ray Equipment

In order to meet the regulated requirements, *prior to ordering or obtaining X-ray equipment*, contact EHS to ensure that regulatory and University requirements are achievable. *This applies to X-ray equipment intended for clinical or research use in locations controlled by the University.*

- To ensure that facilities where X-ray equipment is used meet the minimum design features to facilitate the safe use of X-ray equipment, technical information and floor plans including adjacent rooms should be submitted for review to EHS. The floor plan must show the location of the open beam X-ray equipment. Include specification of any local shielding or shielding proposed for the walls. This information is required to register the equipment before it is used.
- Consideration shall be made to ensure the capacity of the floor, and, if appropriate, the bench, will bear the weight of shielding.
- Before X-ray equipment may be used in Manitoba, it must be registered with CancerCare Manitoba. Once serial numbers are known, fill in the University version of the registration form (on the EHS website) and submit it to EHS. EHS will process the form and forward it to Radiation Protection at CancerCare Manitoba to ensure the fastest approval.
- EHS maintains an inventory of all scintillation counters, gamma counters, radiation survey and contamination meters.

6.1 Permit Holder/ Responsible User Responsibilities related to ordering/obtaining and registering X-ray equipment

The Permit Holder/ Responsible User is responsible to ensure:

- All relocations or transfers of X-ray equipment within the University are pre-approved by EHS.
- All movement of X-ray equipment to and from the University is coordinated in advance with EHS.
- EHS is informed of all scintillation counters, gamma counters, radiation survey and contamination meters in the Permit Holder's department whether they are in use or not. EHS must be informed of newly acquired equipment as well as equipment that is leaving the department. EHS will assist in making the proper arrangements to discard or transport.
- Contact EHS (radsafety@umanitoba.ca) to ensure radiation safety pre-approval PRIOR to placing an order or relocating X-ray equipment.

7. Rules for Working with X-ray Equipment

The following basic rules must be followed when working with X-ray equipment:

1. Prior to beginning work, it is important to be familiar with the specific hazards of the X-rays present.
2. Open Beam X-ray equipment used for research purposes shall be attended by a Designated Worker or must be locked (secure) when not attended by a person listed on the Internal X-ray Permit.

3. When possible, X-ray equipment is to be used in a way that ensures that radiation fields in accessible (0.3 meters from any object or shield) operating areas do not exceed 25 microsieverts per hour and dose rates do not exceed 2.5 microsieverts per hour in adjacent areas.
4. Operators shall keep their hands and body out of the beam.
5. Follow manufacturer's directions for use and leakage testing procedures. Additional shielding may be required.
6. Report all radiation-related incidents to Environmental Health and Safety. Contact the Radiation Safety Officer to report the situation as soon as possible. The Radiation Safety Officer has the responsibility to:
    a. Assess or arrange for the assessment of worker exposure to ionizing radiation.
    b. Revise or remove restrictions on access to the area in terms of radiological hazard.
    c. Report incidents as required by regulations.

8. Leakage Testing

To ensure that faculty, staff, and students working with X-ray equipment are exposed to the minimal level of radiation possible as a consequence of X-ray leakage from the X-ray equipment.

8.1 Policy

The Permit Holder/ Responsible User is responsible to ensure that the X-ray leakage testing on research X-ray equipment shall be done on an annual basis and/or after any modification or relocation of the equipment.

8.2 Procedure

Follow the manufacturer's instructions. If the manufacturer guidance is not available:

1. Turn on the X-ray instrument on the highest setting.
2. Use a thin window Geiger counter (example Ludlum 44-9) or any other suitable meter and slowly pass the meter along all openings to search for X-ray leakage.
3. If you need assistance or you do not have access to a Geiger counter, contact EHS.
4. Verify the interlocks.

Summarize the survey results in the X-ray Leakage Survey Report (EHS website). Keep the report in the Radiation Safety Records binder. X-ray Leakage Survey Reports must be kept for at least 30 years.

9. Radiation Safety Training and Consent

Provincial and Federal regulations require that workers are informed of risks in the workplace and trained to identify potential hazards and how to work safely. Regulations require that documentation of X-ray safety training must be kept for 5 years.

To ensure workers are aware of the risks, have the necessary knowledge to work safely and are able to perform the needed work practices competently in the lab, the following training program must be completed.

9.1 Registration of Personnel with the X-ray Safety Program

All personnel shall submit a form to Environmental Health and Safety (EHS) to record their consent to their role on a Permit to work with X-ray equipment and to establish their past training and experience (Form on EHS webpage).

EHS X-ray safety training must be completed prior to being listed as a Designated Worker or Laboratory Radiation Supervisor.
EHS will keep documentation (attendance, content, tests) of all radiation safety training provided by EHS staff.

9.2 Training for Permit Holders

Upon the issuance of a Permit to a new Permit Holder, Radiation Safety staff will conduct a New Permit orientation session with the Permit Holder to communicate the basics of the University X-ray Safety Program as per a checklist. Time limit: 2 weeks from issuance of the Permit and prior to the first use of the X-ray equipment.

Permit Holders are strongly encouraged to participate in the same training that is required to be a Designated Worker.

Any Permit Holders who do not meet the training requirements of a Designated Worker will not be listed on a permit as permitted to work with X-ray equipment.

9.3 Training for Designated Workers (including Laboratory Radiation Supervisors)

Designated workers must hold a valid certificate designating them as a Certified Densitometry Technologist (CDT) or Certified Bone Densitometry Technologist (CBDT) to use dual energy X-ray absorption (DXA) equipment on human subjects.

9.3.1 Self study

Prior to being listed on an Internal Radioisotope Permit, all Designated Workers/Laboratory Radiation Supervisors will complete a self-study as directed by the Radiation Safety Officer and complete a take home assignment. Topics include:

- Theory of Radiation
- Radiation Exposure
- Legal Requirements

9.3.2 Lab assignment

The lab assignment should be completed with a mentor in the prospective X-ray equipment lab. The mentor is preferably an experienced Designated Worker from the same lab. If one is not available, the Radiation Safety Officer may appoint an alternate. Topics include:

- Legal Requirements and Security
- Radiation Detection, Shielding, Time and Distance
- Emergency Procedures

9.3.3 A challenge exam

A challenge exam may be administered on an individual basis.

If an individual chooses to sit the challenge exam, only one opportunity will be granted. If the individual does not successfully complete the exam, he or she shall participate in the specified training.

- Summer students are not given the option of the challenge exam.
- The Permit Holder shall ensure that at least one Designated Worker on a Permit has completed the Self Study and Lab Assignment rather than the challenge exam.

9.3.4 Past-Training Exemption

The Radiation Safety Officer may grant a 'past training exemption' if satisfied that appropriate formal training has occurred in the last three years. Appeal to the X-ray Committee may be requested. The decision of the X-ray Committee is final.

9.3.4 Refresher

Every three years, the Radiation Safety Officer shall audit each permit with a prescribed checklist. This process will include the Permit Holder and all available Designated Workers as listed on the Permit. The completed checklist will be kept by EHS as a record of the review session.

A Designated Worker will be removed from the Permit 36 months after the last date of training.

Implementation: As of January 1, 2018, the RSO will choose 1/3 of the current permits to be 'refreshed' within the calendar year and then subsequent refresher training will occur in every third anniversary of this date for these permits. Similarly, 1/3 of permits will undergo refresher training in 2019 and the remaining third in 2020. Newly issued permits will be scheduled for refresher training on the three year anniversary date of the permit being issued.

9.4 Site Specific Training Records

When there exists a radiation risk in the lab that is not mitigated by the procedures in this manual, Manitoba Workplace Health and Safety regulations require:

- Safe work procedures that reduce the risk as much as reasonably practicable,
- Workers must be trained in these site-specific procedures and
- Permit Holders must ensure the procedures are followed.
- Documents of the site-specific training should be kept in the Radiation Safety Manual or Records Binder and site-specific training shall be refreshed within three years (or whenever the safe work procedure changes).

UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title:	**Measuring Worker Exposure to Radiation**		
Number:	RSP-6		Page 1 of 16
Issued by:	Environmental Health and Safety	Date issued:	June 23, 2017
Approved by:	Radiation Protection Committee	Date approved:	June 29, 2017

1. Introduction

The goal of radiation protection is to carefully control worker exposure to ionizing radiation. The hazards of radioactive materials and X-ray equipment are well studied. The properties of radiation fields from the radioactive materials and X-ray equipment used at the University are well established.

As covered previously in RSP-2 (and separately in the University Radiation Safety Technical Manual), before work can begin a careful assessment is made.

- Before an Internal Permit is approved, the Radiation Safety Officer (RSO) reviews and assesses the sources of ionizing radiation, the amounts, the intended use, the facility and the workers. Great care is used to ensure the workers have the training and resources to work safely.
- All X-ray equipment used in Manitoba must be registered (through the University RSO) with Manitoba Health. Manitoba Health reviews specifics of the X-ray Equipment in conjunction with the facility layout and shielding to ensure the protection of workers and all members of the public.

At the University other control measures are in place as covered in RSP-3 for radioactive chemicals (called Open Sources), RSP-4 for Sealed Sources and Radiation Devices and RSP-5 for X-ray Equipment. RSP-3, 4 and 5 outline the strategies in place to limit the possibility of workers being exposed to radiation:

- Radiation survey meters are calibrated to measure the radiation field and are available 24-hours by contacting the University Security Services and asking for radiation safety assistance.
- Workers are trained to contact the Radiation Safety Officer (RSO) for access to a radiation survey meter (dose meter) to confirm the radiation field or dose from damaged packages and if there is an incident involving radioactive materials, Radiation Devices or X-ray Equipment. The RSO will verify radiation fields in the workplace at least annually. Additionally, with every order or transfer of radioactive material, an assessment is made to determine if immediate dose measurements in the workplace are required.
- Any use of Open Source radioactive material above Basic Level must be done in a room classified at a higher level by the Canadian Nuclear Safety Commission (CNSC). Dose calculations are provided to CNSC to request the reclassification and after the reclassification is received, devices may be placed in the area to confirm the calculation.
- Any projects involving more than 10 000 exemption quantities of radioactive material must be approved by Canadian Nuclear Safety Commission (CNSC).
- At the University, many ancillary or lab workers (other than permitted workers) have access to most laboratories. To protect non-permitted workers from unnecessary or inadvertent

exposure to ionizing radiation where there is a theoretical possibility that a worker could be exposed to ionizing radiation fields above 25 microsieverts per hour:
- Access to the permitted room is restricted to workers on the Permit or persons accompanied by workers on the Permit and
- The room has a 24-hour emergency entrance safe work procedure approved by the Radiation Safety Officer; filed with Security Services; and shared with Environmental Health and Safety and Physical Plant. The University also has radiation survey meters to measure radiation fields.

This RSP (RSP-6) covers the procedures in place at the University to ensure the radiation protection program is working. To minimize the risk to all workers, the University is committed to measuring radiation fields with a radiation survey meter and implementing dosimeters or bioassay to measure worker exposure to ionizing radiation. Where possible, the results of measured fields or worker exposure will be used to optimize the effectiveness of control measures in compliance with all applicable regulations. Specifically, RSP-6 covers:

- The potential radiation exposure of workers categorized by 'dose limits'. The Dose Limits are specified in the Canadian Radiation Protection Regulations for radioactive material. As the federal dose limits are more restrictive, at the University, the same dose limits are applied to workers using X-ray equipment even though X-ray Equipment is regulated provincially.
- Depending on the anticipated occupational doses, workers are categorized as Nuclear Energy Workers (NEWs) or '(other) members of the public'.
- Nuclear Energy Workers (NEWs) sign an agreement (section 7.5) that they are willing to be NEWs after studying information on the hazards of ionizing radiation, must be eighteen years old, and are required by federal law to immediately declare when they become pregnant to the Radiation Safety Officer (RSO) and their supervisor.
- Everyone else is considered a member of the public and are constrained to work that will not expose them to radiation above the lower dose limit. The procedures in this manual along with conditions listed on Internal Permits are in place to ensure doses to workers are minimized. This lower member of the public limit is protective of any age and health status worker.
- Provision of a dosimetry program: badge dosimeters or ring dosimeters are provided to workers that work with radioactive material, Radiation Devices or X-ray equipment that are capable of exposing the worker to ionizing radiation by working in the area. These dosimeters measure an accumulation of exposure to ionizing radiation to a specific worker.
- Workers that are pregnant or nursing may choose to contact the RSO or the Occupational Health Coordinator to get more information and an assessment regarding the safety of their work for their unborn or nursing child.
- Procedures related to Nuclear Energy Workers (NEWs) and the process for an NEW to declare pregnancy.
- Bioassay or Screening for workers may be required if using volatile or High Levels of Open Source radioactive materials to determine if a worker has internalized radioactive material. This requirement will be included in the conditions of the Internal Permit.

2. Definitions

ALARA is the acronym for keeping all exposures to ionizing radiation As Low As Reasonably Achievable, taking into account economic and social factors. This is known as the ALARA principle.

Bioassay is a protocol to measure the amount of radioisotope in the body for the purpose of ascertaining a worker's radiation dose.

Clinical X-ray equipment, for the purposes of this manual, shall refer to X-ray equipment that is used on human subjects to provide medical or dental care. The safe use of dental X-ray equipment is additionally guided by the Health Canada "Recommended Safety procedures for the Use of Dental X-ray Equipment- Safety Code 30".

CNSC means the Canadian Nuclear Safety Commission.

Designated Worker means an individual listed on the Permit as working under the authority of the Permit Holder.

Dosimeter means a device for measuring a dose of radiation that is worn or carried by an individual.

EHS means Environmental Health and Safety.

Laboratory Radiation Supervisor (LRS) is a Designated Worker nominated by a Permit Holder to assist the Permit Holder to carry out the duties as specified in this manual. The LRS is responsible to ensure the Radiation Safety Manual is up to date and available to all Designated Workers. The LRS shall keep records that Designated Workers have been informed of changes to the Radiation Safety Manual.

Members of the Public, for the purposes of this manual, is defined as a person that during the course of their work at the University there does not exist a reasonable probability that the person may receive a dose of radiation that is greater than the prescribed limit for the general public in Canadian Radiation Protection Regulations.

Nuclear Energy Worker (NEW) means a person who is required in the course of their work at the University 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.

Permit means the internal permit issued by the Radiation Protection Committee to control all procurement, use, storage, transfer and disposal of all radioactive materials, Radiation Devices, X-ray Equipment and other sources of ionizing radiation in all areas under the control of the University.

Permit Holder/Responsible User means the individual issued the Permit who is required to be a faculty member or report to a Dean, Director or Department Head or who is supervised by a Dean, Director or Department Head.

Radiation Device, for the purpose of this manual shall refer to a device that contains more than the exemption quantity of a nuclear substance and that enables the nuclear substance to be used for its radiation properties.

Radiation Safety Officer means the University employee Environmental Health and Safety has designated as the Radiation Safety Officer pursuant from the Radiation Safety Policy.

Radiation survey meter means an instrument that is capable of measuring radiation dose rates.

Radioactive material, for the purposes of this manual, the term "radioactive material" shall be limited to materials used for their radioactive properties in the course of research or teaching. Further, "radioactive material" means an unstable isotope of an element that decays, or disintegrates spontaneously, emitting radiation of sufficient energy to create charged particles by adding or removing an electron or breaking chemical bonds.

Radioisotope means radioactive material as defined above. Historically, the Internal Permits issued to control the use of radioactive material and radiation devices are called 'Internal Radioisotope Permits.

Research X-ray equipment, for the purposes of this manual, shall refer to X-ray equipment that may include:

- Any X-ray equipment that is not used on humans subjects or
- Any X-ray equipment when it is used to irradiate humans under a research study protocol.

RSP means Radiation Standard Procedures that are approved by the University Radiation Protection Committee and documented in the University of Manitoba Radiation Safety Manual.

The University is the University of Manitoba.

WRHA means Winnipeg Regional Health Authority.

X-ray means artificially produced electromagnetic radiation of wave length shorter than 0.000 000 25 mm (0.25 nanometers).

X-ray equipment or X-ray machine means an operable device, the principle purpose and function of which is the production of X-rays, together with such ancillary apparatus as may be necessary for this purpose. For locations in the province of Manitoba, X-ray equipment is governed by the Manitoba Provincial Regulations.

3. Worker Categories by Dose Limits

3.1 Dose limits for workers permitted to use radioactive material or Radiation Devices

The Canadian Nuclear Safety and Control Act and regulations set limits for the maximum permissible dose of ionizing radiation an individual may receive from the possession and use of radioactive material and Radiation Devices. See Appendix E - CNSC Dose Limits at the end of this manual.

3.2 Dose limits for workers using X-ray Equipment

At the University of Manitoba, the dose limits set in the Canadian Nuclear Safety regulations are applied to persons using research and clinical X-ray equipment (or X-ray doses set provincially – whichever is more restrictive).

3.3 Dose limits for Members of the Public and Nuclear Energy Workers

- Individuals in the workplace, with the potential for receiving annual doses exceeding the limits set for the general public, shall be designated by the Radiation Safety Officer as Nuclear Energy Workers (NEWs). See Appendix E - CNSC Dose Limits at the end of this manual.

- All Permit Holders and Designated Workers are considered "Member(s) of the Public" unless notified by the Radiation Safety Officer of Nuclear Energy Worker (NEW) status (See Section 7).

4. Dosimetry and Bioassay Policy Statements

- The University places great emphasis on the need to keep all exposures As Low As Reasonably Achievable, economic and social factors taken into account. This is known as the ALARA principle and it should be adhered to at all times.

- Processes shall be in place to ensure the radiation fields are monitored, dosimetry and bioassay are used to measure worker exposure to radiation to achieve ALARA and comply with regulations.

- Pregnant or Nursing: According to Manitoba Workplace Safety and Health regulations, when a worker (NEW or non-NEW) informs her supervisor that she is pregnant or nursing, the employer must provide information related to the risks to the unborn or nursing child and take action to minimize the risk. When approached by either worker or supervisor, the Radiation Safety Officer will follow the steps in this RSP, Section 6 to provide technical assistance.

5. External Dosimeter Procedures

A dosimeter means a device for measuring a dose of radiation that is worn or carried by an individual. Dosimeters shall be used to determine the external radiation exposure of persons requiring external exposure monitoring in order to measure the effectiveness of control measures and to comply with all applicable regulations (including protecting a worker's privacy).

5.1 Requirements to Wear a Dosimeter

People will require external dosimetry when:

- Working with radioactive material or Radiation Devices as indicated in the Other Conditions of Approval on the related Internal Radioisotope Permit.
- Operating:
  - Research X-ray equipment and they are listed as a designated worker on a X-ray Permit, or
  - Clinical open beam X-ray equipment.

5.2 Exclusion from Dosimetry Program

Certain persons may be excluded from the dosimetry program based on past dosimetry records and when lab procedures remain unchanged. Such exclusions will be documented on the Internal Permit under Other Conditions of Approval.

5.3 Two Types of Dosimeters

There are two types of dosimeters in use at the University: badges and rings.

5.3.1 Badge dosimeters

- Badge dosimeters will be worn as stated in the permit conditions.
- Badge dosimeters are normally worn clipped to the chest pocket of the person's lab coat or at the waist.
- To accurately estimate a person's exposure dosimeters must be worn under shielding such as lead aprons.

5.3.2 Ring dosimeters

- Ring dosimeters will be worn by anyone working with a container with more than 50 MBq of P-32, Sr-89, Y-90, Sm-153 or Re-186 or as stated in the permit conditions.
- They are worn under disposable gloves on the hand most likely to be exposed to radiation. The detection area of the ring should be facing the source of radiation (palm side).

5.4 Rules for all Dosimeters

To ensure the reported exposure is indicative of an actual personal exposure the following procedures must be followed:

- The control badge provides a reading of the background radiation is not to be worn by an individual. The control badge is stored away from radioactive materials and protected from radiation from Radiation Devices and X-ray equipment.
- Each (non-control) dosimeter is only be worn by one individual during the wearing period.
- Dosimeters are only worn at University clinic locations or permitted research labs.
- Dosimeters are stored away from X-ray areas or where radioactive materials are used or stored.
- Dosimeters are not worn during or after a medical procedure involving radioactive materials (Nuclear Medicine procedures) or during a medical X-ray.
- Dosimeters that are worn in labs permitted for Open Source radioactive materials are a regular part of the lab's contamination monitoring program. A contaminated dosimeter could result in a report of high exposure to the dosimeter that may not be personal and should be reported to the Radiation Safety Officer immediately.
- Badge and Ring dosimeters are measured at least quarterly.
- For persons needing to take dosimeters to rural University clinic locations or permitted research labs - if you need to transport your dosimeter on a plane – DO NOT ALLOW it to be X-rayed. Assume all checked baggage will be X-rayed - you have to hand your dosimeter to the attendant when you carry it through airport security!

5.5 Dosimetry Program

Departments using dosimetry services for more than four eligible users shall specify a Dosimetry Coordinator to control, distribute and return dosimeters. Departments where there are four or less eligible users will use dosimetry services coordinated by Environmental Health and Safety.

- Only persons planning to work with the eligible radioisotopes or X-ray equipment as defined in Section 5.1 of this RSP during the specified wearing period should be issued a dosimeter.
- All dosimeters which were not worn during the wearing period must be declared as such to the Dosimetry Coordinator.
- Errant charges (late, lost or damages fees) will be passed to the subscribing wearer's department.
- The National Dose Registry (Health Canada) records each dose on an individual basis.
- It is imperative that individuals assigned dosimeters cooperate with the Dosimetry Coordinator by keeping dosimeters accessible at their exchange time.

5.6 Review of Dosimetry Results

Personal exposure reports are reviewed by the Radiation Safety Officer (RSO).

- If a person is a not designated as a Nuclear Energy Worker and has a recorded reading above the investigation threshold, the RSO will inform the worker directly.
- The RSO will communicate all dosimetry results for Nuclear Energy Workers (NEWs) to the Laboratory Radiation Supervisor (LRS) to share with the Permit Holder and the LRS will communicate the individual doses to the individuals (even nil).
- Reports of personal exposure above 0.2 millisievert per wearing period are investigated by the RSO. The person assigned the badge and the Dosimetry Coordinator shall cooperate with the investigation.

6. Pregnant or Nursing Workers

When a worker informs the Radiation Safety Officer (RSO) that she is pregnant or nursing, the University Radiation Safety Officer will:

- Provide an information package regarding the risk of maternal occupational radiation exposure to the embryo/fetus (INFO-0700 available by contacting the RSO), and
- Inform the worker of her choice to report her pregnancy, or that she is nursing, in writing to the RSO, or the University Occupation Health Coordinator, her supervisor and the Permit Holder of every Internal Radioisotope Permit that she is listed on as a designated worker.

Once this report is received by the RSO, or the University Occupational Health Coordinator, they will initiate an assessment to determine whether:

- There are reasonably practicable steps to be taken to minimize the exposure of the worker to the condition that creates the risk, or
- If alternate work is available that involves no risk or less risk and the worker is reasonably capable of performing that work, the worker is temporarily assigned to that alternate work without loss of pay or benefit.

7. Nuclear Energy Workers (NEWs)

The Canadian Nuclear Safety and Control Act and regulations set limits for the maximum permissible dose of ionizing radiation an individual may receive from the possession and use of radioactive material and Radiation Devices. See Appendix E- CNSC Dose Limits at the end of this manual.

7.1 Process for becoming a Nuclear Energy Worker

Individuals in the workplace, with the potential for receiving annual doses exceeding the limits set for the general public shall be designated by the Radiation Safety Officer as Nuclear Energy Workers (NEWs).

- The Radiation Safety Officer (RSO) shall determine which workers will be designated as Nuclear Energy Workers (NEWs), based on the anticipated job, specific radiation exposures or past radiation dose history.
- The Radiation Safety Officer shall maintain a full list of the Nuclear Energy Workers related to all licenses held by the University of Manitoba.

Persons designated as NEWs shall be provided with the following written information by the Radiation Safety Officer:

- The risks related to radiation exposure to the worker and any embryo or fetus.
- The applicable dose limits.
- The worker's anticipated and/or actual radiation dose levels.
- For female workers, the pregnancy radiation dose limits and the workers obligations as regards to pregnancy. In accordance with the Canadian Nuclear Safety regulations, the Radiation Safety Officer must give notice to all female workers designated as "NEW" of their duty to inform their Permit Holder and the Radiation Safety Officer of their pregnancy.

Employees designated as NEWs shall:

- Acknowledge their designation as NEW status and their receipt of the above information in writing.
- The acknowledgement shall also include a declaration to indicate if they previously wore a radiation detecting device during the current 1 and 5 year dosimetry period and their recorded personal accumulated doses for the period(s).
- Note: The 5 year dosimetry periods commenced January 1, 2001.
- Provide their personal information as required by National Dose Registry to the Departmental Dosimetry Coordinator or the Radiation Safety Officer.

Every person upon accepting the designation as a NEW shall supply the RSO with the following personal information.

- Full name (All given names, surname and any previous surnames.)
- Social Insurance Number
- Gender
- Date and place of birth (Province/ state and country)
- If previously in a position where radiation dose records were measured and recorded, dose history for the current 1 and 5 year history periods.

This information is considered personal and private, and will be maintained in confidence by the Radiation Safety Officer and Environmental Health and Safety, and shall be used only in contact with an appropriate government department in the context of the radiation dose received by that individual.

7.2 Reclassification of a Worker

Occasionally it may be necessary to re-classify a worker previously designated as "Member of Public" or "ancillary" worker as a "Nuclear Energy Worker". This will occur when it appears likely the person's annual radiation dose will approach or exceed 1 millisievert.

- A reclassification will not be done without a careful ALARA analysis of the work function by the Radiation Safety Officer.
- Persons who are reclassified shall be so informed and shall have the right to refuse the reclassification and to be accommodated as appropriate.
- If they accept the designation they must acknowledge that acceptance as defined in Section 7.1 in this RSP.

7.3 Nuclear Energy Worker Requirement to Declare Pregnancy

- Each female worker that is designated a NEW shall be informed:
  - prior to being hired, or
  - if already employed, when being designated NEW; and,
  - subsequently before beginning or resuming work with radioactive material of:
    - the risks of maternal radiation exposure to the embryo/fetus;
    - her applicable dose limit during pregnancy; and
    - her rights and obligations with respect to her occupational radiation exposure if she becomes pregnant.
- Any female NEW shall, as soon as her pregnancy has been diagnosed, provide written declaration of the pregnancy to the Radiation Safety Officer (RSO), her supervisor and the Permit Holder of any Internal Radioisotope Permit listing her as a Designated Worker.
- The radiation dose to the declared pregnant NEW for the remainder of her pregnancy shall not exceed her applicable dose limit, and her supervisor and Permit Holders shall attempt to make reasonable accommodation for the declared pregnant worker, in order to minimize her radiation dose during the remainder of her pregnancy, as far as possible without undue hardship or costs.

7.4 Declaration of Nuclear Energy Worker's Pregnancy Form

Please print

First Name:	Last Name:
SIN #:	Date of Birth:
Department:	
Room #:	

In accordance with the Canadian Nuclear Safety Act and Radiation Protection Regulations, I hereby declare that I am pregnant. My estimated due date is.....
I understand that this information:

- is required by law (Radiation Protection Regulations, Section 11).
- will be disclosed to my supervisor, my Permit Holder(s) and the Radiation Safety Officer.
- will be shared with the University Occupational Health Coordinator.
- is considered confidential.

I understand that the Radiation Safety Officer will review my radiation dose history and work assignments with my supervisor, and my Permit Holder, to determine whether any special precautions or accommodations are necessary.

I have been informed about the risks associated with radiation and reviewed documents within the information package regarding the risk of maternal occupational radiation exposure to the embryo/fetus. (This package is available from Environmental Health and Safety.)
Signatures:

Worker: _____ Date:_____

Permit Holder:_____ Date:_____

Supervisor: _____ Date:_____

Radiation Safety Officer: _____ Date:_____

7.5 Acceptance of Nuclear Energy Worker Status Form

Surname:	Given Names:
Previous Surname(s) (if applicable):	Social Insurance Number:
Date of birth: (Month/day/year)	Gender (Circle one) M F
Place of birth (Country) (Province/State)	

In accordance with the Canadian *Nuclear Safety and Control Act* (NSCA) and *Regulations*, I, _____, acknowledge that because of my occupational radiation exposure, I am designated as a **Nuclear Energy Worker (NEW).**

A Nuclear Energy Worker is defined in the Nuclear Safety and Control Act 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.*" The prescribed limit on effective dose for members of the public is 1 millisievert per year.

As required by the Canadian Nuclear Safety Commission's Radiation Protection Regulations (CNSC- RPR), I have been informed in writing of:

- The risks associated with the ionizing radiation to which I may be exposed during the course of my work, as described in the provided document "*Risks Associated with Radiation: General Information (November 2000).*
- The applicable occupational radiation dose limits as specified in the CNSC- RPR;
- My anticipated annual occupational radiation dose (range);

and (for females only)

- My obligation to report my pregnancy immediately (to my work supervisor and the Radiation Safety Officer) and my right to be accommodated within reason, as outlined in the provided document *"Dose Limits for Pregnant Workers, Rationale for the Limits in the Radiation Protection Regulations (CNSC- January 1999)*.

I understand that my work assignments will likely expose me to approximately _____ millisievert(s) of occupational radiation dose exposure each year. I have been informed that I will be informed in writing of my personal radiation dose measurements at least once annually.

I agree to accept the Nuclear Energy Worker (NEW) designation and understand my anticipated annual occupational radiation exposure and how that compares to the CNSC regulatory dose limits. I have been informed of the radiation risk information as well as my rights and obligations. I also understand that the CNSC - RPR (Sections 9, 10 and 11) require me to submit the required personal information, which will only be used by the Dosimetry Coordinator and Radiation Safety Officer in the context of my radiation dose records (Health Canada National Dosimetry Service), and communications with the Canadian Nuclear Safety Commission.

I further declare (Check all that apply):

- □ I have not previously worn a dosimeter in the current 5 year dosimetry period. (5 year dosimetry periods began January 1, 2001).
- □ I have previously worn a dosimeter and my accumulated radiation dose in the current year dosimetry period is _____mSv.
- □ I have previously worn a dosimeter and my accumulated radiation dose in the current 5 year dosimetry period is _____mSv.
- □ I have previously worn a dosimeter and I hereby authorized the National Dose Registry to release my current 5 Year accumulated dose to the University of Manitoba Radiation Safety Office.

(Note: Option D is only applicable if the dosimeter was worn in Canada. If dosimeter was worn outside Canada it is the worker's responsibility to obtain the dose record.)

Signatures:

Worker: _____ Date:_____

Permit Holder:_____ Date:_____

8. Bioassay

Bioassay is a protocol to measure the amount of radioisotope in the body for the purpose of ascertaining a worker's radiation dose. Depending on the radioisotope, its chemical form, the biological pathway in the human body and the length of time associated with the possible exposure, bioassay may require diverse protocols. For example, exposure to tritiated water could require analyses of the worker's urine by liquid scintillation counting. Most commonly it is the use of radioiodine that requires action to measure the accumulation in the thyroid of the worker that is surprisingly easy with a handheld contamination meter.

- Bioassays and screening shall be used to determine the internal radiation exposure of all Designated Workers using in excess of the activity levels described in Nuclear Safety Control regulations, or licence condition, in order to measure the effectiveness of control measures and to comply with all applicable regulations.
- Bioassay is a term used for rigorously controlled measurement and screening is the term used for a rough check to see if more investigation (bioassay) would be required. *Currently, the University is only capable of screening and if the result of screening indicates a 'Bioassay' is needed, special arrangements would need to be made.*

8.1 Thyroid Screening and Bioassay

8.1.1 Activity Level Above Which Thyroid Screening is Required

Directly quoted from the CNSC licence Condition – November 2016:

"(a) Every person who in any 24-hour period uses a total quantity of Iodine 124, Iodine 125 or Iodine 131 exceeding:
  (i) 2 MBq in an open room;
  (ii) 200 MBq in a fume hood;
  (iii) 20 000 MBq in a glove box;
  (iv) any other quantity in other containment approved in writing by the CNSC shall undergo thyroid screening within a period more than 24 hours after the last use that resulted in any of the above limits exceeded and less than 5 days after the limit was exceeded.

(b) Every person who in any 24-hour period uses a total quantity of Iodine 123 exceeding:
  (i) 200 MBq in an open room;
  (ii) 200 000 MBq in a fume hood;
  (iii) 2 000 000 MBq in a glove box;
  (v) any other quantity in other containment approved in writing by the CNSC shall undergo thyroid screening within a period more than 8 hours after the last use that resulted in any of the above limits exceeded and less than 48 hours after the limit was exceeded.

(c) Every person who is involved in a spill of greater than 2 MBq of Iodine-124, Iodine-125 or Iodine-131 shall undergo thyroid screening within a period more than 24 hours after the last use that resulted in any of the above limits exceeded and less than 5 days after the spill or contamination.

(d) Every person who is involved in a spill of greater than 200 MBq of Iodine- 123, Iodine-125 or Iodine-131 shall undergo thyroid screening within a period more than 8 hours after the last use that resulted in any of the above limits exceeded and less than 48 hours after the spill or contamination."

8.1.2 Thyroid Screening Procedure

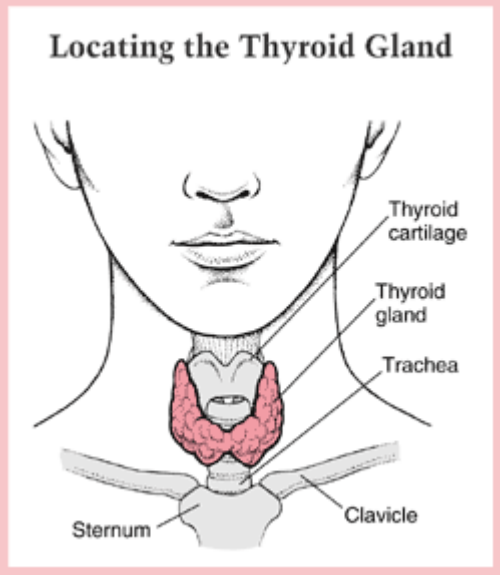
Lab personnel are to perform screening using the following protocol. Based on the results further action may be required.

- All meters used for Thyroid Screening must have participation in Health Canada, Thyroid Monitoring Intercomparison Study in the previous 12 months.
- A baseline screening is required before actually starting work.
- The University does not use or have a procedure for Bioassay for Iodine-123.
- For Iodine-124, the Radiation Safety Officer will contact WRHA Radiopharmacy to seek permission to use their thyroid screening detectors.
- For Iodine-125 and Iodine-131, follow the procedure below.

Equipment required for Thyroid Screening:

Meter (e.g. Ludlum Model 3)
Detector - Sodium Iodide Crystal, gamma scintillator (e.g. Ludlum Model 44-3 or 44-21)
The meter together with the detector must be checked annually against a standard calibration source to verify accuracy and counting efficiency. (Contact the Radiation Safety Officer.)

Figure 1: Location of the Thyroid



Procedure:

1. The procedure is to be performed in an area of low background activity, after removing contaminated gloves or apron.

2. Check the response of the meter with a calibration source.

3. Make a Background Count - Hold detector as close as possible without contact to the arm or leg, take a reading (approximately 60 sec), and record this value on the Bioassay Record as a background count. If you have difficulty determining a steady background reading, make sure the integration switch (next to the audio switch on most meters) is set at "s" for slow (longer integration times).

4. Make a THYROID COUNT - Hold the detector close to your thyroid at a distance of 2 cm (see Figure 1: Location of the Thyroid). Take a reading after 60 seconds and record the result on the Bioassay Record. Calculate the net thyroid count by subtracting the background and enter on record.

5. A WRITTEN RECORD OF ALL MEASUREMENTS MUST BE MAINTAINED.

6. Forward a copy of the records to Environmental Health and Safety within one business day.

8.1.3 Courses of Action based on Results of Thyroid Screening

- If Net Thyroid Count < 200cpm, no further action is necessary
- If Net Thyroid Count > 200cpm:
  - Monitor clothing at neck-line for contamination and record results.
  - If contamination is found - wash neckline, re-monitor and record.
  - If measured contamination is reduced, continue to wash until all removable contamination is eliminated.
  - If washing does not reduce measured activity then a thyroid uptake has most likely occurred.
  - Check other staff and the laboratory for contamination.
  - Record details of the procedures followed to detect or quantify contamination and possible explanations in the written record.
  - CONTACT the Radiation Safety Officer (RSO) to complete the Calculation of Thyroid Uptake in Bq (below).

Calculate level of Thyroid Uptake (to be made by RSO)

Calculate the update in Becquerels as follows:

$$\text{Thyroid Uptake} = \text{Net Thyroid Count (counts /sec)} \times \frac{100\%}{\%\text{ efficiency of the meter}}$$

- If Thyroid Uptake < 1kBq: RSO will notify the Designated Worker and Permit Holder immediately.
- If Thyroid Uptake > 1kBq: RSO will notify the Designated Worker and Permit Holder immediately. A DETAILED REPORT will be required to be made by the Designated Worker in cooperation with the Permit Holder and sent to Environmental Health and Safety.
- If the uptake is established to be greater than 10 kBq, the Radiation Safety Officer shall immediately inform the CNSC and arrange to have a Bioassay performed within 24 hours by an agency licensed by the CNSC to perform internal dosimetry.

8.2 Levels of Other Radioisotopes that Require Bioassay

Personnel working with activities in excess of the levels in Table 1 (below) in any single day shall be assessed by the Radiation Safety Officer to determine if participation in a bioassay program is indicated. The trigger levels will depend on radioisotope, the volatility of its chemical form and the engineering controls in place.

Bioassay is recommended if the worker is required to wear respiratory protection equipment specifically to limit the intake of radioactive materials.

Table 1: Activity Handled in Daily Operation throughout the Period of One Year, Above Which Bioassay is Recommended (from CNSC GD-150)

Confinement	Volatility		
	Gases and volatile liquids	Powders	Non-Volatile liquids and solids
None	≥ 2 ALI	≥ 20 ALI	≥ 200 ALI
Fume Hood	≥ 200 ALI	≥ 2 000 ALI	≥ 20 000 ALI
Glovebox	≥ 20 000ALI	≥ 200 000 ALI	≥ 2 000 000 ALI
Pseudo-sealed*	≥ 50 ALI	Not applicable	≥ 10 000 ALI

* Pseudo-sealed sources are short half-life radionuclides that are handled exclusively in sealed vials and syringes and that meet the following conditions:

1. The radiological half-life is less than 7 days;
2. The handling of radioactivity is more or less uniform throughout the year;
3. The radioactive material is not aerosolized, or boiled in an open or vented container;
4. The radioactive material is in the form of a dilute liquid solution; and
5. The radioactive material is contained in a multi-dose vial that is never opened and amounts are withdrawn only into hypodermic syringes for immediate injection into another multi-dose vial, or another form of closed containment, or into patients

UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title: **Radiation Safety Policy**

Number: Appendix A (version June 29, 2017)

As published on the University Of Manitoba 'Governing Documents' web page

Policy:	**Radiation Safety**
Effective Date:	August 26, 2011
Revised Date:	September 14, 2016
Review Date:	September 14, 2026
Approving Body:	President
Authority	Nuclear Safety and Control Act, The Workplace Safety and Health Act (Manitoba), and other statutes and their regulations and the policy and procedures established by the University
Responsible Executive Officers:	Vice-President (Administration) and Vice-President (Research and International)
Delegates:	Chief Risk Officer and Associate Vice-President (Research)
Contact:	Environmental Health and Safety Coordinator
Application:	All employees, students and external parties (individuals with adjunct appointments and nil-salaried appointments)

Part I
Reason for Policy

1.1 The reason for this Policy is to identify the University's responsibility and accountability for the safe use of radioactive materials, radiation devices and X-ray equipment in order to protect the environment, students, academic and support staff, and visitors to the campus from the adverse effects of ionizing radiation.

Part II
Policy Content

Definitions

2.1 The following terms have the following defined meanings for the purpose of this Policy and the Procedures:

(a) "Committee" means the Radiation Protection Committee;

(b) "Designated Worker" means an individual listed on the Permit as working under the authority of the Permit Holder;

(c) "Permit" means the internal permit issued by the Committee pursuant to section 2.4 of the Procedures to control all procurement, use, storage, transfer and disposal of all

radioactive materials, radiation devices, X-ray equipment and other sources of ionizing radiation in all areas under the control of the University;

(d) "Permit Holder/Responsible User" means the individual issued the Permit by the Committee who is required to be a faculty member or report to a Dean, Director or Department Head or who is supervised by a Dean, Director or Department Head.

(e) "Radiation Safety Officer" means the University employee Environmental Health and Safety designated as the Radiation Safety Officer pursuant to section 2.5 of this Policy.

(f) "Radiation Safety Program" means the program developed pursuant to section 2.4 of this Policy.

2.2 The University is committed to:

(a) complying with the Nuclear Safety and Control Act, The Workplace Safety and Health Act (Manitoba), and all legislation, policies and procedures with respect to the procurement, use, storage, transfer and disposal of all radioactive materials, radiation devices and X-ray equipment in all areas under the control of the University.

(b) ensuring that exposure to radiation by staff, students and members of the public do not exceed dose limits established by regulation;

(c) ensuring that all exposure to radiation be kept as low as reasonably achievable, taking into consideration social and economic factors; and

(d) ensuring that a high standard of radiological safety and security is maintained at all times in the work environment.

2.3 The University has established and shall maintain a Radiation Protection Committee comprising members of the University community and stakeholders knowledgeable in the safe use of radioactive materials, radiation devices and X-ray equipment. The Radiation Protection Committee shall:

(a) be appointed by and report to the Associate Vice-President (Research); (b) have the mandate and authority as are specified in the Radiation Safety Procedures;

(b) have those duties and responsibilities for committee membership and officers as are specified in the Radiation Safety Procedures.

2.4 The Radiation Safety Program has been developed and shall be maintained, and administered by the Radiation Safety Officer, to ensure the required level of control relating to the use of ionizing radiation, without unduly hampering research. The Radiation Safety Program has been developed in consultation with the Radiation Protection Committee.

2.5 The University shall designate an employee in Environmental Health and Safety to act as the Radiation Safety Officer. The Radiation Safety Officer shall be responsible to the Chief Risk Officer for administering the Radiation Safety Program, providing advice, guidance, technical support and ensuring that Permit Holders and Designated Workers are aware of

their responsibilities to comply with the Radiation Safety Policy and Procedures. The Radiation Safety Officer shall act in consultation with the Committee.

Part III Accountability

3.1 The Office of Legal Counsel is responsible for advising the Vice-President (Administration) and the Vice-President (Research and International) that a formal review of this Policy is required.

3.2 The Chief Risk Officer and/or the Associate Vice-President (Research) are responsible for the implementation, administration and review of this Policy.

3.3 All employees, students and external parties are responsible for complying with this Policy.

Part IV
Authority to Approve Procedures

4.1 The Vice-President (Administration) and Vice-President (Research and International) or the President may approve Procedures, if applicable, which are secondary to and comply with this Policy.

Part V
Review

5.1 Governing Document reviews shall be conducted every ten (10) years. The next scheduled review date for this Policy is September 14, 2026.

5.2 In the interim, this Policy may be revised or repealed if:

(a) the Vice-President (Administration) and Vice-President (Research and International) or the Approving Body deems it necessary or desirable to do so;

(b) the Policy is no longer legislatively or statutorily compliant; and/or

(c) the Policy is now in conflict with another Governing Document.

5.3 If this Policy is revised or repealed all Secondary Documents, if applicable, shall be reviewed as soon as possible in order that they:

(a) comply with the revised Policy; or

(b) are in turn repealed.

Part VI
Effect on Previous Statements

6.1 This Policy supersedes all of the following:

(a) Radiation Safety Policy (dated August 26, 2011);

(b) all previous Board of Governors/Senate Governing Documents on the subject matter contained herein; and

(c) all previous Administration Governing Documents on the subject matter contained herein.

Part VII
Cross References

7.1 This Policy should be cross referenced to the following relevant Governing Documents, legislation and/or forms:

(a) Health and Safety Policy

(b) Radiation Safety Procedure

(c) Nuclear Safety and Control Act

(d) The Workplace Safety and Health Act (Manitoba)

UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title: **Radiation Safety Procedure**

Number: Appendix B (version June 29, 2017)

As published on the University Of Manitoba 'Governing Documents' web page

Procedure:	Radiation Safety
Parent Policy:	Radiation Safety Policy
Effective Date:	August 26, 2011
Revised Date:	September 14, 2016
Review Date:	September 14, 2026
Approving Body:	President, Vice-President (Administration) or Vice-President (Research and International)
Authority	Nuclear Safety and Control Act, The Workplace Safety and Health Act (Manitoba)
Responsible Executive Officers:	Vice-President (Administration) and Vice-President (Research and International)
Delegates:	Chief Risk Officer and Associate Vice-President (Research)
Contact:	Environmental Health and Safety Coordinator
Application:	All employees, students and external parties (individuals with adjunct appointments and nil-salaried appointments)

Part I
Reason for Procedure

1.1 To set procedures and responsibilities in connection with the Radiation Safety Policy for all radioactive material, radiation devices and X- ray equipment in all areas under the control of the University.

Part II
Procedural Content

Radiation Protection Committee

2.1 The Radiation Protection Committee is authorized to:

(a) advise on the safe use of radioactive materials, radiation devices and X-ray equipment in all areas under the control of the University;

(b) make recommendations to University Governing Documents relating to radiation protection;

(c) approve standard procedures and guidelines relating to radiation safety;

(d) issue (or deny) Permits to control the use of all licensed activities involving radioactive material, X-Ray equipment and other sources of ionizing radiation; enforce the Radiation Safety Program and supervise the external and internal dose monitoring and verification of compliance;

(e) revoke Permits from individuals who contravene these Procedures or the Policy;

(f) review reports of all inspections, incidents, unusual occurrences, and other relevant materials from the Radiation Safety Officer and make recommendations as appropriate.

2.2 Committee Membership

(a) The number of appointed members of the Committee shall not be more than ten (10);

(b) Each member shall serve a terms of five (5) years, with the option to serve one (1) additional term for up to five (5) years;

(c) At least one (1) member of the Committee shall be a nuclear medicine physician to fulfill the role of medical advisor;

(d) At least one (1) member of the Committee shall be a supervising dentist with the College of Dentistry;

(e) One (1) member of the Committee shall be nominated by the Director of the Research Institute of Oncology and Hematology;

(f) One (1) member of the Committee shall be from the bargaining unit representing technical support staff;

(g) One (1) member of the Committee shall be from the bargaining unit representing faculty members;

(h) The members shall be appointed by the Associate Vice-President (Research);

(i) Alternates shall be appointed during an extended leave of a Committee member;

(j) The Associate Vice-President (Research) may appoint an ex-officio, nonvoting member to the Committee; and

(k) The Radiation Safety Officer and other designated Environmental Health and Safety staff shall be non-voting members and shall act as resources to the Committee.

2.3 Officers of the Committee

(a) Chair

(i) The Chair shall be appointed by and report to the Associate Vice-President (Research);

(ii) The Chair may participate to an equal extent as any other member of the Committee in the discussions and decisions; and

(iii) The Chair shall select one (1) member of the Committee to act on behalf of the Chair in the event of his/her absence.

(b) Secretariat

Environmental Health and Safety shall provide secretarial support to the Committee, maintain a file of all correspondence to and from the Committee, record minutes of meetings and shall issue notices of meetings after consultation with the Chair.

2.4 The Committee issues Permits to control all procurement, use, storage, transfer and disposal of all radioactive materials, radiation devices and X-ray equipment in all areas under the control of the University. The Permit will specify:

(a) The Permit Holder;

(b) Designated Workers;

(c) Laboratory Radiation Supervisor (if one has been identified);

(d) Permitted radioactive material and possession limits; radiation devices or X-ray equipment;

(e) Approved locations;

(f) Approved usage;

(g) An approved disposal procedure; and

(h) Other conditions of use as appropriate.

2.5 The Permit is conditional on the strict adherence to all terms and conditions and parameters listed on the Permit.

2.6 All applications for Permits must be completed by the Permit Holder/ Responsible User and submitted to Environmental Health and Safety. The Radiation Safety Officer shall assess the application, and forward it to the Chair of the Committee for approval.

Eligibility

2.7 Permit Holder/ Responsible User must hold an academic appointment at the level of lecturer or higher, or be support staff and are accountable to a Dean, Director or Department Head.

2.8 In order to use radioactive materials, radiation devices, X-ray equipment or other sources of ionizing radiation one must be:

(a) A Designated Worker; or

(b) In the case of X-ray equipment that is enclosed and interlocked by the manufacturer and has passed an X-ray leakage test, a person acting under the supervision of a Designated Worker, listed on the related Permit.

Responsibilities of Permit Holders

2.9 The Permit Holder is responsible to:

(a) ensure that all Designated Workers as listed on the Permit are aware of th Radiation Safety Policy and Procedures;

(b) ensure that all Designated Workers are trained to work safely with radiation and to provide site-specific training in the safe use of radioactive materials, radiation devices and X-ray equipment listed on the Permit;

(c) regularly assess and inspect their areas for compliance with the Policy and Radiation Safety Procedures;

(d) ensure that any incidents that occur in their area are promptly reported to Environmental Health and Safety;

(e) adhere to all responsibilities as listed on the Permit; and (f) keep records of all site specific training pertaining to the Permit.

Responsibilities of Designated Workers

2.10 Designated Workers shall adhere to all responsibilities as listed in the Radiation Safety Manual and comply with the Radiation Safety Policy and Procedures.

Radiation Safety Manual

2.11 Environmental Health and Safety shall develop and maintain the Radiation Safety Manual containing the standard procedures relating to the Radiation Safety Policy and Procedures. The Committee shall approve and enforce the standard procedures as contained in the Radiation Safety Manual.

Training

2.12 All Permit Holders and Designated Workers shall be trained in accordance with the standard procedures as outlined in the Radiation Safety Manual. Environmental Health and Safety shall keep copies of EHS supplied training.

Reports and Assessments

2.13 Environmental Health and Safety shall make periodic assessments of all permitted activities. Inspections may be announced or unannounced. All users are required to cooperate with the inspection.

2.14 Environmental Health and Safety may require periodic written reports from the Permit Holder.

Enforcement

2.15 On the first occurrence of an offence, the Permit Holder will be notified verbally and in writing by the Radiation Safety Officer of the offence with reference to the Radiation Safety Procedure.

2.16 On the second occurrence within a year of an offence, the Radiation Safety Officer will send a letter to the Permit Holder, as a "Notice of Non-Compliance" to the Permit Holder that:

(i) is copied to the Permit Holder's supervisor;

(ii) has reference to the Radiation Safety Procedures, the duties of the Permit Holder in that respect, and the consequences of further infractions; and

(iii) will be communicated to all members of the Committee.

2.17 On the third occurrence within a year of an offence, the Radiation Safety Officer shall inform the Chair of the Committee and the following process will be followed:

(a) The Chair will call an emergency ad hoc meeting of the Committee to be held within seven (7) days. The Chair will invite the Permit Holder and his/her supervisor. At this meeting, the Permit Holder will be required to show cause as to why the Permit should not be revoked if a majority of the membership of the Committee members in attendance is not satisfied that the Permit Holder has provided justification for retaining the Permit, the Permit will be revoked and Environmental Health and Safety will dispose of all radioactive materials and lock-out any research X-ray equipment.

(b) The Chair of the Committee will notify the Dean of the appropriate Faculty and the Associate Vice-President (Research) of the decision of the Committee.

2.18 The Committee may decide to bypass one or more of the above noted steps if a serious violation occurs.

2.19 Notwithstanding any of the above actions, if it is the opinion of the Radiation Safety Officer that a serious, immediate risk to health, safety, environment or security exists, the Radiation Safety Officer shall have the authority to suspend operations or temporarily suspend a Permit. The Radiation Safety Officer will make a report on the situation, and the steps taken, to the Chair of the Committee. The Chair of the Committee will proceed as though this incident was a third occurrence within a year as outlined in 2.17.

Part III
Accountability

3.1 The Office of Legal Counsel is responsible for advising the Vice-President (Administration) and the Vice-President (Research and International) that a formal review of this Procedure is required.

3.2 The Chief Risk Officer and Associate Vice-President (Research) are responsible for the implementation, administration and review of this Procedure.

Part IV
Review

4.1 Governing Document reviews shall be conducted every ten (10) years. The next scheduled review date for this Procedure is September 14, 2026.

4.2 In the interim, this Procedure may be revised or repealed if:

(a) the President, Vice-President (Administration) or Vice-President (Research and International) or the Approving Body deems it necessary or desirable to do so;

(b) the Procedure is no longer legislatively or statutorily compliant;

(c) the Procedure is now in conflict with another Governing Document; and/or

(d) the Parent Policy is revised or repealed.

Part V
Effect on Previous Statements

5.1 This Procedure supersedes all of the following:

(a) Procedure: Radiation Safety (August 26, 2011);

(b) all previous Board of Governors/Senate Governing Documents on the subject matter contained herein; and

(c) all previous Administration Governing Documents on the subject matter contained herein.

Part VI
Cross References

6.1 This Procedure should be cross-referenced to the following relevant Governing Documents, legislation and/or forms:

(a) Health and Safety Policy

(b) Radiation Safety Policy

(c) Nuclear Safety and Control Act

(d) The Workplace Safety and Health Act (Manitoba)

UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title:	**Radiation Protection Committee and Radiation Safety Officer – Terms of Reference**		
Number:	Appendix C		Page 1 of 8
Issued by:	Environmental Health and Safety	Date issued:	June 23, 2017
Approved by:	Radiation Protection Committee	Date approved:	June 29, 2017

1. Purpose

The Terms of Reference for the Radiation Protection Committee are set out in accordance with the University Governing Documents entitled "Radiation Safety Policy" (Appendix A) and "Radiation Safety Procedure" (Appendix B), in connection with the Radiation Safety Program for all radioactive material, radiation devices and X-ray equipment in all areas under the control of the University of Manitoba. Appendixes A and B are at the end of this manual.

2. Definitions

Action Level is defined as a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee's radiation protection program and triggers a requirement for specific action to be taken.

Clinical X-ray equipment, for the purposes of this manual, shall refer to X-ray equipment that is used on human subjects to provide medical or dental care. The safe use of dental X-ray equipment is additionally guided by the Health Canada "Recommended Safety procedures for the Use of Dental X-ray Equipment- Safety Code 30".

CNSC means the Canadian Nuclear Safety Commission

Decommissioning is the process of releasing equipment or a room from the conditions on the Internal Permit. Decommissioning requires documentation to record that all radioactive material has been removed and no radioactive contamination is present in excess of legal limits or that the permitted X-ray equipment is removed or locked out of service. See RSP-2 Section 5.3. The current forms for decommissioning Permits or equipment will be on the Environmental Health and Safety website.

EHS means Environmental Health and Safety

Laboratory Hazard Clearance is the University process to communicate the mitigation of lab hazards to non – designated workers that will be working in a radioisotope permitted room.

Major Radiological Incident is a spill or unplanned release involving more than 10 megabecquerels (270 micorcuries) or 100 Exemption Quantities (EQs) whichever is more restrictive. See Appendix D at the end of this manual for a list of EQ.

Radiation Device, for the purpose of this manual shall refer to a device that contains more than the exemption quantity of a nuclear substance and that enables the nuclear substance to be used for its radiation properties.

Radioactive material, for the purposes of this manual, the term "radioactive material" shall be limited to materials used for their radioactive properties in the course of research or teaching. Further, "radioactive material" means an unstable isotope of an element that decays, or disintegrates spontaneously, emitting radiation of sufficient energy to create charged particles by adding or removing an electron or breaking chemical bonds.

Research X-ray equipment, for the purposes of this manual, shall refer to X-ray equipment that may include:

- Any X-ray equipment that is not used on humans subjects or
- Any X-ray equipment when it is used to irradiate humans under a research study protocol.

RSP means Radiation Standard Procedures that are approved by the University Radiation Protection Committee and documented in the University of Manitoba Radiation Safety Manual.

X-ray means artificially produced electromagnetic radiation of wave length shorter than 0.000 000 25 mm (0.25 nanometers).

X-ray equipment or X-ray machine means an operable device, the principle purpose and function of which is the production of X-rays, together with such ancillary apparatus as may be necessary for this purpose. For locations in the province of Manitoba, X-ray equipment is governed by the Manitoba Provincial Regulations.

3. Terms of Reference

3.1 Radiation Protection Committee

The University has established and shall maintain a Radiation Protection Committee comprising members of the University community and stakeholders knowledgeable in the safe use of radioactive material, radiation devices and X-ray equipment. The Committee shall report to the Associate Vice-President (Research).

The Radiation Protection Committee is authorized to:

a. Advise on the safe use of radioactive material, radiation devices and X-ray equipment in all areas under the control of the University.
b. Make recommendations related to radiation safety on University Policies and Procedures.
c. Approve radiation safety procedures and guidelines as developed by Environmental Health and Safety and maintained in the Radiation Safety Manual. The Radiation Protection Committee shall enforce the radiation safety procedures.
d. Issue Internal Permits to control the use of all licensed activities involving radioactive material, radiation devices and X-ray equipment.
e. Enforce the Radiation Safety Program and to supervise the external and internal dose monitoring and verification of compliance.

f. Make determination regarding revoking Permits from individuals who contravene these Procedures or the Policy on Radiation Safety.
g. Review reports of all inspections, incidents, unusual occurrences, and other relevant materials from the Radiation Safety Officer and make recommendations as appropriate.

3.2 Membership

a. The number of appointed voting members of the Committee shall not be more than ten (10) including the chair.
b. Appointed members shall serve a term of five (5) years, with the option to serve one (1) additional term for up to five years.
c. At least one (1) member of the committee shall be a nuclear medicine physician to fulfill the role of medical advisor.
d. At least one (1) member of the committee shall be a supervising dentist with the College of Dentistry.
e. One member shall be nominated by the Director of the Research Institute of Oncology and Hematology.
f. At least one (1) member of the Committee shall be from the bargaining unit representing technical support staff.
g. At least one (1) member of the Committee shall be from the bargaining unit representing faculty members.
h. The members shall be appointed by the Associate Vice-President (Research).
i. Alternates shall be appointed during an extended leave of a Committee member.
j. The Associate Vice-President (Research) may appoint an ex-officio, non-voting member to the Committee.
k. The Radiation Safety Officer and other designated Environmental Health and Safety staff shall be non-voting members and shall act as resources to the Committee.

3.3 Chair

a. The Chair shall be appointed by and report to the Associate Vice-President (Research).
b. The Chair may participate to an equal extent as any other member of the Committee in the discussions and decisions.
c. The Chair shall select one (1) member of the Committee to be 'Vice- Chair' and act on behalf of the Chair in the event the Chair is absent.

3.4 Secretariat

Environmental Health and Safety shall provide secretarial support to the committee.

a. Maintain a file of all correspondence to and from the committee.
b. Record minutes of meetings, for correspondence arising from meetings and for issuing notices of meetings after consultation with the chair.
c. Maintain a file of minutes of committee meetings and ensuring that:
   - One copy is sent to each member.
   - One copy is filed with Environmental Health and Safety.

3.5 Meetings

a. The committee shall schedule meetings at least semi-annually.
b. The date of the next regular meeting shall be determined at each meeting.
c. Special meetings may be called by the chair, (or vice chair in the event of his/her absence) for the purposes of considering causes of accidents or dangerous occurrences,

contamination incidents, high exposures, enforcement or conditions dangerous to safety or health.

d. The quorum for committee meetings shall consist of one-half of the voting members.

3.6 X-ray Committee

The University shall establish and maintain an X-ray Committee as a subcommittee to the Radiation Protection Committee comprising of members of the University community and stakeholders knowledgeable in the safe use of X-ray equipment.

3.6.1 Membership

a. The chair of the X-ray Committee shall be a member of the Radiation Protection Committee and is appointed by the Associate Vice-President (Research).
b. At least one (1) member of the Committee shall be a supervising dentist with the College of Dentistry.
c. Other members shall be appointed by the chair of the X-ray Committee, in consultation with the chair of the Radiation Protection Committee, to represent the University community as stakeholders that are knowledgeable in the safe use of X-ray equipment.
d. Appointed members shall serve a term of five (5) years, with the option to serve one (1) additional term for up to five years.

3.6.2 Meetings

The X-ray Committee will follow Section 3.5 as above. The X-ray Committee shall report to the Radiation Protection Committee and have the following mandate and authority:

a. Members are responsible to maintain an awareness of all applicable or new revised X-ray equipment regulations and standards.
b. To provide advice on the safe use of X-ray equipment in all areas under the control of the University.
c. To make recommendations on University Governing Documents related to X-ray equipment.
d. To oversee the development, implementation and maintenance of the X-ray Safety Program, including:
    i. Control the registration, storage, use, transfer and disposal of all X-ray equipment at The University of Manitoba in conjunction with Environmental Health and Safety.
    ii. Implement risk-based procedures to control X-ray hazards.
    iii. Define necessary signage related to the X-ray equipment.
    iv. Define dosimetry requirements related to X-ray equipment.
    v. An Internal Permit system for Research X-ray equipment, which will:
        - Identify responsibilities of the Permit Holder/Owner of a Research X-ray Equipment.
        - Outline the minimum qualifications of persons permitted to use Research X-ray equipment at locations under the control of the University of Manitoba.

3.7 Radiation Safety Officer

Environmental Health and Safety is responsible for the provision of the function of the Radiation Safety Officer. The Radiation Safety Officer administers the Radiation Safety Program, acting in consultation with the Radiation Protection Committee. At least one individual shall be available to fulfill these duties on a full time basis. The duties of the Radiation Safety Officer are to:

a. Provide advice, guidance, and technical support related to the use of radioactive material, radiation devices and X-ray equipment.
b. Ensure that Permit Holders and Designated Workers are aware of their responsibilities to comply with the Radiation Safety Policy and Procedures.
c. Ensure routine compliance inspections are conducted of all laboratories and storage areas listed on Internal Permits at least annually.
d. Report results of compliance inspections to the Radiation Protection Committee with recommendations for corrective actions where infractions to regulations or University procedures have occurred.
e. Fulfill the role as outlined in Radiation Standard Procedures (RSPs) regarding emergency procedures, supervise the cleanup and corrective action of all Major Radiological Incidents.
f. Authorize purchases of radioactive materials; and coordinate and monitor the acquisition, transportation, storage, use and disposal of radioactive material, radiation devices and X-ray equipment.
g. Investigate all significant personnel exposures and provide direction for bioassays and necessary safety precautions and report significant exposures to the Radiation Protection Committee.
h. Coordinate and develop training programs on radiation safety and provide advice to University personnel on the use of radioactive material, radiation devices and X-ray equipment.
i. Process applications for Internal Permits and make recommendations on them to the Radiation Protection Committee.
j. Maintain records of Permits, personnel exposure, unusual occurrences, and other activities involving radioactive material, radiation devices and X-ray equipment.
k. Advise the Radiation Protection Committee on current pertinent Canadian Nuclear Safety Commission (CNSC) regulations and any other regulations governing the use of radioactive material, radiation devices and X-ray equipment; and policy matters as well as on operations and activities of the Radiation Safety Program.
l. Prepare draft copies of the Radiation Protection Committee annual report to present to the Radiation Protection Committee.
m. Communicate effectively with the Canadian Nuclear Safety Commission (CNSC) and ensure the timely licence application and amendments to the CNSC licence application.
n. Establish and maintain effective communication with provincial agencies governing radiation and X-ray safety as required.
o. Prepare drafts of policies and procedures for the committee to oversee the use of radioactive material, radiation devices and X-ray equipment.
p. Prepare draft Radiation Standard Procedures (RSPs) outlining practical procedures and conditions including the definition of Action Levels that will help achieve the highest possible degree of safety in the use of radioactive material, radiation devices and X-ray equipment within the University. These procedures shall be designed to achieve the highest level of security of radioactive material, radiation devices and X-ray equipment and limit doses to persons and the environment to As Low As Reasonably Achievable, social and economic factors taken into account (ALARA). These procedures shall be documented in the Radiation Safety Manual.
q. Designate Nuclear Energy Workers based on proposed projects and exposure histories and inform workers in writing of:
    - Their designation,

- The risks associated with this type of work, including the risks associated with embryos and fetuses to radiation,
- The applicable effective dose limits and equivalent dose limits,
- The worker's dose levels.

r. Advised on the design of rooms and workspaces intended for the use of radioactive material, radiation devices and X-ray equipment in terms of compliance with relevant regulations.

s. Serve other functions as defined by other University policies and procedures.

4. Internal Permits

The Committee issues Internal Permits to control all procurement, use, storage, transfer and disposal of all radioactive materials, radiation devices and X-ray equipment used for research purposes in all areas under the control of the University. The Permit will specify:

- The Permit Holder;
- Designated Workers;
- Laboratory Radiation Supervisor (LRS), if an LRS is not named, the Permit Holder will be specified as the LRS;
- Permitted radioactive material and possession limits; radiation devices or X-ray equipment;
- Approved locations;
- Approved usage;
- An approved disposal procedure; and
- Other conditions of use as appropriate.

4.1 Eligibility to hold a Permit

Permit Holder/ Responsible User must hold an academic appointment at the level of lecturer or higher, or be support staff and are accountable to a Dean, Director or Department Head.

4.2 Permission to use radioactive material, radiation device or Research X-ray equipment

To use radioactive materials, radiation devices and Research X-ray equipment one must be:

- A Designated Worker.
- In the case of X-ray equipment that is enclosed and interlocked by the manufacturer and has passed an X-ray leakage test, a person acting under the supervision of a Designated Worker listed on the related Permit.

4.3 Permit Conditions

The Permit is conditional on the strict adherence to all terms and conditions and parameters listed on the Permit.

- Once identified, issues of non-compliance must be resolved as soon as practicable.
- Any issues not resolved within a maximum of 15 working days will be considered a second (or subsequent) occurrence.
- If in the opinion of the Radiation Safety Officer, the non-compliance is a safety risk a shorter deadline maybe communicated to the Permit Holder and if the deadline is passed, the situation would also be considered a second (or subsequent) offence.
- At the sole discretion of the Radiation Safety Officer, the deadline may be extended if there are extenuating circumstances that affect the resolution of the non-compliance.

4.4 Permit Approvals

a. Permit applications and requests to amend an existing Permit must be completed by the Permit Holder/ Responsible User and submitted to Environmental Health and Safety.
b. The Radiation Safety Officer shall assess the application. It may take up to four weeks for the Radiation Safety Officer to assess an amendment or application. If CNSC approval of a licence amendment, design approval form, or a project approval is required, the Permit (or amendment) may take longer.
c. If recommended by the Radiation Safety Officer, the Internal Radioisotope Permit will be forwarded to the Chair or the Vice-chair of the Committee for approval and signature.
d. The approved Internal Permit will be forwarded to the applicant by Environmental Health and Safety. The Radiation Safety Officer will keep a copy on file.

UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title: **Regulatory Quantities, Limits and Levels**

Number: Appendix D (version June 29, 2017)

The data in the table below are applicable to many sections of the Radiation Safety Manual. Columns 1, 2, and 4-9 are as published in the CNSC REGDOC-1.6.1 (version 2). The contents of the other columns represent University specific procedures.

Radioisotope	Exemptionquantity (EQ) - container needs radiation warning symbol	Major Incident 100 EQs – entrance needs radiation warning symbol	ALI estimate (inhalation)	ALI estimate (ingestion)	Basic level ≤ 5 ALI◊	Intermediatelevel ≤ 50 ALI◊	High level ≤ 500 ALI◊	CNSC Surface Contamination Limits Bq/cm^2	Wipes University Decontamination Level Bq/cm^2
Ag-110m	1 MBq	100 MBq	2.7 MBq	7.1 MBq	13.5 MBq	135 MBq	1.35 GBq	3	0.3
Am-241	10 kBq	10 000 kBq	740 Bq	100 kBq	3.7 kBq	37 kBq	370 kBq	3	0.3
Ar-41*	1 GBq	100 GBq	45 kBq	N/A	225 kBq	2.25 MBq	22.5 MBq	300	30
Au-198	1 MBq	100 MBq	18 MBq	20 MBq	90 MBq	900 MBq	9 GBq	30	3
Ba-133	1 MBq	100 MBq	11 MBq	20 MBq	55 MBq	550 MBq	5.5 GBq	30	3
Bi-210	1 MBq	100 MBq	330 kBq	15 MBq	1.65 MBq	16.5 MBq	165 MBq	3	0.3
Br-82	1 MBq	100 MBq	23 MBq	37 MBq	115 MBq	1.15 GBq	11.5 GBq	30	3
C-11	1 MBq	100 MBq	9.1 GBq	830 MBq	4.2 GBq	41.7 GBq	417 GBq	300	30
C-14	10 MBq	1000 MBq	3.1 GBq	34 MBq	170 MBq	1.7 GBq	17 GBq	300	0.5
Ca-45	10 MBq	1000 MBq	8.7 MBq	26 MBq	43.5 MBq	435 MBq	4.35 GBq	300	0.5
Ca-47	1 MBq	100 MBq	9.5 MBq	13 MBq	47.5 MBq	475 MBq	4.75 GBq	30	3
Cd-109	1 MBq	100 MBq	2.1 MBq	10 MBq	10.5 MBq	105 MBq	1.05 GBq	300	0.5
Ce-139	1 MBq	100 MBq	14 MBq	77 MBq	70 MBq	700 MBq	7 GBq	30	3
Ce-141	10 MBq	1000 MBq	6.5 MBq	28 MBq	32.5 MBq	325 MBq	3.25 GBq	300	30
Ce-143	1 MBq	100 MBq	20 MBq	18 MBq	100 MBq	1 GBq	10 GBq	30	3

Radioisotope	Exemption quantity (EQ) - container needs radiation warning	Major Incident 100 EQs – entrance needs radiation warning symbol	ALI estimate (inhalation)	ALI estimate (ingestion)	Basic level ≤ 5 ALI◊	Intermediate level ≤ 50 ALI◊	High level ≤ 500 ALI◊	CNSC Surface Contamination Limits Bq/cm^2	Wipes University Decontamination Level Bq/cm^2
Cl-36	1 MBq	100 MBq	3.9 MBq	22 MBq	19.5 MBq	195 MBq	1.95 GBq	300	30
Co-56	100 kBq	10 000 kBq	4.1 MBq	8 MBq	20.5 MBq	205 MBq	2.05 GBq	3	0.3
Co-57	1 MBq	100 MBq	33 MBq	95 MBq	165 MBq	1.65 GBq	16.5 GBq	300	0.5
Co-58	1 MBq	100 MBq	12 MBq	27 MBq	60 MBq	600 MBq	6 GBq	30	3
Co-60	100 kBq	10 000 kBq	1.2 MBq	5.9 MBq	6 MBq	60 MBq	600 MBq	3	0.3
Cr-51	10 MBq	1000 MBq	560 MBq	530 MBq	2.65 GBq	26.5 GBq	265 GBq	300	0.5
Cs-134	10 kBq	1000 kBq	2.1 MBq	1.1 MBq	5.5 MBq	55 MBq	550 MBq	3	0.3
Cs-137	10 kBq	1000 kBq	3 MBq	1.5 MBq	7.5 MBq	75 MBq	750 MBq	3	0.3
Cu-60	100 kBq	10 000 kBq	320 MBq	280 MBq	1.4 GBq	14 GBq	140 GBq	300	30
Cu-64	1 MBq	100 MBq	130 MBq	170 MBq	650 MBq	6.5 GBq	65 GBq	300	0.5
Cu-67	1 MBq	100 MBq	34 MBq	59 MBq	170 MBq	1.7 GBq	17 GBq	30	3
Er-169	10 MBq	1000 MBq	22 MBq	54 MBq	110 MBq	1.1 GBq	11 GBq	300	30
F-18	1 MBq	100 MBq	220 MBq	410 MBq	1.1 GBq	11 GBq	110 GBq	300	30
Fe-55	1 MBq	100 MBq	22 MBq	61 MBq	110 MBq	1.1 GBq	11 GBq	300	0.5
Fe-59	1 MBq	100 MBq	6.3 MBq	11 MBq	31.5 MBq	315 MBq	3.15 GBq	30	0.5
Ga-67	1 MBq	100 MBq	71 MBq	110 MBq	355 MBq	3.55 GBq	35.5 GBq	300	30
Ga-68	10 kBq	1000 kBq	250 MBq	200 MBq	1 GBq	10 GBq	100 GBq	300	30
Ge-68	100 kBq	10 000 kBq	2.5 MBq	15 MBq	12.5 MBq	125 MBq	1.25 GBq	300	30
H-3	1 GBq	100 GBq	1 GBq	1 GBq	5 GBq	50 GBq	500 GBq	300	0.5

Radioisotope	Exemption quantity (EQ) - container needs radiation warning	Major Incident 100 EQs – entrance needs radiation warning symbol	ALI estimate (inhalation)	ALI estimate (ingestion)	Basic level ≤ 5 ALI◊	Intermediate level ≤ 50 ALI◊	High level ≤ 500 ALI◊	CNSC Surface Contamination Limits Bq/cm^2	Wipes University Decontamination Level Bq/cm^2
Hg-194	10 kBq	1000 kBq	10.5 MBq	390 kBq	1.95 MBq	19.5 MBq	195 MBq	30	3
Hg-197	10 MBq	1000 MBq	235 MBq	87 MBq	435 MBq	4.35 GBq	43.5 GBq	300	30
Hg-203	100 kBq	10 000 kBq	11 MBq	11 MBq	55 MBq	550 MBq	5.5 GBq	30	3
I-123	10 MBq	1000 MBq	182 MBq	95 MBq	475 MBq	4.75 GBq	47.5 GBq	300	30
I-124	10 kBq	1000 kBq	3.2 MBq	1.5 MBq	7.5 MBq	75 MBq	750 MBq	3	0.3
I-125	1 MBq	100 MBq	2.7 MBq	1.3 MBq	6.5 MBq	65 MBq	650 MBq	300	0.5
I-131	1 MBq	100 MBq	1.8 MBq	910 kBq	4.55 MBq	45.5 MBq	455 MBq	30	0.5
In-111	1 MBq	100 MBq	65 MBq	69 MBq	325 MBq	3.25 GBq	32.5 GBq	300	30
In-113m	1 MBq	100 MBq	630 MBq	710 MBq	3.15 GBq	31.5 GBq	315 GBq	300	30
In-114	10 kBq	1000 kBq						300	30
Ir-192	10 kBq	1000 kBq	4.1 Mbq	14 MBq	20.5 MBq	205 MBq	2.05 GBq	30	3
K-42	1 MBq	100 MBq	100 MBq	47 MBq	235 MBq	2.35 GBq	23.5 GBq	300	30
Kr-79*	100 kBq	10 000 kBq	250 kBq	N/A	1.25 MBq	12.5 MBq	125 MBq	30	3
Kr-85*	10 kBq	1000 kBq	11 MBq	N/A	55 MBq	550 MBq	5.5 GBq	300	30
La-140	100 kBq	10 000 kBq	13 MBq	10 MBq	50 MBq	500 MBq	5 GBq	30	3
Lu-177	10 MBq	1000 MBq	18 MBq	38 MBq	90 MBq	900 MBq	9 GBq	300	30
Lu-177m	10 kBq	1000 kBq	1.7 MBq	12 MBq	8.5 MBq	85 MBq	850 MBq	3	0.3
Mn-52	100 kBq	10 000 kBq	11 MBq	11 MBq	55 MBq	550 MBq	5.5 GBq	3	0.3
Mn-52m	100 kBq	10 000 kBq	400 MBq	290 MBq	1.45 GBq	14.5 GBq	145 GBq	300	30
Mn-54	1 MBq	100 MBq	17 MBq	28 MBq	85 MBq	850 MBq	8.5 GBq	30	3

Radioisotope	Exemption quantity (EQ) - container needs radiation warning	Major Incident 100 EQs – entrance needs radiation warning symbol	ALI estimate (inhalation)	ALI estimate (ingestion)	Basic level ≤ 5 ALI◊	Intermediate level ≤ 50 ALI◊	High level ≤ 500 ALI◊	CNSC Surface Contamination Limits Bq/cm^2	Wipes University Decontamination Level Bq/cm^2
Mn-56	100 kBq	10 000 kBq	100 MBq	80 MBq	400 MBq	4 GBq	40 GBq	300	0.5
Mo-99	1 MBq	100 MBq	18 MBq	17 MBq	85 MBq	850 MBq	8.5 GBq	30	3
N-13	1 GBq	100 GBq	15 GBq	1.2 GBq	6 GBq	60 GBq	600 GBq	300	30
Na-22	1 MBq	100 MBq	10 Mbq	6.3 MBq	31.5 MBq	315 MBq	3.15 GBq	3	0.3
Na-24	100 kBq	10 000 kBq	38 MBq	47 MBq	190 MBq	1.9 GBq	19 GBq	300	0.5
Nb-95	1 MBq	100 MBq	15 MBq	34 MBq	75 MBq	750 MBq	7.5 GBq	30	3
Nb-98	100 kBq	10 000 kBq	200 MBq	180 MBq	900 MBq	9 GBq	90 GBq	300	30
Ni-63	100 MBq	10 000 MBq	38 MBq	130 MBq	190 MBq	1.9 GBq	19 GBq	300	30
O-15	1 GBq	100 GBq	41 GBq	3.7 GBq	18.5 GBq	185 GBq	1850 GBq	300	30
P-32	100 kBq	10 000 kBq	6.9 MBq	8.3 MBq	34.5 MBq	345 MBq	3.45 GBq	300	0.5
P-33	100 MBq	10 000 MBq	15 MBq	83 MBq	75 MBq	750 MBq	7.5 GBq	300	0.5
Pa-233	10 MBq	1000 MBq	6.3 MBq	23 MBq	31.5 MBq	315 MBq	3.15 GBq	30	3
Pb-210	0.01 MBq	1 MBq	18 kBq	29 kBq	90 kBq	900 kBq	9 MBq	3	0.3
Pm-147	10 MBq	1000 MBq	5.7 MBq	77 MBq	28.5 MBq	285 MBq	2.85 GBq	300	30
Po-210	0.01 MBq	1 MBq	9.1 kBq	83 kBq	45.5 kBq	455 kBq	4.55 MBq	3	0.3
Pr-144	10 kBq	1000 kBq	670 MBq	400 MBq	2 GBq	20 GBq	200 GBq	300	30
Pu-238	0.01 MBq	1 MBq	670 Bq	87 kBq	3.35 kBq	33.5 kBq	335 kBq	3	0.3
Pu-239	0.01 MBq	1 MBq	630 Bq	80 kBq	400 kBq	4 MBq	40 MBq	3	0.3
Pu-240	0.001 MBq	0.1 MBq	630 Bq	80 kBq	400 kBq	4 MBq	40 MBq	3	0.3
Pu-241	0.1 MBq	10 MBq	34 kBq	4.3 MBq	170 kBq	1.7 MBq	17 MBq	300	30

Radioisotope	Exemption quantity (EQ) - container needs radiation warning	Major Incident 100 EQs – entrance needs radiation warning symbol	ALI estimate (inhalation)	ALI estimate (ingestion)	Basic level ≤ 5 ALI◊	Intermediate level ≤ 50 ALI◊	High level ≤ 500 ALI◊	CNSC Surface Contamination Limits Bq/cm^2	Wipes University Decontamination Level Bq/cm^2
Ra-223	0.1 MBq	10 MBq	3.5 kBq	200 kBq	17.5 kBq	175 kBq	1.75 MBq	30	3
Ra-226	10 kBq	1000 kBq	1.7 kBq	71 kBq	8.5 kBq	85 kBq	850 kBq	3	0.3
Rb-86	0.1 MBq	10 MBq	15 MBq	7.1 MBq	35.5 MBq	355 MBq	3.55 GBq	30	3
Re-186	1 MBq	100 MBq	17 MBq	13 MBq	65 MBq	650 MBq	6.5 GBq	30	3
Re-188	0.1 MBq	10 MBq	27 MBq	14 MBq	70 MBq	700 MBq	7 GBq	30	3
Ru-103	1 MBq	100 MBq	9.1 MBq	27 MBq	45.5 MBq	455 MBq	4.55 GBq	30	3
Ru-106	0.1 MBq	10 MBq	570 kBq	2.9 MBq	2.85 MBq	28.5 MBq	285 MBq	30	3
S-35	100 MBq	10 000 MBq	18 MBq	105 MBq	90 MBq	900 MBq	9 GBq	300	0.5
Sb-122	0.01 MBq	1 MBq	17 MBq	12 MBq	60 MBq	600 MBq	6 GBq	30	3
Sb-124	1 MBq	100 MBq	4.3 MBq	8 MBq	21.5 MBq	215 MBq	2.15 GBq	3	0.3
Sc-46	1 MBq	100 MBq	4.2 MBq	13 MBq	21 MBq	210 MBq	2.1 GBq	3	0.3
Se-75	1 MBq	100 MBq	12 MBq	7.7 MBq	38.5 MBq	385 MBq	3.85 GBq	30	3
Sm-153	1 MBq	100 MBq	29 MBq	27 MBq	135 MBq	1.35 GBq	13.5 GBq	30	3
Sn-113	10 MBq	1000 MBq	11 MBq	27 MBq	55 MBq	550 MBq	5.5 GBq	300	0.5
Sr-85	1 MBq	100 MBq	31 MBq	36 MBq	155 MBq	1.55 GBq	15.5 GBq	30	0.5
Sr-89	1 MBq	100 MBq	3.6 MBq	7.7 MBq	18 MBq	180 MBq	1.8 GBq	300	0.5
Sr-90	10 kBq	1000 kBq	260 kBq	710 kBq	1.3 MBq	13 MBq	130 MBq	30	3
Tc-99	10 MBq	1000 MBq	6.3 MBq	26 MBq	31.5 MBq	315 MBq	3.15 GBq	300	30
Tc-99m	10 MBq	1000 MBq	690 MBq	910 MBq	3.45 GBq	34.5 GBq	345 GBq	300	30
Te-127	1 MBq	100 MBq	110 MBq	120 MBq	550 MBq	5.5 GBq	55 GBq	300	30

Radioisotope	Exemption quantity (EQ) - container needs radiation warning	Major Incident 100 EQs – entrance needs radiation warning symbol	ALI estimate (inhalation)	ALI estimate (ingestion)	Basic level ≤ 5 ALI◊	Intermediate level ≤ 50 ALI◊	High level ≤ 500 ALI◊	CNSC Surface Contamination Limits Bq/cm^2	Wipes University Decontamination Level Bq/cm^2
Th-228	10 kBq	1000 kBq	630 Bq	290 kBq	3.15 kBq	31.5 kBq	315 kBq	3	0.3
Th-230	10 kBq	1000 kBq	710 Bq	95 kBq	3.55 kBq	35.5 kBq	355 kBq	3	0.3
Th-232	10 kBq	1000 kBq	690 Bq	91 kBq	3.45 kBq	34.5 kBq	345 kBq	3	0.3
Tl-201	1 MBq	100 MBq	260 MBq	210 MBq	1.05 GBq	10.5 GBq	105 GBq	300	30
Tl-204	10 kBq	1000 kBq	32 MBq	15 MBq	75 MBq	750 MBq	7.5 GBq	300	30
U Natural	1 kBq	100 kBq	3.2 kBq	410 kBq	16 kBq	160 kBq	1.6 MBq	3	0.3
U-234	10 kBq	1000 kBq	2.9 kBq	410 kBq	14.5 kBq	145 kBq	1.45 MBq	3	0.3
U-235	10 kBq	1000 kBq	3.3 kBq	430 kBq	16.5 kBq	165 kBq	1.65 MBq	3	0.3
U-238	10 kBq	1000 kBq	3.5 kBq	450 kBq	17.5 kBq	175 kBq	1.75 MBq	3	0.3
V-48	100 kBq	10 000 kBq	7.4 MBq	10 MBq	37 MBq	370 MBq	3.7 GBq	3	0.3
V-49	10 kBq	1000 kBq	770 MBq	1.1 GBq	3.85 GBq	38.5 GBq	385 GBq	300	30
Xe-127*	10 kBq	1000 kBq	250 kBq	N/A	1.25 MBq	12.5 MBq	125 MBq	30	3
Xe-133*	10 kBq	1000 kBq	2 MBq		10 MBq	100 MBq	1 GBq	300	30
Y-88	10 kBq	1000 kBq	6.1 MBq	15 MBq	30.5 MBq	305 MBq	3.05 GBq	3	0.3
Y-90	100 kBq	10 000 kBq	12 MBq	7.4 MBq	37 MBq	370 MBq	3.7 GBq	30	3
Yb-169	10 MBq	1000 MBq	8.3 MBq	28 MBq	41.5 MBq	415 MBq	4.15 GBq	30	3
Zn-65	1 MBq	100 MBq	7.1 MBq	5.1 MBq	25.5 MBq	255 MBq	2.55 GBq	3	0.3
Zr-89	10 kBq	1000 kBq	27 MBq	25 MBq	125 MBq	1.25 GBq	12.5 GBq	3	0.3
Zr-95	1 MBq	100 MBq	4.8 MBq	23 MBq	24 MBq	240 MBq	2.4 GBq	30	3

Notes: ◊ "Container Limit" - in storage or in use at a single time. Includes waste containers.

* Concentration, in Bq/m^3, that results in a dose of 20 mSv if one is exposed to this concentration for 2,000 hours.

UNIVERSITY OF MANITOBA

Radiation Safety Manual

Title: **CNSC Dose Limits**

Number: Appendix E (version June 29, 2017)

Maximum Permissible Effective Doses of Ionizing Radiation

Organ or Tissue	Member of the Public (mSv per year)	Nuclear Energy Worker (mSv per year)
Whole Body	1	50 5 yr cumulative max 100mSv balance of pregnancy max 4 mSv
Lens of an eye	15	150
Skin	50	500
Hands & Feet	50	500
Gonads (testes and ovaries)	0.2	10
Red bone marrow, colon, lung, stomach	0.012	6
Bladder, breast, liver, esophagus, thyroid gland	0.05	2.5
Skin (when the skin of the whole body in exposed)	0.01	0.5
Bone surfaces	0.01	0.5
All other organs	0.05	2.5

CNSC Canadian Nuclear Safety Commission

Effective Dose Effective Dose includes weighting factors for the different types of radiation and susceptibility of different tissues.