McGill University

Radiation Safety Manual
Edition 7.0

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Reviewed by: University Laboratory Safety Committee (ULSC)

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Useful Contact Information

For all emergencies **call 911**. Then inform campus security services at **514-398-3000 (Downtown Campus)** or **514-398-7777 (Macdonald Campus)**

Inquiries regarding *hazardous waste disposal* should be directed to:

Hazardous Waste Management	Tel: **5066** Web: www.mcgill.ca/hwm

Inquiries regarding *radiation safety* should be directed to:

McGill Radiation Safety Officer	Tel: **2245**
Environmental Health & Safety	Tel: **4563** Web: www.mcgill.ca/ehs Email: ehs@mcgill.ca
Fire Prevention	Tel: **3473** Email: fireprevention@mcgill.ca
Facilities Call Centre	Tel: **4555** Email: fcc.fod@mcgill.ca

1. INTRODUCTION

The 7th edition of the McGill University Radiation Safety Policy Manual (hereafter referred to as The Manual) has been revised by the EHS management team and members of the McGill University Laboratory Safety Committee (ULSC).

This manual was designed to inform all laboratory personnel about McGill University's policy regarding ionizing radiation.

Since the manual will be periodically revised, readers are asked to contact Environmental Health & Safety (EHS) at local 4563 or ehs@mcgill.ca with comments, suggestions, omissions or errors. The changes made in the manual will be tracked and recorded in the form found in **Appendix P**.

1.1 RADIATION SAFETY IN CANADA

The Canadian Nuclear Safety Commission (CNSC) licenses the acquisition and use of all nuclear substances as well as radiation emitting equipment such as nuclear reactors and accelerators. The Health Protection Branch of Health Canada formulates regulations related to the manufacture and functioning of new radiation equipment under the Radiation Emitting Devices Act (R.S.C., 1985, c. R-1). Some provinces also have their own regulations for the use of radiation emitting equipment (e.g. x-ray emitting equipment).

Under the Nuclear Safety and Control Act, the CNSC has the mandates:

- regulation of the development, production and use of nuclear energy in Canada;
- regulation of the production, possession and use of nuclear substances, prescribed equipment and prescribed information;
- prevent unreasonable risk to the environment and to the health and safety of persons, associated with that development, production, possession or use;
- implementation of measures respecting international control of the use of nuclear energy and substances, including measures respecting the non-proliferation of nuclear weapons; and
- dissemination of scientific, technical and regulatory information concerning the activities of the CNSC.

The institution is visited regularly by CNSC compliance inspectors to ensure that the above regulations and conditions listed on the McGill University's Consolidated Nuclear Substances License (No. 01222-4) are being met by radioisotope users. The CNSC has the ultimate authority to withdraw radioisotope user privileges if serious violations are observed. A serious violation by one user could affect all those who use nuclear substances under McGill University's License.

1.2 PURPOSE AND SCOPE OF MANUAL

The Manual embodies the policy of McGill University in the field of ionizing radiation. It describes the organization, services, procedures and regulations with respect to the procurement, storage, use and disposal of, nuclear substances and radiation-emitting devices. For the purpose of this manual, radiation sources comprise:

- All nuclear substances (with minor exceptions) requiring licenses issued by the CNSC.
- Devices emitting ionizing radiation requiring CNSC licenses.
- Radiation-emitting device not requiring CNSC licenses but subject to provincial control (e.g. conventional X-ray machines).

The Manual does not cover sources of non-ionizing radiation such as lasers and microwave generators.

The Manual is applicable in all buildings, grounds and operations under the jurisdiction of McGill University. Most of the procedures and rules apply wherever radiation sources of the types indicated are used. However, the diversity of radiation sources and devices used on campus is such that additional procedures and regulations may be required in specially designated areas. These special procedures and recommendations are described in annexes to this manual, which are also available on the website.

1.3 ALARA PRINCIPLE

The Manual provide the guidelines for the responsibilities and good practice which are consistent with both the regulatory requirements of the CNSC and the ALARA principle.

As defined by the CNSC: ALARA is an optimization tool in radiation protection used to keep individual, workplace and public dose limits **a**s **l**ow **a**s **r**easonable **a**chievable, social and economic factors being taken into account. ALARA is not a dose limit; it is a practice that aims to keep dose levels as far as possible below regulatory limits.

ALARA is not only a sound safety principle, but is a regulatory requirement for all radiation safety programs. The ALARA principle is a cornerstone of the McGill radiation safety program and is applied throughout this manual.

2. RADIATION SAFETY ORGANIZATION

Responsibility for radiation safety begins with the individual handling radiation sources in his or her laboratory and extends upwards, through a chain comprising the Permit Holder (see Section 2.5), the Radiation Safety Officer (see Section 2.4), Environmental Health & Safety (see Section 2.11) and the University Laboratory Safety Committee (see Section 2.3). Services relating to radiation protection (e.g. monitoring, waste disposal) are provided centrally and are described in Sections 2.11, 5.3 and paragraph 8.3.2.N

2.1 APPLICANT AUTHORITY, SIGNING AUTHORITY & ORGANOGRAM

The Vice-Principal of Research and International Relations as the senior officer of the academic sector of McGill University has authority over the Permit Holders and thus assumes the role of "Applicant Authority" as specified by the CNSC. This person has full legal and financial responsibility for the licence and thus is ultimately responsible for all licensed activities at the University. The RSO is the primary Signing Authority and can act for the Applicant for all matters encompassed by the CNSC licence.

The radiation safety program is a service provided by Environmental Health & Safety (EHS). EHS reports to the Vice-Principal, Administration and Finance. For a visual description, consult the attached organogram **(see Appendix A)**.

2.2 RADIATION SAFETY PROGRAM POLICIES

The radiation safety program describes measures that McGill University is committed in keeping with the amount of exposure to radiation sources, radiation emitting devices received by its staff, students, and public to levels that are **a**s **l**ow **a**s **r**easonable **a**chievable (ALARA), taking into account social and economic factors.

McGill University acknowledges that it is insufficient to just simply respect the appropriate dose limit; efforts will be made to further reduce doses. McGill University is committed to the concept of maintaining doses at ALARA, thorough the implementation of:

- i) management control over work practices
- ii) personnel qualification and training,
- iii) control of occupational and public exposure to radiation;
- iv) planning for unusual circumstances

2.2.1 CNSC Requirements

The Canadian Nuclear Safety Commission has issued McGill University a Consolidated Nuclear Substances and Radiation Devices Licence for the **possession**, **transfer, use, storage, exportation** and **importation** of nuclear substances and radiation devices.

A Consolidated License is a single broad-scope license issued by the CNSC to an institution having many users of nuclear substances who are primarily in one location. The application for an issuance of a consolidated license to an institution rather than to each individual radioisotope user emphasizes to the institution its responsibility for a radiation safety program.

Upon issue of this licence the university assumes the responsibility to ensure that any use of controlled nuclear substances on campus complies with the **Nuclear Safety and Control Act, CNSC Regulations, Transport Packaging of Nuclear Substances Regulations**, as well as specific conditions that apply to the McGill's Consolidated Licence.

The CNSC requires the following three components are in place:

1. A safety committee responsible for radiation safety affairs
2. Designated Institutional Radiation Safety Officer (RSO)
3. Radiation Safety Manual

The Committee at McGill responsible for radiation safety is the University Laboratory Safety Committee (ULSC). This Committee reports to and its Chair is appointed by the Vice-Principal of Research and International Relations, who is the applicant Authority. *It is the Committee that has the authority to **implement** and **enforce** the radiation safety policy encompassing the acquisition, use, handling, transfer, storage and disposal of radioactive materials.* This Committee has the responsibility to develop and approve radiation safety policies and to provide oversight of the radiation safety program.

The RSO is an EHS officer reporting to the Operations Manager of EHS, and has overall responsibility for EHS services related to radiation safety. The RSO handles liaison with the CNSC and regularly informs the Operations Manager of daily business operations.

The radiation safety manual is prepared by EHS and presented to the ULSC for approval. Any amendment to this manual will be submitted to the CNSC for approval prior to implementing a new policy or procedure. It should be reviewed once annually by the RSO to ensure the information remains current and is readily available to all on the EHS website

2.2.2 McGill Enforcement Policy-Internal Responsibility System

McGill University has an institutional responsibility to respect CNSC regulations as well as McGill internal policy. The roles and responsibilities for safety are described in more detail in McGill's Internal Responsibility System found in the EHS website.

Enforcement of safety is an integral part of the Internal Responsibility System and the expectation is that those with authority will enforce safety as per their responsibilities, however in the event there is a situation that is immediately dangerous to life or health, or a serious violation of CNSC regulations, the RSO, the EHS Operations Manager or the Director of EHS can take measures, such as suspension of a procedure or removal of nuclear substances from a user, until the situation is rectified. The permit holder (see section 2.5) will be provided with a time frame and clear consequences if the non-compliance has not been corrected.

2.2.3 CNSC – Administrative Monetary Penalties

Administrative Monetary Penalties (AMP's) are fines imposed by the CNSC, without court involvement for the violation of a regulatory requirement. These fines can be applied against any individual or the University as a whole for regulatory violations. Fines range from $300 - $25,000 for individuals, and from $1,000 - $10, 000 persons other than individuals (example: corporations). A list of finable offences are listed in the Administrative Monetary Penalties Regulation **(see Appendix O)**.

2.2.4 Radioisotope Laboratory and Equipment Decommissioning and Commissioning Policy

2.2.4.1 Radioisotope laboratory Commissioning

When a radioisotope laboratory is being planned, there are two broad areas that should be considered: protection of the general public and protection of the authorized radioisotope user.

All laboratories for the use of nuclear substances be must first be approved by the RSO to confirm their conformity to regulations and policy. The RSO will determine the appropriate classification level for the laboratory and the conditions of use for the nuclear substances to be used or stored.

The CNSC guidance document GD 52 (Design Guide for Nuclear Substance Laboratories and Nuclear Medicine Rooms) provides laboratory planning information, with specific features in ventilation, finishing, plumbing, storage and miscellaneous topics including coat hooks, installation of radiation monitors devices, desks and study spaces. Consult the guide for further details.

2.2.4.2 Radioisotope laboratory and/or Equipment Decommissioning

Whenever a permit holder vacates an authorized room/laboratory or discontinues work with nuclear substances it is necessary to conduct a decommissioning of the room and/or laboratory. Further, any equipment used with radioactive sources, whether they be open or closed, must also be deemed safe and free of surface contamination prior to relocation or sending it out for servicing.

Decommissioning certifies that the room/laboratory or any piece of equipment for radioactive material is free of radioactivity or radioactive surface contamination. Decommissioning is achieved in three steps:

- the removal and/or disposal of all nuclear substance;
- monitoring for contamination and decontamination if required; and
- removal of all radiation warning signs, posters and labels.

For details on decommissioning procedures, refer to the Radiation Safety Operating Procedures (RADS.001).

It is responsibility of the permit holder to leave the laboratory in a safe condition and free of radioactive contamination, otherwise the decontamination work will be done by the RSO at the expense of the permit holder or their department.

The CNSC asks permit holders to keep the associated decommissioning records for a minimum of 3 years.

2.2.5 Radiation Safety Training Policy

All persons asked to work with nuclear substances (radioactive sources) and/or radiation emitting devices at McGill must undergo radiation safety training. Training taken at other institutions may be deemed acceptable, at the discretion of the McGill RSO.

There are 3 types of radiation safety courses being offered:

Principles of Laboratory Radiation Safety. The core course for first time users of nuclear substances. Authorized radiation users need to repeat the training every 3 years, by challenging the radiation safety exam or repeating the core course.

- Topics covered included: Nuclear Safety Control Act, Basic Radiation Physics; Radiation and Radioactivity; Particles and Electromagnetic Radiation Interaction with Matter; Quantity and Units; Radiation Detection; Ionization and Health Effects; Dose and Exposure; Radiation Detection and Instrumentation; Radiation Protection Regulation; Internal and External Exposure; Dosimeters; Nuclear Substances Regulation; ALARA; Contamination Control; Organization and Administration of Radiation Safety Program; Purchase (MMP), Tracking System (myLab) and Dispose Nuclear Substances; Emergency Procedures; McGill Internal Policies (i.e. decommissioning policy, training Policy); Packaging and Transport Regulation.

Radiation Safety Awareness Course. This course is designed for persons who do not work with nuclear substances but who have occasion to be in areas where they are used, for example: security agents, maintenance and custodial personnel.

- Topics covered included: What is radiation, Effects on Health, Protection against exposure, Labeling, Transport, Storage.

myLab Training (Radiation Module). All radiation users are required to take this course in order to satisfy inventory and tracking requirements for nuclear substances.

- Topics covered included: order nuclear substances, add them to inventory, record usage and rad-waste disposal.

Training must be given prior to the use of radiation materials or equipment. Users can attend radiation safety courses at McGill University or from other recognized institutions. For more information on radiation safety courses contact the EHS.

2.2.6 McGill Nuclear Substance Acquisition Policy

Prior to obtaining any nuclear substances users must first apply for an Internal Permit from the RSO. Once an Internal Permit is issued the user then has access to the McGill Marketplace portal and myLab McGill Tracking System to purchase radiation materials from nuclear substances and radiation device suppliers. For details see Section 4.4.

2.2.7 Pregnancy & Breast-Feeding Policy

It is up to the pregnant Radiation User to decide whether or not she will formally declare her pregnancy to the RSO. Should she choose to declare her pregnancy to the RSO, then the RSO will meet with her to review radiation safety procedures and the risk to the fetus, and present the guidelines outlined in the Nuclear Safety and Control Act document "Radiation Protection Regulations (SOR/2000-203)" and in the Commission des normes, de l'équité, de la santé et de la sécurité du travail (CNESST) document "Safety Working Conditions for a Safe Maternity Experience - Guide for the Pregnant or Breast-Feeding Worker".

The first trimester is known to be the most radiosensitive time for a fetus, thus, it is beneficial, but not required, to meet with the RSO as soon as possible to review safety practices and monitoring options. The policy covers not only the pregnancy period of the employee but also the breast-feeding months.

If she chooses not to declare her pregnancy to the RSO. Only the radiation limits for adult Radiation User will be in effect, not the limits for the fetus. Undeclared pregnant workers are considered as protected under the regulations for adult Radiation Users. However this does not apply for Nuclear Energy Workers (NEWs). They should be advised that CNSC regulations require a NEW who becomes pregnant to inform the RSO of the pregnancy in writing so that measures are taken to limit the dose she may receive to 4 mSv for the balance of the pregnancy.

2.3 UNIVERSITY LABORATORY SAFETY COMMITTEE

The University Laboratory Safety Committee (ULSC) is the designated committee responsible for Radiation Safety as per CNSC requirements. More information on the mandate, makeup of the Committee, meeting agendas and minutes go to the EHS website.

2.4 RADIATION SAFETY OFFICER

The RSO is the individual designated by the University Administration (the licensee) to manage the radiation safety program in accordance with the Canadian Nuclear Safety and Control Act (CNSCA) and Regulations and the specific conditions of the consolidated license. The RSO must be a competent, adequately trained and a sufficiently experienced individual with the resources, authority and time to fulfill the mandate. The lines of communication between the RSO and the university administration must be direct enough to ensure adequate implementation of all aspects of the radiation safety program.

2.4.1 Duties of the RSO with Respect to the Institution

The Radiation Safety Officer shall:

- act as the chief liaison officer between McGill University and outside authorities, such as the Canadian Nuclear Safety Commission (CNSC), Health Canada, Radiation Protection Bureau, Bureau of Radiation and Medical Devices, National Dosimetry Services and the Commission des normes, de l'équité, de la santé et de la sécurité du travail (CNESST) du Québec, in all matters relating to radiation safety;
- monitor compliance with radiation safety procedures described in this manual;
- ensure the preparation and dissemination of information on radiation safety;
- monitor and/or review special request for authorization to purchase nuclear substances and radiation devices through McGill Market Place (MMP);
- conduct and/or supervise commissioning procedures in order to ensure that the proposed handling and location for storage are acceptable and comply with regulations and licence requirements;
- supervise and control the acquisition, use, transfer and disposal of nuclear substances and radiation devices
- develop and provide application forms for internal permit applications and information bulletins and guidelines for those requesting such material;
- ensure appropriate radiation protection training is provided for all personnel and students from actual users to cleaning staff, security personnel and maintenance people;
- assess the qualification and competence of personnel and students who will use nuclear substances and radiation devices
- designate authorized radiation user as Nuclear Energy Worker in accordance with regulations;
- maintain the Internal Permit management system and keep records and forms of all related information, including: lists of Permit Holders, Internal Permit, Nuclear Energy Workers (NEW), radiation users, and areas where radioactive sources or radiation emitting devices are stored or used, Occupational radiation exposures;
- develop and implement programs to inspect and review licensed activities, location of nuclear substances and radiation devices storages;
- systematically and periodically review survey data for radiation and contamination levels (wipe test monitoring) in all areas where nuclear substances are used, stored or disposed (section 5.4);
- implement a personnel monitoring program including bioassay (i.e. thyroid monitoring) where applicable;
- ensure the distribution, use, and maintenance of personnel radiation monitoring devices and equipment;

- review and records of occupational radiation exposures and recommend ways of reducing exposures in accordance with the ALARA regulatory guide (G-129)
- assess and investigate any radiation overexposure and advise the Canadian Nuclear Safety Commission;
- conduct and/or supervise decontamination (loose and/or fixed contamination), commissioning and decommissioning procedures;
- certify decommissioned laboratories and/or equipment as being free of contamination;
- investigate all accidents or incidents involving nuclear substances or radiation devices and report it to the Canadian Nuclear Safety Commission if required;
- investigate any incurred losses or damage of nuclear substances or radiation devices and report it the Canadian Nuclear Safety Commission;
- provide waste disposal procedures in accordance with conditions of the license;
- maintain inventory of sealed sources and radiation devices
- ensure leak testing of sealed radioactive sources and maintain records;
- organize transportation of nuclear substances outside and inside University premises if required, ensure keeping record of any transport documents required;
- co-ordinate the development of radiation emergency plans;
- review plans for construction or renovation of radioisotope laboratories in respect to the CNSC guidance document GD 52; and
- conduct routine maintenance and calibration of any radiation detection equipment.

2.4.2 Duties of the RSO with Respect to the University Laboratory Safety Committee

The Radiation Safety Officer shall:

- Review annually and propose to the University Laboratory Safety Committee (ULSC) any amendments to the Radiation Safety Manual;
- prepare and submit summaries of radiation safety services and the results of inspections, follow ups and decommissioning projects;
- prepare, in consultation with the University Laboratory Safety Committee, an annual and/or activity report to the Canadian Nuclear Safety Commission (CNSC) as required by the Consolidated License;
- complete and submit, in consultation with the ULSC, the renewal application of McGill University's CNSC license for nuclear substances and radiation devices (No. 01222-4) in accordance with the Nuclear Safety and Control Act (NSCA) and the regulations made under the NSCA; and
- present information on accidents or incidents comprising radiation exposure.

2.5 PERMIT HOLDERS

The Permit Holder (PH) is the person responsible for the safe procurement, storage, use and disposal of specific radiation sources. He/she is usually in charge of research or teaching operations. In particular, a Permit Holder must:

- Submit application to EHS for an Internal Permit.
- Advise EHS of any changes affecting the Permit.
- Work according to the practices stated in the Canadian Nuclear Safety Commission (CNSC) Safety Poster for Basic-Level, Intermediate-Level, High-Level and Containment-Level laboratories.
- Adhere to conditions stated in the internal radioisotope permit.
- Post no food and beverage signs, up-to-date internal radioisotope permit, CNSC Safety poster, laboratory information card, visible to all lab occupants, and radiation warning signs identifying radiation work areas.

- Provide adequate facilities, equipment and supervision to ensure that workers or students follow the rules and regulations set out by the CNSC and the McGill University Laboratory Safety Committee.
- Use the myLab system to maintain an up-to-date inventory of radiation sources including the locations where they are installed, stored, handled, applied or disposed (see 4.4).
- Use the MMP-myLab in tandem system to track the purchase, storage, use and disposal of nuclear substances.
- Establish working procedures and emergency measures, and post them where required.
- In co-operation with the Radiation Safety Officer, designate personnel as Radiation Users and when necessary designate personnel as Nuclear Energy Workers and maintain lists of such personnel.
- Ensure that all Radiation Users and Nuclear Energy Workers under their jurisdiction receive adequate instruction in the safe handling of the radiation sources and radiation-emitting equipment commensurate with their duties. Also, ensure that each of these workers reads and understands the relevant sections of the Radiation Safety Manual.
- Allow only authorized persons to enter areas designated for radiation use and to get access to radiation materials.
- Ensure that any nuclear substance and/or radiation device under their jurisdiction are located in a locked area, room or enclosure, (magnetic cards, code locks, keys) when not in use or not under the direct supervision and control of an authorized user.
- Provide special instruction and/or precautionary measures for students, clerical personnel and others who are authorized to enter or work in areas where there is a possibility of radiation exposure, but who are not classified as Radiation Users or Nuclear Energy Workers.
- As soon as the Permit Holder is aware, report incidents of loss, unauthorized use or theft involving radioactive material (nuclear substances or radiation devices) to the RSO.
- Maintain area monitoring and/or wipe test records (see section 5.7.1.2) for inspection by the RSO, EHS technicians and CNSC inspectors.
- Ensure that, when required, personnel wear assigned radiation monitors throughout the working day. The Permit Holder must also keep records of the dose received by each person and, in co-operation with the RSO, investigate any excessive or abnormal dose.
- Refer to the RSO for assistance when deciding if a personnel radiation monitor is needed.
- Ensure that, when required, personnel make themselves available for bioassay procedures such as thyroid monitoring and that adequate records of the results of such procedures are maintained.
- Institute, where appropriate, additional safety precautions and/or monitoring procedures for pregnant Nuclear Energy Workers (NEWs) and, where necessary, re-arrange the duties of pregnant NEWs (see Section 2.2.6).
- Maintain and centralize all required documents and/or records in the McGill Radiation Log Book to facilitate consult by the CNSC inspector and the RSO.

2.6 CLASSIFICATION OF AUTHORIZED RADIATION USERS

According to the McGill University radiation safety program, persons are classified as:

- **Radiation User** is used to define individuals who need not be legally classified as Nuclear Energy Workers but who nevertheless require a range of protective measures because they are using or handling prescribed nuclear substances or radiation emitting devices (see Section 2.6.1).
- **Nuclear Energy Worker** is legally defined by the NSC Act (see Section 2.6.2).
- **Other Personnel** normally include visitors and members of the public (see Section 2.8).

2.6.1 Radiation User

At McGill University, an individual is classified as a "Radiation User" if he or she regularly uses or handles unsealed nuclear substance such that he/she could receive a measurable annual radiation dose less than 1 mSv (100 mrem) above the background level.

Permit Holders must designate those members of their staff, or other persons working in their laboratories or departments, as Radiation Users if they satisfy the above requirement.

A Radiation User is required to:

- Complete the radiation safety training (see section 2.2.4)
- Ensure that her/his name is listed on the Internal Permit
- Read sections of the Manual and sign a declaration that he/she has understood the meaning and implications of these sections
- be familiar with the particular radiation safety procedures in his/her work and work area, and conduct his/her work accordingly; and
- wear a personal radiation monitor or monitors, if required and explained by the Personnel Condition, found on the Internal Permit
- inform the Permit Holder when she knows or suspects that she is pregnant (see section 2.2.6)

2.6.2 Nuclear Energy Workers

In special circumstances, persons may be classified as a Nuclear Energy Worker (NEW) as defined in the NSC Act. *if 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 set at 1 mSv/year (100 mrem/year)*." Also, a person who is likely to be exposed to neutrons to a significant extent must be designated as a NEW, irrespective of the level of beta, gamma and/or X-ray radiation to which he/she is also exposed.

In addition to the obligations assumed by all Radiation Users, as set out in Section 2.6.1 above, a NEW must:

- Read and sign the "Notification of Nuclear Energy Worker Status" form **(see Appendix M)**;
- undergo medical surveillance if required (see Section 5.6);
- be subjected to mandatory routine personnel monitoring of a type appropriate to the work undertaken.

2.7 STUDENTS

The following guidelines apply to students (i.e. undergraduate, graduate and post-doctoral) and normally student participating in classroom demonstrations, laboratory courses and/or projects utilizing low-level radiation sources, or working in an area where radiation sources are presented but does not himself/herself use these sources, is not normally classified as a Radiation User; rather, should be subject to the general public limit of 1 mSv (100 mrem) per annum (see Sections 3.6 and 3.8). Personal monitoring of individual students is not required. No additional precautions are needed for students over the age of 18 if the limits suggested are followed.

A graduate, or a post-doctoral or an undergraduate student who regularly uses nuclear substances (open or sealed sources) is classified as either a Radiation User or a Nuclear Energy Worker, as appropriate (see Sections 2.6.1 and 2.6.2).

When students, are required to handle nuclear substances (open or sealed sources) or to work with radiation-emitting equipment, adequate instruction must be given prior to the actual usage of the sources and suitable monitoring must be undertaken. An authorized Radioisotope User should supervise the action

The Permit Holder, in co-operation with the RSO, must:

- conduct a complete radiation safety assessment of the working area to be used by students; and/or
- conduct a review of the doses likely to be received by these students during the procedures to be undertaken, to ensure compliance with Section 2.6.1 above.

2.8 OTHER PERSONNEL

Other McGill staff or workers may have access to areas where nuclear substances or radiation emitting devices are stored or used, for example:

- Clerical, maintenance & custodial personnel or other non-scientific staff may require access regularly or occasionally. Such access should be permitted only when the sources are in a "safe" condition, i.e. nuclear substances are safely stored and shielded and radiation-emitting equipment is "off".
- Occasionally, laboratory staff who are not radiation user may be asked to participate in a procedure involving radiation. Such persons should be treated as "students" and the guidelines of Section 2.7 should be applied.
- Visitors, if they are taken into areas where nuclear substances and/or radiation emitting devices are in use may be issued radiation personnel monitors (see section 5.3) on a temporary basis if there is a possibility of their receiving a measurable radiation dose during the visit. In this situation, Permit Holder should keep records of personnel monitoring usage (i.e. user name, user address, social insurance number, date, time, activities involved)

2.9 ACCESS TO LABORATORIES AND WORKSHOPS

Access to McGill laboratories, workshops and other work areas housing nuclear substances or radiation emitting devices is limited to McGill staff and students or other persons on official business (example: CNSC or other Government inspectors). Permission to access the laboratory must be obtained from the permit holder or principle investigator.

Steps should be taken to ensure that those entering any of these areas are adequately protected from hazards and informed about the safety and emergency procedures relevant to their activities. For assistance, contact the permit holder or principle investigator.

Other people, in particular young children, are not permitted in hazardous work areas with the exception of University sanctioned tours and visits, for example McGill Open House. In these instances, careful supervision must be exercised.

2.10 AFTER-HOURS WORK

Working alone is considered an unsafe practice at any time. If however, the nature of your work makes it unavoidable, measures should be taken to ensure that others are aware that you are doing so and to have someone check in with you from time to time, either in person or by telephone. Or provide your name to Security Services to have their agents check up on you. Also, ensure that you carry a McGill ID card and limit your work activities since emergency intervention maybe limited.

2.11 ENVIRONMENTAL HEALTH & SAFETY

Environmental Health & Safety (EHS) has the mandate to plan, organize, co-ordinate and implement University programs in occupational health and safety in conformity with applicable laws, regulation, codes and standards.

The objectives of the EHS are to establish and maintain a high standard of safety in all University activities, to recognize and minimize occupational hazards and to prevent accidents and injuries of all kinds. EHS develops, measures and manages several health and safety programs, including the radiation safety program (RSP); the University RSO is an employee of EHS, reporting to the Operations Manager. The principal functions of the EHS are:

- To provide information and training to McGill staff and students in matters related to occupational health and safety.
- To perform specialized occupational hygiene and environmental health measurements and assessments.
- To serve as a liaison between the University and certain regulatory agencies like the CNSC, the Commission des normes, de l'équité, de la santé et de la sécurité du travail (CNESST), the Public Health Agency of Canada (PHAC) and the Canadian Food Inspection Agency (CFIA).
- To assess and investigate incidents and accidents.

3. RADIATION DOSE LIMIT

3.1 RATIONALE AND LEGAL BASIS OF DOSE-EQUIVALENT LIMITS

The purpose of a system of dose limits* is to ensure that the radiation dose received by any person (other than an accidental exposure, or a deliberate exposure as in medical diagnosis) is such that:

- the dose is below the threshold (non-stochastic or deterministic) for any biological effect which requires a minimum dose for expression; and
- the probability of any effect of the all-or-nothing (stochastic) type is small enough to be acceptable to the individual and to society.

The system of radiation dose limits in use in Canada (and in most other countries) is based on the recommendations of the International Commission on Radiological Protection (ICRP). Recommendations of the ICRP are voluntary but a legal basis for the limits is provided by the NSC Act Radiation Protection Regulations and Regulations O.C. 554-79 (1979) of the Public Health Protection Act of Quebec.

* In Canada, both the "effective dose limit" and the "equivalent dose limit" are regulated. See the Table in Section 3.6 for the effective or whole body dose limits and **Appendix B** for equivalent dose limits to organs. For the sake of brevity, the effective dose and equivalent dose limit will be referred to in this Manual as the "dose limit".

3.1.1 Adverse Health effects due to radiation

Being exposed to radiation in a short period of time or over a long period of time is no indication of the total radiation dose and, thus, the possible health effect that may occur.

As with all other forms of ionizing radiation, adverse health effects from nuclear substances and radiation emitting devices can be classified as stochastic or deterministic.

- **Stochastic effects:** A term used to group radiation-induced health effects (such as cancer or inheritable diseases) which have a statistical risk. The probability of their occurrence increases proportionally to the radiation dose received: the higher the dose, the higher the probability of occurrence. However, at no time, even for high doses, is it certain that cancer or genetic damage will result.
- **Deterministic effects:** Changes in cells and tissues that are certain to occur after an acute dose of radiation (in excess of a threshold value of at least 1 Sv), below which the radiation

effect is not detected. The severity of health effects – such as cataracts, skin reddening, burns and hair loss – increases with the radiation dose received.

There are others factors that must be considered to understand the complex nature of exposure to ionizing radiation

- **Chronic dose:** Chronic exposure is continuous or intermittent exposure to low levels of radiation over a long period of time. Chronic exposure is considered to produce only effects that can be observed some time following initial exposure. These include genetic effects and other effects such as cancer, precancerous lesions, benign tumors, cataracts, skin changes, and congenital defects. Low doses-less than 100 mSv- spread out over long periods of time (years to decades) don't cause an immediate problem to any body organ. The effects of low doses of radiation, if any, would occur at the level of the cell, and thus changes may not be observed for many years (usually 5-20 years) after exposure.
- **Acute dose:** Exposure to a large, single dose of radiation, or a series of doses, for a short period of time. Large acute dose can result from accidental or emergency exposures or from special medical procedures (radiation therapy). In most cases, a large acute exposure to radiation (above 1 Sv) can cause both immediate and delayed effects. For humans and other mammals, acute exposure, if large enough, can cause rapid development of radiation sickness, evidenced by gastrointestinal disorders, bacterial infections, hemorrhaging, anemia, loss of body fluids, and electrolyte imbalance. Delayed biological effects can include cataracts, temporary sterility, cancer, and genetic effects. Extremely high levels of acute radiation exposure can result in death within a few hours, days or weeks.

All people are chronically exposed to background levels of radiation present in the environment. Radiation users could also receive additional chronic exposures and/or relatively small acute exposures during personal medical exams (ex. dental X-ray).

The probability of a radiation-caused cancer or genetic effect is related to the total amount of radiation accumulated by an individual. Based on current scientific evidence, any exposure to radiation can be harmful (or can increase the risk of cancer); however, at very low exposures, the estimated increases in risk are very small. For this reason, cancer rates in populations receiving very low doses of radiation may not show increases over the rates for unexposed populations.

3.2 DOSE LIMITS FOR OCCUPATIONALLY EXPOSED PERSONS

Any person who is exposed to ionizing radiation as a direct and necessary condition of his occupation, business or employment is said to be "occupationally exposed" and is subject to the dose limits for this group set out in Section 3.6. The effective dose limit for Nuclear Energy Workers, as prescribed by the CNSC, is 100 mSv (10,000 mrem) over 5 years (with a maximum of 50 mSv in any given year or an average of 20 mSv/yr for 5 years) for whole-body exposure. For Radiation Users and "members of the public" the corresponding limit is 1 mSv (100 mrem) per year. These limits protect against diseases such as cancer. The equivalent dose limit for hands and feet (500 mSv/year), skin (500 mSv/year), and eyes (150 mSv/year) control effects like radiation burns or cataracts.

The dose limit for Radiation Users is the same as that for members of the public. While it is legal for a Radiation User to receive more than 1 mSv per annum and up to the 50 mSv limit, any Radiation User who does so, or is likely to do so, must be re-classified as a Nuclear Energy Worker.

Any Radiation User whose annual or quarterly dose, as measured by external monitoring or calculated from the results of bioassay procedures, greatly exceeds the normal value either for that individual or for persons carrying out similar work, is subject to investigation by the RSO, in cooperation with the Permit Holder. High levels or recurrent significant levels may indicate that the individual concerned should be re-classified as a Nuclear Energy Worker.

The principle set out above also applies to Nuclear Energy Workers (NEWs) although the "normal value" for such persons is expected to be higher than for Radiation Users. In addition, there is an overall investigatory level of 10 mSv (1000 mrem) per 6 months, i.e. one-tenth of the statutory limit for NEWs, or 5 mSv (500 mrem) per quarter. (3 months)

3.3 DOSE LIMITS FOR INTERNAL SOURCES

Internal exposure occurs when radioactive material is ingested, swallowed, inhaled or otherwise enters the body and is deposited in body tissues. Internal contamination is particularly hazardous for subatomic particles (ex. alpha, beta, positron, etc.) radioisotopes emitters which have long half-lives and accumulate in bone or lung (e.g. radium-226, strontium-90), thus all internal radiation carries some risk and should be avoided. For this reason stringent precautions are needed in laboratories where unsealed (solid, liquid and gaseous) nuclear substances are handled.

Appendix C of the Manual lists the Annual Limit on Intake (ALI) for commonly used nuclear substances. The ALI for a given radionuclide represents the activity, in Becquerels, that will deliver an effective dose of 20 mSv during the 50 years after it is taken into the body. For a given radionuclide, the ALI depends on the physical characteristics of the nuclide and on its chemical form, which in turn determines its metabolism in the body (see Section 5.5, for ALI in terms of monitoring radioisotope intake).

3.4 NON-RADIATION WORKERS AND THE GENERAL PUBLIC

The legal dose limit for non-radiation workers and members of public (i.e. everyone except NEWs) is 1 mSv (100 mrem) per annum, i.e. one-hundredth of the maximum limit for Nuclear Energy Workers. This is the case under both the CNSC and Quebec regulations (see Section 3.6). This limit covers radiation exposure of all types, except those arising from background radiation and medical procedures, whether received inside or outside university premises. Since McGill has no control over radiation sources outside the University, it should never be assumed that the radiation exposure at a given point within the University is the only source of exposure of the staff concerned. Dose levels in university premises should be interpreted with this in mind.

3.5 ACTION LEVELS

Under the Radiation Protection Regulation documents (Developing and Using Action Levels G-228) **Action Levels** are 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 (McGill University) radiation protection program, and triggers a requirement for specific action to be taken".

Action Levels are designed to alert radiation users before regulatory dose limit are reached and prevent a re-occurrence of the events.

Action levels may be expressed in terms of any parameters of the radiation protection program. Some examples of such parameters are included in the table below:

Activity	Action level	Action
		Log occurrence & action taken (attempt to prevent future occurrences)

Personnel Dosimetry for: (whole body/ extremity)		
► NEW[1]	> 10 mSv[2] / 2 consecutive periods (3 months each)	Investigate the cause of exposure in all cases. The appropriate response will depend upon the result of the investigation. A notification is sent to the individual and their dose are closely monitored for the remainder of the calendar year.
► Pregnant NEW	> 0.1 mSv/month	
► Radiation user	> 15% of annual average dose for all McGill users, cumulative dose	
► Public	Not applicable	
Intake of radionuclides:		
Thyroid Bioassay	> 1000 Bq[3] (investigation Level)	Repeat the bioassay to verify the initial results, and implement measures to prevent further exposure until the cause is identified and remedied
	> 10,000 Bq (Reporting Level)	Investigate and report to CNSC[4]
Sealed sources use:		
Leak Testing for Sealed nuclear substances (>50 MBq)	>200 Bq	Discontinue using the sealed source and/or radiation device. Takes measures to limit the spread of radioactive contamination from the sealed source. Notify the CNSC. Dispose the sealed source
Open sources use:		
Radioactive Surface Contamination (i.e. wipe tests)	>0.5 Bq/cm^2	Investigate cause and decontaminate

Decommissioning	>0.5 Bq/cm^2 for all emitters except alphas >0.05 Bq/cm^2 for alpha emitters	Investigate cause of contamination and decontaminate in both cases
Package Receipt	Damaged Package or radiation level > than package designation	Reinforce CNSC guidelines: ► CNSC INFO 0426 "Receiving Radioactive Packages" ► CNSC "Packaging and Transport of Nuclear Substances Regulations" (SOR/2015-145,s.51) Report to CNSC

[1] Nuclear Energy Worker
[2] millisievert
[3] Becquerel
[4] Canadian Nuclear Safety Commission

3.6 WHOLE-BODY DOSE LIMITS

To protect the radiation users and the public from the potential effects of chronic low-level exposure (i.e., less than 100 mSv), the current radiation practice is to prudently assume similar adverse effects are possible with low-level protracted exposure to radiation. Thus, the risks associated with low-level medical, occupational, and environmental radiation exposure are conservatively calculated to be proportional to those observed with high-level exposure. The results are summarized and presented in the table below and in the Appendix B.

Classification	**Effective Dose** mSv (mrem)[1]	**Requirements**
Nuclear Energy Worker [2]	100 (10000) / 5 yrs[3] Note: A maximum of 50 (5000)[6] in any one year or an average of 20 (2000)/yr	• one year dosimetry period • doses likely to surpass 1 mSv/yr • mandatory personnel monitoring • medical surveillance
Pregnant Nuclear Energy Worker	4(400)	• balance of pregnancy • mandatory personnel monitoring • medical surveillance

Radiation User [4]	1 (100)/yr[5]		• doses not to surpass 1 mSv/yr • recommended personnel monitoring
Public	1 (100)/yr		• one calendar year

[1] mSv (mrem) = millisievert (millirem)

[2] CNSC classifications with legal dose limits. Includes pregnant Nuclear Energy Worker until employer informed of pregnancy.

[3] Yrs = years

[4] McGill classification is just a guideline. In fact, the maximum permissible dose for Radiation Users is the same as for the public, i.e. 1 mSv/yr.

[5] Yr = year

When a dose of radiation received by and committed to a person or an organ or tissue (see **Appendix B**) may have exceeded a prescribed dose limit the CNSC shall be informed and:

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

4. LICENSING AUTHORIZATION

4.1 CNSC LICENCE

The acquisition, possession and use of most nuclear substances (radiation sources) are subject to licensing by the Canadian Nuclear Safety Commission (CNSC). McGill University is issued a consolidated Nuclear Substance and Radiation Device license by the CNSC that is renewed every 5 years. In turn, the University issues “Internal Permits” to individual users, subject to the conditions of the CNSC and McGill radiation safety policy. The following categories of radioactive sources are covered by CNSC Consolidated Nuclear Substance and Radiation Device License No. 01222-4:

- unsealed nuclear substances (open sources or unsealed source) used for investigations not involving human subjects;.
- sealed radioisotope sources (sealed source) used for instrument calibration and other special purposes, whether or not the source is permanently housed in the instrument or equipment.
- sealed sources housed in equipment intended for the irradiation of materials; and
- particle accelerators capable of giving rise to high-energy particles, either as the useful product (e.g. a beam of high-energy electrons, protons or ions) or as a by-product (e.g. stray neutrons). This category covers all accelerators accelerating electrons to an energy greater than 1 MeV.

4.2 INTERNAL PERMITS

An Internal Permit must be obtained from EHS for the acquisition or use of nuclear substances or radiation-emitting equipment. The application form for an Internal Permit is available on the EHS website (see Appendix H-1). This permit is issued to the designated Permit Holder, who assumes the responsibilities described in section 2.5.

Information listed on the internal permit:

- Permit Holder information (i.e., Name, phone, office address, etc.);
- Number of Internal Permit;
- General license conditions;
- Date issued and expiration date;
- Emergency phone number 24/7;
- Laboratory location and CNSC classification;
- Approved Unsealed and sealed nuclear substances and its storage and usage location;
- Amount of activity of any nuclear substance (sealed or unsealed) that the permit Holder is allowed to possess at any moment (Possession limit) ;
- Amount of activity of any nuclear substance (sealed or unsealed) that the permit Holder is allowed to purchase at any moment (Purchase/ship limit);
- List of other persons involved in the work, including:
    - Position;
    - work load classes (i.e. working in open areas and/or Fume Hood, working with sealed sources, etc.);
    - personnel conditions (i.e. Radiation user, NEW, bioassays required, personal dosimeter required, etc.);
    - training;
    - nuclear substances

Any change in the details, for example the addition of a new nuclear substance, an increase in the possession limit, a change in personnel or personnel conditions and/or workload must be the subject of a written request for an amendment of the permit.

4.3 PROCUREMENT, DELIVERY AND TRACKING OF NUCLEAR SUBSTANCES

The Nuclear Safety and Control Act requires strict control over the procurement, delivery, possession, and disposal of nuclear substances.

4.3.1 Procurement:

In order to receive nuclear substances, Faculty and Staff at McGill must issue a purchase requisition in McGill MarketPlace (MMP) describing the required nuclear substance, the quantity, the unit price and delivery requirements. Once all approval conditions have been addressed (i.e. valid internal permit, authorized nuclear substance, authorized user, shipping address, possession and shipment limits), Procurement Services will issue an official McGill Purchase Order to the supplier.

At McGill, *my*Lab is the web component of the McGill Hazardous Material Management System (HMMS), designed to facilitate safe handling and management of hazardous materials including radioactive materials (RAM), from acquisition to disposal, in accordance with CNSC regulatory requirements. As of June 2011 the Radiation module of *my*Lab was made available for use.

The implementation of these two systems, myLab and MMP has brought the following advantages:

- **Streamlined management of inventories**: allows all McGill laboratories to use MMP to order radioactive materials and use *my*Lab for tracking their use and disposal;

- **Safety**: Easy online access to up-to-date inventories of nuclear substances and their precise locations is critical to the safety of McGill researchers, staff, students and visitors and to fire department, police, ambulance services and other first responders, in the event of an accident or emergency;
- **Authorization and access**: to be granted the use of MMP and myLab the user must first comply with the Radiation Safety Training Policy (2.2.4), myLab training course, be classified as a radiation user (2.6.1) and be identified on an Internal Permit (4.2). Once these conditions are met, the user can log onto myLab.mcgill.ca using his/her McGill email address and password.

4.3.2 Delivery

The Permit Holder must designate a room or other area as the reception point for a given laboratory or laboratories; and the person or persons authorized to accept the delivery of packages containing nuclear substance. The designated room or area should be indicated in the myLab system as the "shipping address." Under no circumstances should nuclear substances to be delivered be left unattended, without the knowledge of an authorized person.

Normally all deliveries should be made during working hours. For deliveries outside of working hours only security personnel may accept the package. The security officer on duty will have a key to an appropriate storage room and must be instructed to leave the incoming package of nuclear substance there under lock and key, and then to inform the Permit Holder as soon as possible.

After the delivery of a package of radioactive material, the Permit Holder or delegate must examine the package for damage, leakage and contamination. A clear procedure for such examination must be laid down in each department or laboratory. Damage, leakage and contamination must be assessed using visual inspection and wipe test techniques (see Sections 5.4 and 5.7). If a package is damaged and/or contaminated, the emergency procedures described in Chapter 12 should be followed. The supplier should be notified of any discrepancy between the content of the package, in terms of the type of radioactive source or the activity, as compared with the original order and/or the information given on the label of the package. Environmental Health & Safety must be notified if the above emergency procedures have been activated.

4.3.3 Tracking

The myLab system is a web based computer program that generates an electronic running log inventory for each nuclear substance acquired and each waste container used. Then myLab generates a specific inventory number (ID number) for the vial to monitor usage of the nuclear substance until the vial becomes empty and associated contaminated materials are sent for disposal in a waste container, specific for each radioisotope and physical form (liquid or solid). In addition, myLab also produces an ID number for each waste container used, and tracks the waste generated for different vials disposed in the container.

Prior to disposal, Permit Holder must ensure that the waste container has been tested for surface contamination (5.7), the report should come with the waste container.

Each Permit Holder must continuously update the myLab inventory records for each type of radioactive material (see Appendix J). myLab will ensure that the current inventory activity for each nuclide, plus the activity to be purchased, do not exceed the "Possession Limit" specified in the Internal Permit. The inventory must be available for inspection by authorized persons including Environmental Health & Safety and CNSC inspectors.

Each package containing radioactive material must bear at least two RADIOACTIVE warning labels displaying information about the content and activity of the package (see section 13).

5. Monitoring

5.1 General Principles

Monitoring is an essential component of any radiation safety program. It involves the regular and routine measurement and/or assessment of factors relevant to radiation safety and takes the following forms:

- Area monitoring, i.e. measurement of radiation dose rate at various points in an area where a radiation-emitting machine or equipment is located, or where radioactive sources are stored, handled or used.
- Technique monitoring, i.e. measurement of the dose or dose rate applicable to specific persons or specific locations
- Personnel monitoring, i.e. measurement of the total dose received by individual radiation workers over a specified period of time.
- Monitoring and Controlling of radiation contamination
- Monitoring intake of nuclear substances
- Medical surveillance of radiation workers.

5.2 AREA AND TECHNIQUE MONITORING

Both area and technique monitoring are very common tasks performed by EHS during radiation laboratory inspections or specific radiation surveys. The purpose is to ensure that the room, laboratory equipment, shielding materials, and handling practices and procedures are satisfactory. Permit Holders, Heads of Department, and individual radiation workers should collaborate with EHS in these surveys and should report any situation or change in procedure, which may warrant special investigation.

5.3 PERSONNEL MONITORING

Radiation Users and Nuclear Energy Workers whose main source of exposure is from external beta or X-ray and gamma sources may be subject to routine, continuous monitoring by means of a thermoluminescent dosimeter (TLD) which is worn at all times during working hours. Such monitoring is mandatory for NEWs and recommended for Radiation Users. In addition, NEWs who may be exposed to neutrons must carry a separate neutron badge. The National Dosimetry Service (NDS) of the Radiation Protection Bureau, is a service of Health Canada in Ottawa, it provides whole body and extremity TLD dosimeters. Whole body dosimeters take the form of a badge worn on the lapel or the front pocket of a lab coat, whereas an extremity dosimeter comes in the form of a ring on a finger. The NDS service is a lifetime proposition i.e. they maintain radiation exposure records and associate it with one's social insurance number (S.I.N.) regardless of place of work. To obtain more information or to subscribe to the service, contact EHS.

5.3.1 Thermoluminescent Dosimeters (TLDs)

NDS provides the whole body TLD badges on a 3-month or 1-month cycle. The Permit Holder must make the necessary arrangements for personnel monitoring of radiation workers in his/her own department or laboratory and is also responsible for the cost of the service. Further details are available by consulting with EHS. The exposed TLD badges are measured by NDS, and a report of the radiation dose received by each worker is sent to EHS for review.

- The RSO will then:
    - examine the report and note any unusually high values;
    - send a copy to the department or laboratory;
    - retain the original report for record purposes; and
    - investigate any TLD dose which is either excessive or abnormal (see section 3.5 for action levels

5.3.2 TLD-Good Practices

The individual radiation worker must:

- take good care of their assigned monitor at all times;
- wear the monitor at all times during working hours.
- the extremity badge may be worn either at the wrist as a bracelet or on the finger as a ring, if laboratory gloves are worn, the ring must be placed under the glove.
- the whole body badge at the head/neck area or chest height, and if protective clothing is worn, such as a lead apron, the badge must be placed under the protective clothing since its function is to record the radiation reaching the body, not the radiation reaching the protective clothing;
- under no circumstances should the badge be loaned to another person;
- take care that the badge is not dropped, lost or accidentally placed in a position where it could be exposed to a level of radiation higher than the ambient level
- take care that the badge is not accidentally splashed or otherwise contaminated by a radioactive liquid;
- take care that, outside working hours, the monitor is stored in a safe place away from any radiation source and from any source of intense heat such as a radiator; and
- report any problems with the monitor to the RSO.

See Appendix G for more details.

5.3.3 TLD-Limitations

Personnel monitoring, of the type described in the preceding paragraphs is a satisfactory general indicator of the whole-body dose arising from external sources of penetrating radiation such as X- and gamma-rays. However, the system has some important limitations:

1. the badge reading can be interpreted in terms of a whole-body dose only if the ambient radiation is penetrating, i.e., photons in the MeV energy range, or at least several hundred keV; and isotropic i.e., either the radiation comes from several directions or the radiation worker changes orientation frequently with respect to the radiation source. If these conditions are not met, then the badge reading represents only the dose to superficial tissues and/or to part of the body such as the front of the trunk;
2. the badge does not record any additional dose received by the extremities and/or face and neck in some procedures;
3. the badge does not record doses due to low-energy-particles such as those from tritium(H-3), carbon-14(C-14) and sulphur-35(S-35);
4. the 3-monthly cycle may be too long for individuals whose work carries a higher-than-average risk of radiation exposure; and
5. the badge does not record internal exposure arising from ingestion, inhalation or injection of nuclear substances.

The first limitation (1) cannot be overcome. Each situation must be assessed to determine what the badge reading represents. In most cases, the badge reading is so low that it is of no importance whether it represents a whole-body or a partial-body dose.

Limitations 2 and 4 may be overcome by the use of monthly monitors or monitors such as TLD “finger badges” or pen-type pocket dosimeters. Arrangements for the issue of these monitors may be made through the Radiation Safety Officer. Monitoring of this type is usually considered as “Technique Monitoring” i.e., it is carried out as a special investigation to determine the relationship between the badge reading and the dose received by other parts of the body.

Limitation 3 can only be resolved by the purchase of special monitors, which are sensitive to low-energies; this comes under the heading of "Area Monitoring".

Limitation 5 is overcome to some extent by the use of bioassay procedures as discussed in Section 5.5.

5.3.4 TLD-Extremity Monitors

Radiation workers who may handle more than 50 MBq of phosphorus-32 (P-32), strontium-89 (Sr-89), strontium-90 (Sr-90) or yttrium-90 (Y-90) are required to wear an extremity TLD as a ring badge in addition to the whole body TLD. The National Dosimetry Service (NDS) also supplies the extremity TLDs and for additional information on extremity TLD personnel monitoring contact the RSO.

5.4 CONTROL OF RADIOACTIVE CONTAMINATION

Any laboratory where unsealed nuclear substances are stored and/or used must undergo systematic surface contamination checks called "wipe tests". Suspected surfaces are wiped with a moist swab of raw cotton or filter paper in order to remove contamination and the swab is then assessed for radioactive contamination. Measurements greater than 0.5 Becquerels per square centimeter (0.5 Bq/cm^2) is regarded as evidence of contamination, as shown in the table below. Decontamination procedures are required and discussed in Section 5.9. **The results must be placed in the McGill Radiation Log Book and kept for a maximum of three years**. For more complete details on wipe tests consult Section 5.8.

CNSC AND MCGILL DECONTAMINATION CRITERIA

Radionuclide classification	**Removable surface CNSC contamination limit** (avg over area not to exceed 100 cm^2)	**Removable surface McGill contamination limit** (avg over area not to exceed 100 cm^2)
Class A	3.0 Bq/cm^2	0.5 Bq/cm^2
Class B	30 Bq/cm^2	0.5 Bq/cm^2
Class C	300 Bq/cm^2	0.5 Bq/cm^2

Note: The McGill radioactive surface contamination & decommissioning standard is more restrictive compared to the CNSC contamination and decommissioning standards. For details on the radionuclide classifications, consult Section 6.2.

In addition to regular monitoring carried out by the radiation users in a laboratory, every laboratory handling unsealed nuclear substances is subject to regular inspections and surveys by EHS. The Permit Holder should request a special survey whenever an accident has occurred which might have resulted in contamination, or whenever a complex new procedure has been carried out for the first time.

5.5 RISK-BASED LABORATORY SAFETY INSPECTIONS

The purpose of the laboratory safety inspection program is to ensure that appropriate workplace environment is safe and complies with the CNSC and with other Federal, Provincial, Municipal and Institutional requirements.

The laboratory safety inspection program uses a Risk-Based Approach, laboratories identified as a high risk as ***Intermediate-Level*** or ***High-Level*** classifications will receive, at a minimum, one laboratory safety inspection per year from EHS. While, labs classified as ***Exempt-Level* & *Basic-Level*** will be inspected every 2 years by a visit or a self-inspections. Note: all life threatening issues and/or serious violations will addressed immediately. See 6.2.1 for details on CNSC lab classifications

Laboratories that successfully passed the initial lab inspection and/or which have low material, equipment and process hazards in them will be subject to less frequent inspections by EHS. While laboratories with lab scores below 60% will be inspected a second time and/or will be visited more often.

All inspections are conducted with either the Permit holder or his or her delegate present. Following the inspection, EHS will issue a report containing the findings, identifying the responsible party, and giving a target date for responses based on proposed corrective actions.

5.6 MONITORING INTAKE OF NUCLEAR SUBSTANCES

The CNSC has established effective dose limits for persons during a specified period. For the purpose of calculating the effective dose, one of the parameters used is the annual limit on intake (ALI). The ALI is defined as the activity, in Becquerels, of a radionuclide that will deliver an effective dose of 20 mSv during the 50 year period after the radionuclide is taken into the body of a person 18 years or older or during the period beginning at intake and ending at age 70 after it is taken into the body of a person less than 18 years old. See **Appendix C**, for a list of ALI according to radioisotope.

Nuclear substances may be ingested, inhaled or injected through the skin. If the absorbed radionuclide is a gamma-emitter, it can be detected and measured by a sensitive external counter. This is the procedure used for measuring the ingestion of radionuclides such as I-125, which concentrates mainly in the thyroid gland. A thyroid bioassay service is operated by EHS. The CNSC Regulatory Document R-58 requires persons handling I-125 or I-131 at above specified activity levels to submit to thyroid monitoring. These tests must be done within 5 days of the iodine manipulation. For details and arrangements for thyroid monitoring contact EHS. The minimum activities requiring evaluation are listed below:

Types of operations	Activity handled in unsealed form
Processes carried out in open room	2 MBq (54 µCi)
Processes carried out in fume hood	200 MBq (5.4 mCi)
Processes carried out within closed glove boxes	20 GBq (540 mCi)

Bioassay procedures for other radionuclides have been developed and made available to all laboratory personnel. Body burden assessments can be performed using two methods:

- Excreta analysis (urine and feces); and
- Whole-body counting (for gamma emitting radionuclides)

In accident or in emergency situations, EHS is able to carry out, or to make arrangements for any type of bioassay which may be required.

5.7 MEDICAL SURVEILLANCE

The radiation doses received by the great majority of radiation workers are so low that no correlation can be demonstrated between dose and any known physiological effect, and no deleterious effect can be unequivocally linked to a radiation exposure. Consequently, medical surveillance has no role in assessing the effectiveness of the radiation protection program. Surveillance is therefore limited to the minority of radiation workers who, because of the nature of their work and/or the type of radiation sources they handle, are classified as Nuclear Energy Workers (NEWs). These workers are more likely than non-NEWs to receive a significant dose in the event of an accident.

5.8 MONITORING OF RADIOACTIVE CONTAMINATION

For unsealed nuclear substances, radiation users must monitor for radiation contamination and it can be done in 2 ways: Direct measurement using portable survey monitors or contamination meters as explained in Radiation Safety Operating Procedure, or Indirect measurement, performed by employing the wipe test technique, as documented in SOP # RADS.002

For sealed nuclear substances the monitoring is done by leak tests and this work is performed by EHS. For details refer to the SOP RADS.003

5.9 DECONTAMINATION

In radiation safety, “decontamination” refers to the removal surface radioactivity, and is required whenever wipe tests reveal contamination.

Selection of a cleanser or decontaminant depends on factors such as the nature of the item to be decontaminated and the amount of dirt trapping the contamination. Either a commercial detergent or soap may be used. The key to effective decontamination is to use plenty of cleanser, a good brush or scouring pad, lots of water rinses, and absorbent paper to dry the area.

As a rule of thumb, if the contamination is dry (such as powder), keep it dry. Remove the powder by scraping away the contamination and pick up the small particles with adhesive tape. If contamination is wet, use absorbent materials to pick up the moisture.

Porous surfaces (such as wood and unpainted concrete) difficult to decontaminate and may require disposal. Some isotopes (such as tritium) may become chemically bonded to the surface and are extremely difficult to remove.

Metals may be decontaminated with dilute mineral acids (nitric) a 10% solution of sodium citrate, or with ammonium bifluoride. When all other procedures fail for stainless steel, use hydrochloric acid - this process is effective but unfortunately it will etch the surface. As for bases, commercial polish cleaners will work well. Plastics may be cleaned with ammonium citrate, dilute acids or organic solvents.

For decontamination of both wet and dry surfaces, a final wiping with water or alcohol may be necessary. Decontamination should always be followed by wipe tests to confirm that the remaining radiation activity has been reduced to acceptable levels (less than or equal to 0.5 Bq/cm^2). Finally, all used decontamination materials must be discarded as radioactive waste.

5.9.1 Decontamination of skin

Contamination of skin, especially hands and hair may happen. For hand decontamination a good wash with mild soap and warm (not hot) water is generally satisfactory. This should remove all loose or removable contamination to bellow the limits. If contamination is under the fingernails a soft bristle brush should be used with mild soap and warm water.

Gently rub the skin; do not scrub the skin to the point where is reddening because there may be a risk of the contamination entering the blood stream directly. If soap and water aren't effective use a chemical hands cleanser. Hands cleanser contains small plastic granules to help loosen contamination.

For decontamination of the face and hair, showering once or twice is the most effective. Keep mouth and eyes close, while showering.

If contamination remains or if cuts, abrasions or open wounds are observed:

- Contact the RSO
- Dry and clean the area;

- If skin is contaminated in areas of broken skin use wet swabs in direction away from the area as not to spread contamination into wound.

If ingestion has occurred and/or if the person needs medical attention, immediately call the emergency number 3000 or 7777 and then the person should be accompanied by the RSO to the clinic or hospital.

6. Use of unsealed nuclear substances in teaching & research

6.1 CLASSIFICATIONS OF RADIONUCLIDES

The CNSC has grouped radionuclides into 3 groups. The 3 groups are shown below:

Class A

Ag-110m	Bi-210	Co-56	***Co-60***	Cs-134
Cs-137	I-124	Lu-177m	***Mn-52***	***Na-22***
Po-210	Pu-238	Pu-239	Pu-240	Sb-124
Sc-46	Sr-82	U-234	***U-235***	***U-238***
V-48	Zn-65			

And all Alpha Emitters and their daughter isotope

Class B

Au-198	***Ba-133***	Br-82	Ce-143	Co-58
Cu-67	***Fe-59***	Hg-194	Hg-203	I-131
Ir-192	La-140	Mo-99	Nb-95	Pa-233
Ra-223	Re-186	Re-188	Ru-103	Sb-122

Sm-153	Sr-90	Xe-127	Y-86	Y-90
Yb-169	Zr-89	Zr-95		

Class C Short-lived and emit beta or gamma radiation

C-11	***C-14***	***Ca-45***	Cd-109	Ce-141
Cl-36	Co-57	***Cr-51***	Cu-60	Cu-61
Cu-64	F-18	***Fe-55***	Ga-67	Ga-68
Ge-68	***H-3***	I-123	***I-125***	***In-111***
In-113m	In-144	K-42	Kr-85	Lu-177
Mn-52m	Mn-56	N-13	Na-24	Nb-98
Ni-63	O-15	***P-32***	***P-33***	Pd-103
Pr-144	Pu-241	Rh-106	***S-35***	Sc-44
Sn-113	Sr-89	Tc-94m	Tc-99	Tc-99m
Te-127	Tl-201	V-49	W-181	W-188
Xe-133	Zn-63			

Note: Most frequently used nuclear substances at McGill University for teaching and research are Class C. Isotopes in bold and italic are commonly found in our laboratory facilities, as shown in classes A, B and C

6.2 RADIOISOTOPE LABORATORIES

6.2.1 Classification of Laboratories

Laboratories are classified as:

Exempt-Level Laboratory (McGill Classification)

A room, in which an unsealed nuclear substance is used which is below one "exemption quantity" as defined in section 1 of the Nuclear Substances and Radiation Devices Regulations, or where any supplies of sealed or unsealed nuclear substances are kept without being handled. Examples include storage of waste and/or decaying radioactive material and supplies of nuclear substances held for future use and/or equipment rooms (Liquid Scintillation Counter, Gas Chromatograph-Electron Capture Detector).

Basic-Level Laboratory (CNSC Classification)

A room, in which an unsealed nuclear substance is used which is greater than one "exemption quantity," and where the largest quantity of each unsealed nuclear substance in one container **does not exceed five (5) times its corresponding Annual Limit of Intake** (ALI), as defined in section 12 (1) of the Radiation Protection Regulations.

Intermediate-Level Laboratory (CNSC Classification)

A room, where the largest quantity of each unsealed nuclear substance in one container **does not exceed 50 times its corresponding ALI**.

High-Level Laboratory CNSC Classification)

A room, where the largest quantity of each unsealed nuclear substance in one container **does not exceed 500 times its corresponding ALI**.

Containment-Level Room (CNSC Classification)

A room, where the largest quantity of each unsealed nuclear substance in one container **exceeds 500 times its corresponding ALI**.

6.2.2 Requirements for Radioisotope Laboratory Facilities

Renovated or new radioisotope laboratory facilities shall meet CNSC's requirements in Regulatory Guide DG-52 "*Design Guide for Nuclear Substance Laboratories and Nuclear Medicine Rooms.* The topics covered in the guide include: location, ventilation requirements, finishing and fixtures, plumbing, storage, security, and other miscellaneous items. For details and explanations, consult the guide.

Facilities must be approved by the RSO prior to any work beginning with nuclear substances. Any room or laboratory required a higher classification than BASIC must obtain a written approval from the CNSC.

6.4 POSTING LOCATIONS

All approved locations must be posted with an approved Radioactive Warning Sign. And these locations include the following:

All points of entry, laboratory, storage area, or other licensed area

- Radioactive Warning Sign, Lab Information Card with Permit Holder name and office phone number, 24 hour contact number

Inside the lab, in a prominent location

- Copy of the Internal Permit, CNSC Safety Poster that corresponds to the Lab Classification

Storage Location

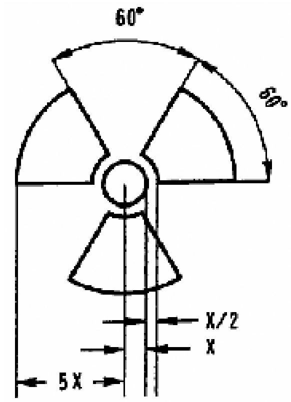
- Radioactive Warning Sign

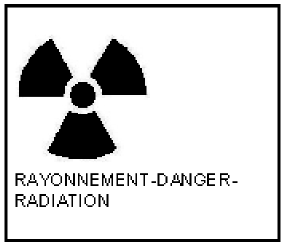
Work Area

- Radioactive Warning Sign or Tape identifying the workstation

6.5 POSTING OF RADIATION WARNING SIGNS

Radioactive Warning Signs (RWS) may not be used in a place where the radiation or nuclear substance is not present. The same applies to for radiation working areas; signage should be kept to minimum because too many signs may incur unwanted fear. According to the CNSC, RWS must be magenta or black on yellow background (i.e. the universal trefoil & letters in magenta or black) and with the appropriate wording **"RAYONNEMENT-DANGER-RADIATION"**





NOTE:
The three blades and the central disk of this symbol shall be:
(a) magenta and black
(b) located on a yellow background

NUCLEAR SAFETY AND CONTROL ACT: Radiation Protection Regulations, 31 May, 2000

6.6 STORAGE OF RADIOACTIVE MATERIAL

- All radioactive material must be stored in shielded containers which are marked with:
  - a description of the contents of the container, including radionuclide, chemical form, physical form if appropriate, maximum activity on a stated date, and;
  - a radiation warning sign.
- All containers must be stored in a safe area, which must be lockable.
- The storage area must be of fire resistant construction.
- The storage facility must have sufficient shielding to reduce the radiation in occupied and accessible areas to levels that are consistent with the action levels and dose limits summarized in Sections 3.5 and 3.6.
- Gaseous or volatile nuclear substances must be kept in a fume hood provided with adequate ventilation.
- A radionuclide storage room must display a warning sign on the door.

6.7 HANDLING OF UNSEALED NUCLEAR SUBSTANCES

In any laboratory where both radioactive and non-radioactive work is carried out, a separate area must be set aside for radioisotope work and this confined work section be clearly designated as the “radioactive area”.

- Laboratories must be kept locked when not attended.
- Smoking, eating, drinking and storage of food or beverages and applying cosmetics or contact lenses are prohibited in any area used for storage and manipulation of nuclear substances.
- Pipetting of radioactive solutions must not be carried out by mouth.
- Whenever possible, procedures involving nuclear substances should be carried out on trays or on benches lined with disposable absorbent material.
- Procedures that might produce airborne radioactive contamination (example: gases, vapors, mists and dust) should be carried out in a fume hood.
- Procedures involving dry radioactive powders should be carried out in a glove box.
- Keep contaminated glassware segregated from clean glassware.
- Disposable containers and instruments should be used if possible.
- Personal protection equipment (e.g. protective eyewear and lab coat) must be worn. When hand contamination is possible, protective gloves are required. Closed shoes must be worn.

- After handling unsealed nuclear substances, and before leaving the laboratory, users must wash their hands and ensure that hands, clothing and shoes are free of radioactive contamination.
- Equipment, other tools and utensils used for work with radioactive material should not be used for other purposes and should be surveyed for contamination prior to removal from the laboratory.
- Have a radiation monitor available when working with nuclear substances, and use it to arrange procedures so as to minimize personal radiation exposure. It must be remembered that these instruments are ineffective to radiation produced by weak beta emitters such as H-3, C-14 and S-35 and in these cases wipe tests are required.
- Wipe tests must be made on surfaces and equipment likely to become contaminated with radioactive material. These tests should be made either weekly for frequent regular use or after each significant workload. Records of the tests must be properly documented and filed (see Sections 5.4 and 5.7 for further details), in the McGill Radiation Log Book.

7. Use of sealed sources

7.1 TYPES OF SEALED SOURCES

A sealed radioactive source is a radioisotope that is fully encapsulated in metal or other container such that there is no contact between the radioactive material and the equipment. Sources commonly used in teaching and research are of the following types:

- Category 5 sources as defined by IAEA (Categorization of Radioactive Sources, Safety Guide RS-G-1.9, 2005) "most unlikely to be personally dangerous", usually of activity in the range 1-10 KBq (30 nCi - 0.3 pCi), free-standing (i.e. not permanently installed in specific equipment).
- Category 5 sources, permanently installed in an instrument such as a gas chromatograph or a liquid scintillation counter. Examples are Ra-226 and Cs-137 of activity 0.1 - 1 MBq (3-30 μCi) for liquid scintillation counters and Ni-63 of activity 100-500 MBq (3-15 mCi) for gas chromatographs.
- Category 1 (very high risk) and 2 (High risk) sources, usually Cs-137 or Co-60, permanently housed in an irradiator. The source activity in this case is usually at least 10 TBq (300 Ci) and may be considerably "personally extremely dangerous" and "personally very dangerous".

7.2 INVENTORY REQUIREMENTS

Every Permit Holder must establish and maintain an inventory of sealed sources in myLab. The inventory includes the following information: nature of each source, where the source is "free-standing" or permanently housed in an instrument or equipment, and the location of each source.

If the source is removed from the inventory, details including the date of the disposal or transfer needs to be documented.

7.3 STORAGE AND HANDLING OF SEALED SOURCES

Permit Holders must ensure that all sealed sources in their possession are:

- Protected at all times from loss or physical damage;
- In the case of "free-standing" sources, kept in a safe (locked) storage area when not in use. The storage area should be shielded so as to provide protection of the standard specified in Section 6.7. -Sources permanently installed in equipment such as liquid scintillation counters are normally provided with adequate shielding by the manufacturer;
- Leak tested yearly when the source activity in use is equal or greater than 50 MBq (1.35 mCi) or every two years for the radionuclide in storage or every six months for the free standing sealed source. This may be accomplished by means of a "wipe test" (see Sections 5.4 and 5.7) on the surface of the source and on the exposed surfaces of the equipment in the vicinity of the

source. These leak tests should be performed as directed by the manufacturer. In the absence of this information, a SOP approved by the CNSC is applied.

- Free-standing radioactive sources of any type or activity should be handled with care, using forceps and/or laboratory gloves rather than bare fingers. Where the activity of the source(s) and the nature and duration of the procedure warrant it, protection should be provided for the user.

8. Use of unsealed sources

8.1 General Principles

The use of unsealed nuclear substances gives rise to radioactive waste, which has to be disposed of in a responsible and safe manner. The waste may include residual amounts of the original or partially decayed radionuclide, contaminated materials (i.e. vials, pipette tips, tissue paper etc.), and radioactive animal carcasses. The disposal procedures are based on the following principles:

- Minimizing local accumulation of large quantities of waste.
- Using external disposal of waste unsuitable for local disposal.
- Safeguarding of both the local (laboratory) and the external environments.
- Reducing exposure for personnel involved in waste management (ALARA principle).
- Using procedures that can be followed simply and routinely.
- Protecting non-lab personnel (e.g. cleaners, security personnel) from handling radioactive waste.

8.2 REGULATIONS GOVERNING WASTE DISPOSAL

8.2.1 Exemption Quantity

For the purpose of this RSM, Exemption Quantity (EQ) may be defined as a quantity (Activity expressed in Bq)) of a radionuclide below which CNSC regulation is not required. Or the CNSC allows possession of a quantity of a nuclear substance without an internal permit if the quantity does not exceed its EQ. The exemption quantities of commonly used radionuclides are listed in **Appendix K**.

8.3 DISPOSAL PROCEDURES

Disposal of radioactive wastes is done via the storage and disposal system operated by the Hazardous Waste Management of McGill University. The CNSC disposal limit table is found below:

CNSC Regulatory Limits for Radioactive Waste

Radio nuclide	EQ	ALI	Garbage (solid)		Sewer		Air
	MBq	MBq	µCi/ kg	MBq/ kg	µCi/ yr/ Bldg	MBq/ yr/ Bldg	kBq/ m^3
C-14	100	34	100	3.7	27000	10000	
Ca-45	1	20					
Cr-51	1	530	100	3.7	2700	100	

Fe-59	0.1	10	0.27	0.01	27	1	
H-3	1000	1000	1000	37.0	27000000	1000000	37
I-123	10	95	100	3.7	27000	1000	3
I-125	1	1	1.0	0.037	2700	100	0.03
Cd-109	1						
S-35	100	26	10	0.37	27000	1000	
P-32	0.01	8	10	0.37	27	1	
P-33	1	80	27	1.0	270	10	

8.3.1 Disposal using Hazardous Waste Management

The Hazardous Waste Management (HWM) at McGill University provides a free service for collection and disposal of radioactive waste. Liquid scintillation vials (LSV), solid waste, liquid waste and animal carcasses are collected in plastic containers (4 and 1 litre formats), white cardboard boxes and steel pails. Details on procedures and on the service provided are available by contacting the HWM at local 5066, or visiting their website (http://www.mcgill.ca/hwm).

The HWM supplies laboratories with different types of containers. The user must properly complete identification tags, attached to each container, prior to pick up by the Hazardous Waste Management technician. In addition, users are required to segregate radioactive waste in separate containers, according to three categories. They include:

- **Liquid Scintillation Vials** (LSV) are disposed in the 5 gallon (20 liter) steel pails and then the letters "LSV" are written on the container lid. There is no need to empty each liquid scintillation vial. It is recommended to place a plastic bag inside to line the pails and to attach the completed identification tag.
- **Solid Waste** is disposed in the 5 gallon (20 liter) steel pails or cardboard boxes or in smaller containers like 4 liter white plastic or 1 liter clear plastic containers. Only solid and dry materials should be placed in these containers and the completed identification tag must be attached.
- **Liquid waste** other than LSV must be emptied in 4 liter white plastic or 1 liter clear plastic containers and identified with the completed identification tag.
- **Animal Carcasses** must be placed in a double plastic bag, tied and tagged with completed identification label. Carcasses must be frozen at the time of collection.

8.3.2 Dose Rate at Surface of Waste Container

The identification tag is provided by HWM. The Permit Holder must therefore ensure that the dose rate at the surface of each container leaving the laboratory is less than 50 μSv/h (5 mrem/h). If this condition cannot be met communicate with HWM and review Appendix D:

- if the dose rate at the surface of the container falls within 50 to 100 μSv/h (5 to 10 mrem/h), a Radioactive II label must be attached to the container (in addition to the identification tag

provided by Hazardous Waste Management) and the Transport Index (dose rate in mrem/h at 1 m from the surface of the container) noted on the label; and
- if the surface dose rate lies within 100 μSv/h to 2 mSv/h (10 to 200 mrem/h), and the dose rate at 1 m is less than 100 μSv/h (10 mrem/h), a Radioactive III label must be attached and the Transport Index posted, as above.

HWM must be notified in advance when class III containers are to be collected.

Radioactive II and III labels can be obtained from HWM. The Permit Holder is legally charged with the observance of the above procedures, since inadequate or false labeling of radioactive waste could lead to unnecessary exposure of personnel involved in waste management or members of the public.

See **Appendix D** for more information on transportation labels for packages containing nuclear substances.

8.3.3 Decay of Radioactive Waste

As an effort to reduce the costs of radioactive waste, HWM decays the following nuclear substances:

- phosphorus-32 (P-32)
- phosphorus-33 (P-33)
- sulphur-35 (S-35), and
- iodine-125 (I-125).

These nuclear substances will be automatically set aside for decay. The same HWM containers (i.e. cardboard box or plastic jug) and identification tags will be used. However, it is very important that the containers be properly identified and tracked using the myLab system, which automatically calculates the radioactivity levels within the container. Note: no other radioisotope may be mixed with them, basically, there should be one waste container for each decayable radioisotope.

9. Types & characteristics of radiation-emitting devices

9.1 BASIC PRINCIPLES

A radiation-emitting device is any device that is capable of emitting ionizing radiation when activated. This definition applies to devices such as X-ray machines, X-ray irradiators, electron microscopes, X-ray fluorescence analyzers, X-ray photoelectron spectrometers, and X-ray diffraction equipment whose sole function is the generation of ionizing radiation.

An important distinction between an X-ray radiation-emitting device and a radioactive source is that the former can be switched off, whereas a radioactive source can only be shielded and continues to emit radiation even when it is not in use. It is important to emphasize, especially to cleaners, security personnel and non-technical staff, that a radiation device is harmless when switched off.

9.2 X-RAY MACHINES & IRRADIATORS

An X-ray machine used for experimental purposes is essentially an X-ray irradiator in which the useful beam is confined to a specific direction, shape and size by means of slit, cone, diaphragm or other collimating device. The collimator may provide only a single fixed shape and size of the beam, or may allow for variation in these factors. Where possible, the useful beam should be permanently directed into an enclosed and shielded box into which the object to be irradiated can be inserted. The door or lid of the box should be interlocked with the on/off switch of the X-ray machine/irradiator. The dose rate outside the box should be such that, taking into account the workload of the X-ray machine/irradiator and the occupancy of the surrounding area, the annual dose limit for Radiation Users is not exceeded. Unauthorized workers should be excluded from the immediate vicinity of the X-ray machine/irradiator during the whole of any period in which the machine is in use.

If the conditions set out above cannot be met, and it is impossible to restrict the X-ray beam to a single direction and/or to confine their radiated space to a shielded box, then the X-ray apparatus must be installed in a separate shielded room.

Notwithstanding any shielding and interlocking arrangements, Radiation Users should take great care to avoid exposing any part of their bodies to a direct X-ray beam. This is particularly important in the case of X-ray diffraction units, where a narrow but very intense beam may need to be manipulated under manual control.

9.3 IMAGING PROCEDURES

A diagnostic-type X-ray machine may be used for imaging in research, for example with experimental animals. Such images must be obtained either by radiography or by fluorographic techniques using an image amplifier. Direct-viewing fluorography is forbidden.

Normally, the operator of an X-ray machine should stand behind a protective screen or in another room during exposures. However, sometimes it is essential for the operator to stand near to an unshielded X-ray beam during an exposure, for example to carry out a procedure on an experimental animal. In such cases the worker must wear appropriate protective clothing (lead-rubber aprons and gloves), or be provided with a portable protective screen. In any case, it is important to avoid exposing parts of the body to a direct X-ray beam.

9.4 RADIATION SURVEY OF X-RAY EQUIPMENT

Outside the useful beam, X-ray machines and irradiator give rise to leakage radiation, i.e. stray radiation transmitted through the housing of the X-ray tube when the beam is "on", and also scattered radiation originating in objects placed in the direct beam. A radiation survey must therefore be made in the area surrounding the X-ray machine, if this space is accessible during exposures. Alternatively, if the machine is housed in a separate shielded room (Section 9.2 above) then the survey should be conducted in the area outside the room. Environmental Health & Safety will normally undertake such surveys. The results must be documented and filed.

X-ray generators that are many years old may include thermionic-tube rectifiers (more modern equipment use silicon rectifiers). Such thermionic rectifiers do not normally present a hazard, but if a circuit fault develops, it is possible for the rectifier to become, in effect, an X-ray tube and to emit ionizing radiation. This emission is associated with a sharp drop in the intensity of the emission by the X-ray tube proper. Owners of old X-ray equipment should be aware of this possibility and the rectifiers should be included in any radiation survey.

9.5 OTHER RADIATION-EMITTING DEVICES

Electron microscopes, X-ray fluorescence analyzers, X-ray photoelectron spectrometers are likely to generate measurable levels of ionizing radiation (soft X-rays). This is not usually a problem, because the exposure rate is normally barely distinguishable from background, but nevertheless a radiation survey should be carried out similar to that required for an X-ray machine/irradiator (Section 9.4). The results must be documented and filed.

10. ANIMAL WORK INVOLVING RADIATION

Where an experiment involves the administration of radionuclides to animals, the researcher must provide an animal use protocol to the Animal Compliance Office, and undergo a review. If radiation is used, EHS will issue the permit and specify the conditions of use.

Permit Holder must provide Environmental Health & Safety with the following information at the planning stage:

- a short description of the experiment and its estimated total duration;
- nature and activity of the radionuclides and/or radiopharmaceuticals involved;
- the method of administration, with information relating to metabolism and excretion that could be relevant to radiation safety and the disposal of radioactive waste;
- a short description of the process that confirm that the housing for animals treated with radionuclides will not be used for any other purpose until the level of radioactive contamination surface meets criteria for release or re-use;
- the description of the procedure to meet McGill's radiation safety policies of monitoring, cleaning, decontamination and decommissioning, if necessary, of all areas of animal housing before being re-occupied;
- Description of the measures to restrict authorized personnel access to the area until the area has been decommissioned.

In light of the information provided in the above paragraph, Environmental Health & Safety may recommend any or all of the following:

- identification of the enclosures or cages with the radiation symbol, together with a warning label indicating the radionuclide, the activity and the date of administration;
- wearing of protective clothing by personnel handling the animals. This usually means protection against radioactive contamination (gowns, gloves, etc.) rather than protection against external radiation;
- use of external personal monitors (e.g. TLD badges) by staff handling the animals and/or participating in bioassay procedures (see Section 5.5.1);
- limits on the duration of work in the vicinity of radioactive animals and/or shielding of cages or enclosures;
- improvement of the ventilation in the rooms involved; and
- disposal of animal carcasses as radioactive material (see paragraph 8.3.2).

Radiation sources other than radionuclides may be used in animal experiments, either for irradiation (see Sections 9.2) or for imaging (see Section 9.3). These procedures do not call for precautions specifically related to the fact that the object of the irradiation is a live animal.

11.1 USE OF RADIATION SOURCES IN TEACHING

This section applies in those instances where students may have occasion to handle radioactive materials and/or radiation emitting devices as part of classroom or laboratory exercises connected with the courses in which they are enrolled. Such activities must be undertaken with the utmost concern for the safety of the students involved and the following conditions must be observed:

a. An Internal Permit must cover all radioisotopes or radiation devices used for teaching purposes. It is necessary that a unique permit be obtained specifically for teaching purposes, and that the Permit Holder be the instructor or the chief technician for the exercises in question. The Permit Holder must be fully familiar with the work done and assume responsibilities for the safe use of the radionuclides.

b. The instructor must be qualified to provide adequate supervision and safe advice to students. Further, instructors must know proper procedures to follow in the event of spills, accidents, and emergencies and to be prepared to give competent leadership to students as required.
c. Special care must be taken in the design of exercises for students that the possibility of the exposure of participants and observers to external radiation or contamination be kept **as low as reasonably achievable (ALARA).**
d. Before undertaking any project requiring the handling of radionuclides, students must be given clear and complete instructions in radiation safety procedures.
e. Adequate personnel protective clothing (PPE) for the procedures at hand must be available and worn by all students participating.
f. Environmental Health & Safety must be notified immediately of any incident involving loss of radioactive material, or injury or personal contamination of students, however minor.
g. Students are not permitted to work alone with nuclear substances and/or radiation devices.

11.2 DEMONSTRATIONS INVOLVING RADIATION SOURCES

- Radioactive sources used for demonstration purposes should be of minimum activity and preferably of low toxicity (see Appendix C).
- Unshielded sources should be exposed for the minimum time needed to carry out the demonstration.
- Volatile radioactive liquids, especially iodine radioisotopes, should be used only in a fume-hood or a well-ventilated room.
- Notwithstanding the fact that only low activity sources are used, the instructor should handle the sources as if they were of much higher activity, in order to demonstrate the principles of safe handling.
- Particular care should be taken when radiation-emitting devices such as X-ray machines are used in classroom demonstrations, to ensure that the direct beam does not inadvertently point towards any student.

11.3 SPECIAL PROJECT INVOLVING RADIATION SOURCES

Any use of unsealed nuclear substances that are in a quantity of more of 10,000 times the EQ (see section 8.2.1) are considered special projects. Such activities must be undertaken with the utmost concern for the safety of the people involved and the following conditions must be observed:

a. Description of the project, including the safety aspects, shall be presented to and authorized in writing by University Laboratory Safety Committee.
b. Prior to issue a McGill Internal Radioisotope Permit, the RSO shall obtain an authorization, in writing, by the CNSC.
c. The Internal Permit must cover all radioisotopes used for the special project and respond to all criteria indicated on section 4 of this Manual.
d. It is necessary that the Permit Holder be an employee of McGill. The Permit Holder must be fully conversant with the work done and assume responsibilities for the use of the nuclear substance and the safety precautions to be taken.
e. The Permit Holder must be qualified so as to provide adequate supervision and safety advice to personnel involved in the project. Personnel participant in the project are not permitted to work alone.
f. Permit Holder must know proper procedures to follow in the event of spills, accidents, and emergencies and to be prepared to give competent leadership to personnel as required.
g. Special care must be taken in the design of the procedure that the possibility of the exposure of participants and observers to external radiation or contamination be kept **as low as reasonably achievable (ALARA).**
h. Before handling the nuclear substance, participants must be given clear and complete instructions in radiation safety aspects.
i. Adequate personnel protective equipment for the procedures at hand must be available and worn by all people participating.

j. Environmental Health & Safety must be notified immediately of any incident involving loss of nuclear substance, or injury or personal contamination of personnel, however minor.

12. ACCIDENT & EMERGENCY PROCEDURES

12.1 GENERAL

Accidental exposure includes:

- contamination of the environment, or of a person's skin or clothing by radioactive material, for example following a spill of radioactive liquid;
- intake of radioactive material by ingestion, inhalation, injection or through a cut or wound; or
- an external source of unwanted irradiation such as an X-ray machine or radioactive source.

Anyone who knows or suspects that they or anyone else, have been involved in any abnormal situation as described above, should immediately report the incident or accident, with as much detail as possible, to the Permit Holder. If skin, clothing or shoes may be contaminated, it is preferable to remain on the spot (moving away from the immediate area of contamination) and to call 3000 for assistance. In this way the spread of contamination to other rooms is prevented.

All incidents involving abnormal exposure and/or contamination must be reported to EHS, either at the time (if immediate assistance is needed) or as soon as possible afterwards. EHS will:

1. assist in emergency procedures, including decontamination where necessary;
2. estimate the radiation dose(s) received by the person(s) involved. This may necessitate the immediate read-out of personnel (TLD) dosimeters and/or the provision of special bioassay procedures for the individual(s) concerned;
3. advise on the necessity, or otherwise, of medical examination and arrange such examination if appropriate. If the person needs medical attention, then this person should be accompanied by the RSO;
4. investigate the incident with a view to determining its cause and advising on remedial measures to prevent a recurrence;
5. in co-operation with the Permit Holder prepare a full report for the RSO to ensure adequate documentation; and
6. if required, the RSO will submit a report to the CNSC within 21 days.

12.2 EXTERNAL EXPOSURE (NOT INVOLVING CONTAMINATION)

The most difficult and crucial step is to recognize that an abnormal situation has occurred; for example that an X-ray machine has failed to switch off, or the shutter of an irradiator failed to close, or a sealed source is on the bench instead in its container.

It is therefore important for radiation workers to become thoroughly familiar with the normal appearance and operation of the sources and/or radiation-emitting devices with which they are working, especially if the devices or sources are capable of delivering a high dose-rate. It is highly desirable for an X-ray machine or irradiator to be equipped with an "emergency off" button in a prominent and accessible position.

Once an accidental external exposure has been recognized, proceed as follows:

i. immediately perform all necessary actions to prevent further exposure, e.g. withdraw the exposed part of the body from the beam, switch off the X-ray beam or irradiator, shield the radioactive sources, etc. In some circumstances, the exposed person cannot perform these actions on their own and must first call for assistance;

ii. report the incident to the Permit Holder who, in turn, will inform the RSO;
iii. make a preliminary estimate of the radiation dose(s) received by the exposed person(s), in co-operation with the RSO. It is better, at this stage, to overestimate rather than underestimate. A more definitive dose estimate is usually made later, when the dosimeter reading for the exposed person is determined;
iv. steps 3, 4 and 6 of the general procedure set out in Section 12.1 should be followed; and
v. bioassay procedures are not required when the accident does not involve nuclear substances.

12.3 ACCIDENTS INVOLVING RADIOACTIVE CONTAMINATION

12.3.1 Minor Accidents

In situations where the total activity is less than 100 exemption quantities of a radioisotope and there is no apparent contamination of personnel, the following procedures should be adopted:

i. estimate the activity involved and the nature of the contamination;
ii. confine the spill and prepare to clean-up;
iii. wear disposable gloves and lab coat and clean up the spill using absorbent paper and place the contaminated materials in a radioactive waste container;
iv. wash articles or surfaces with an appropriate detergent and disposable towels. Care should be taken not to contaminate oneself and to avoid the spreading of contamination;
v. perform a wipe test as described in Sections 5.8, and then repeat step iii until contamination levels are acceptable.
vi. check hands, clothing and shoes for contamination;
vii. report the spill and clean up to the Permit Holder and to the RSO (He/she will verity if actions taken will not allow a similar accident to reoccur in the future);
viii. record spill details and contamination monitoring details (date, name of personnel implicated, instrument data and calibration date, floor plan, wipe test result, including a blank); and
ix. adjust inventory and waste records appropriately;
x. records must be retained by the Permit Holder, for a minimum of one year after the license expire, for inspection by the RSO and the CNSC.

12.3.2 Major Accidents

Where the total activity is more than 100 exemption quantities and/or there is a non-negligible risk of radiation exposure, the following applies:

i. notify at once all other persons in the room and/or area and call 3000;
ii. clear the area, and persons not involved in the spill should leave immediately;
iii. close off and secure the spill area to prevent entry and post warning signs;
iv. monitor with a suitable detector the persons suspected to be contaminated and, if appropriate, proceed with the personnel decontamination measures described in Section 12.3.3;
v. estimate the activity involved and the nature of the contamination;
vi. monitor the area with a suitable detector and estimate the total exposure expected for the personnel involved in the decontamination measures; this is not a simple procedure and it must be performed by trained personnel only; if the decontamination procedures are not expected to lead to a significant exposure for the personnel (i.e. less than 100 millirem or 1mSv) and if no airborne contamination is expected (in cases of doubt, ask for assistance from EHS), proceed as described in Section 12.3.1. Otherwise, proceed as described in Section 12.4 (accident involving radioactive dusts, fumes or gases);
vii. notify the RSO of the incident at the end of clean up procedures, so that the RSO can send a complete report to the CNSC and;
viii. records must be retained by the Permit Holder, for a minimum of one year after the license expire, for inspection by the RSO and the CNSC, and should include the following information:

date and time when accident occurred, names of personnel implicated, location (floor plan), instrument data, instrument calibration date, and background measurement.

12.3.3 Personnel decontamination procedures

The following procedures apply for personnel decontamination:

- estimate the activity involved, the nature of the contamination and the affected area;
- wash the affected area with mild soap and lukewarm water. Take care not to injure the skin, as it would provide a direct pathway for radioactive contamination into the body. If the spill is on clothing, the article must be discarded at once and placed in a plastic bag or other closed container. Any spill on the skin must be flushed thoroughly. Showering is not advised before the local contamination is thoroughly cleansed; and
- notify the RSO of the incident.

12.4 ACCIDENTS INVOLVING RADIOACTIVE DUSTS, FUMES OR GASES

- Notify all other persons and vacate the room immediately. Call emergency number 3000 (Downtown) or 7777 (Macdonald).
- Ascertain that all doors giving access to the room are closed and post warning signs to prevent non-authorized access. If possible, switch off air circulation devices.
- The RSO will provide assistance for decontamination, air monitoring, surveying persons suspected of being contaminated, laboratory inspection, and accident investigation and reporting.

12.5 FIRES IN THE PROXIMITY OF NUCLEAR SUBSTANCES

The emergency instructions applicable to the building concerned must be followed exactly. It is essential to report the location of radioactive sources to the firefighting teams and to estimate any additional risk, which these sources may present. The RSO will survey the premises at the end of the emergency and, before authorizing access to the premises, will ensure that there is no significant risk of radiation exposure.

12.6 FATAL RADIATION DOSE

In any emergency situation, which could result in fatalities, the radiation hazard may be taken into account only if anyone could receive a large whole-body dose, i.e. 0.5 Sv (50 REM) or more. This level is greatly in excess of the normal limits for Nuclear Energy Workers (NEWs).

The risk of receiving a life-threatening dose of radiation at McGill University is **extremely remote**. In the event of a life-threatening accident (such as heart attack or serious fall), measures to save the life must be of primary consideration. Then the radiological aspects of the accident (such as possible spread of contamination) are secondary.

13. RECEIVING RADIOACTIVE PACKAGES

In Canada, the packaging and labeling of radioactive shipments are governed by the CNSC’s Transport Packaging of Nuclear substances regulations. Most nuclear substances are shipped as excepted Packages or as Type A packages. For details, consult the SOP # RADS.004

14. LABORATORY WORK AREA & PERSONAL PROTECTIVE EQUIPMENT

14.1 Laboratory work area

Anyone working with nuclear substances must first be trained prior to handling nuclear substances. A specific area in the lab must be designated for radioactive work, this can include a bench, a table, or a small room. This area must be demarcated with a radiation warning sign and tape.

To avoid cross contamination, these areas must be separate from locations where non-radioactive work is performed. During experimental work, the radiation work area must be covered with absorbent paper, the equipment must be identified with a radiation warning label and if there is a risk of spills, the experimental apparatus should be placed in a spill tray.

14.2 Personal protective equipment

Eye and Face Protection:

All students, staff, faculty and visitors must wear appropriate eye and/or facial protection in the following:

- All areas where hazardous materials, or substances of an unknown nature, are stored, used or handled
- All areas where the possibility of splash, flying objects, moving particles and/or rupture exist
- All areas where there are other eye hazards, e.g. UV or laser light

Lab coats and other protective clothing:

Appropriate protective clothing (e.g., lab coats, aprons, and coveralls) is required in all experimental areas where hazardous materials are handled.

Specialized protective clothing:

For additional protection, staff or students should wear over the lab coat a lead apron if gamma and X-ray emitters are being used or a rubber apron if high energy beta emitters are being manipulated. Note, that the whole body personal dosimeter must be placed behind the lead or rubber apron.

NB. Hazardous materials are defined as:

- controlled products, as defined by WHMIS legislation and;
- open radioactive sources, as defined by the Canadian Nuclear Safety and Control act.

15. REFERENCES

15.1 REGULATIONS

1. Canada:
    1. Nuclear Safety and Control Act (SOR/2000 201).
2. Quebec:
    1. Public Health Act (S.Q. 2001, c.60)
    2. Act respecting Occupational Health and Safety (R.S.Q. 1979, c.63).
    3. Environmental Quality Act (R.S.Q. 2001, c.Q-2).

15.2 GOVERNMENT AGENCIES (Canadian & International)

1. Canadian Nuclear Safety Commission – www.cnsc-ccsn.gc.ca
2. Health Canada (Radiation Protection Branch) – http://www.hc-sc.gc.ca/ahc-asc/branch-dirgen/hecs-dgsesc/sep-psm/rpb-br-eng.php
3. International Commission on Radiological Protection (ICPR) www.icrp.org
4. International Atomic Energy Agency www.iaea.org

15.3 PROFESSIONAL RADIATION SAFETY ORGANIZATIONS

1. Radiation Safety Institute of Canadian – www.radiationsafety.ca
2. Canadian Radiation Protection Association – http://www.crpa-acrp.ca
3. Health Physics Society (USA) – www.hps.org

15.4 UNIVERSITY PUBLICATIONS

1. York University Radiation Safety Manual (December 2014)
2. Memorial University Radiation Safety Manual (March 2014)
3. Ryerson University Radiation Safety Manual (2014)
4. University of Ottawa Radiation Safety Manual (July 2012)

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Radiation Standard Operating Procedures (RSOP)

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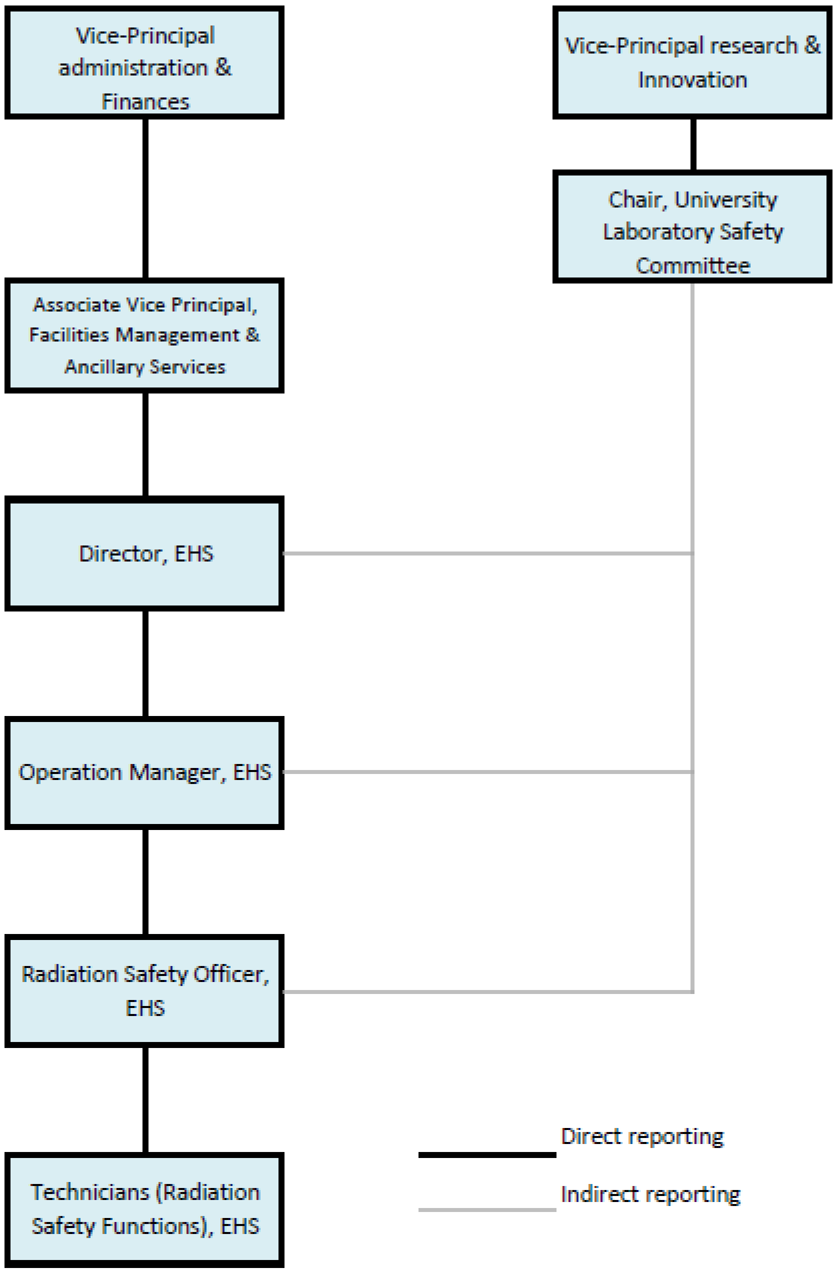
RSOP Decommissioning Lab rooms or equipment
RSOP Contamination Control Procedures
RSOP Leak Test Procedures
RSOP Receiving and Open Radioactive Packages

APPENDIX A – McGill University Radiation Safety Organogram (2012)



APPENDIX B – Equivalent Dose Limits to an Organs or Tissue[1]

Organ or Tissue	Nuclear Energy Worker[2] (mSv)	Radiation User & Public[3] (mSv)
Lens of an Eye	50[4]	15
Hands and Feet	500	50
Skin	500	50

[1] Nuclear Safety and Control Act; Radiation Protection Regulation SOR/2000-203, section 14(1)

[2] One-year Dosimetry period

[3] One calendar year

[4] CNSC e-Doc: 4894468, April 2016: Proposed Changes to the Equivalent Dose Limit for Lens of the Eye

APPENDIX C - General Properties of Some Radionuclides Currently Used in Research

Radio-nucli-ides	Half-life	**Particles** type, energy in MeV (int. %)	**Photons** type, energy in Mev (int. %)	**Gamma dose rate** (mR/h at 1m/ mCi)	**ALI**[1] ingestion (MBq)	**ALI** inhalation (MBq)
^{3} H	12.3 y	β-,.018(100)	-	-	1000	1000[2]
^{13} N	9.97 s	β+,1.2(100)	γ,0.511(200)	-	130	38
^{14} C	5720 y	β-,0.156(100)	-	-	34	1000[4]
^{15} O	122 s	β+,1.7(100)	γ,0.511(200)	-	Contact RSO[3]	Contact RSO
^{18} F	109 m	β+,0.633(97)	γ,0.511(194)	-	410	220
^{22} Na	2.6 y	β+,0.545(90)	γ,1.23(100) γ,0.511(180)	1.2	6.3	10[5]
^{24} Na	15 h	β-,1.39(100)	γ,1.37(100) γ,2.75(100)	1.84	47	38
^{32} P	14.3 d	β-,1.71(100)	-	-	8.3	6.9
^{33} P	25.4 d	β-,0.249(100)	-	-	83	15
^{35} S	87.2 d	β-,0.167(100)	-	-	110	18[6]
^{36} Cl	3 X 10^5 y	β-,0.714	-	-	22	39
^{42} K	12.4 h	β-,2.0(18) β-,3.5(82)	γ,1.5(17.9)	0.14	47	100
^{45} Ca	163 d	β-,0.357(100)	-	-	26	8.7
^{46} Sc	84 d	β-,0.357(100)	γ,0.89(100) γ,1.12(100)	1.1	13	4.2

^{51}Cr	27.8 d	-	X-ray,0.005(18) γ,0.320(9.8)	0.016	530	560[7]
^{55}Fe	2.7 y	-	X-ray,0.006(28)	-	61	22[8]
^{59}Fe	44.5 d	β-,0.130(1.2) β-,0.273(46) β-,0.465(53) β-,1.565(0.18)	γ,0.142(1.0) γ,0.192(3.0) γ,1.099(56) γ,1.291(44)	0.64	11	6.3[8]
^{57}Co	271 d	-	X-ray,0.006(56) γ,0.014(9.5) γ,0.122(85) γ,0.136(10.6) γ,0.692(0.16)	0.09	95	33[9]
^{58}Co	71.4 d	β+,0.474(15)	γ,0.810(99.4) γ,0.511(31)	0.55	27	12[9]
^{60}Co	5.261 y	β-,0.320(100)	γ,1.17(100) γ,1.33(100)	1.32	5.9	1.2[9]
^{63}Ni	92 y	β-,0.67(100)	-	-	130	38[10]
^{65}Zn	244 d	β+,0.329(1.4)	X-ray,0.008(34) γ,1.12(51) γ,0.511(2.9)	0.27	5.1	7.1
^{67}Ga	78 h	e-,0.009(32)	X-ray,0.009(56) γ,0.093(41) γ,0.184(21) γ,0.208(2.3) γ,0.300(16.8) γ,0.393(4.7) γ,0.887(0.15)	0.11	110	71[11]
^{75}Se	119 d	-	X-ray,0.01(50) X-ray,0.012(7.6) γ,0.066(1.1) γ,0.096(3.5) γ,0.121(17.7) γ,0.136(61) γ,0.198(1.5) γ,0.264(59) γ,0.279(25.2)	0.2	7.7	12

			γ,0.303(1.3) γ,0.400(11.4)			
^{85}Kr	10.7 y	β-,0.67(99)	γ,0.514(42)	0.004	--	910
^{86} Rb	18.7 d	β-,0.698(8.7) β-,1.774(91.2)	γ,1.076(8.8)	0.05	7.1	15
^{85} Sr	65.1d	-	X-ray,0.514(99)	-	36	31[(12)]
^{90} Sr	28.1 y	β-,0.546(100)	-	-	0.71	0.26[(12)]
^{99} Mo	66 h	β-,0.436(16.6) β-,0.847(1.2) β-,1.214(82)	X-ray,0.018(3.3) γ,0.366(1.2) γ,0.739(12.2) γ,0.778(4.3)	0.18	17	18
^{99m} Tc	6.0 h	e-,0.119(8.0) e-,0.137(1.1)	X-ray,0.018(6.2) X-ray,0.021(1.2) γ,0.14(88.9)	0.07	910	690[(13)]
^{109} Cd	464 d	e-,0.062(42) e-,0.084(44) e-,0.07(10.2)	X-ray,0.022(84) X-ray,0.025(18) γ,0.088(3.7)	-	10	2.1
^{119m} Sn	293 d	e-,0.023(16.8) e-,0.036(32) e-,0.062(52) e-,0.065(16)	X-ray,0.025(23) X-ray,0.029(5) γ,0.024(16)	-	Contact RSO	Contact RSO
^{123} I	13.3 h	e-,0.022(12) e-,0.127(14) e-,0.154(2)	X-ray,0.027(71) X-ray,0.031(16) γ,0.159(83) γ,0.0528(1.4)	-	95	95
^{125} I	59.6 d	e-,0.003(156) e-,0.004(80) e-,0.023(21) e-,0.031(10.5) e-,0.035(3)	X-ray,0.0004(15) X-ray,0.027(114) X-ray,0.031(26) γ,0.035(6.7)	0.15	1.3	1.4[(14)]
^{129} I	1.57 X 10^7 y	β-,0.1544(100)	γ,0.0396(7.5)	-	0.18	0.21
^{131} I	8.04 d	β-,0.248(2) β-,0.303(0.6)	X-ray,0.029(3.9) X-ray,0.033(0.9)	0.22	0.91	1[(14)]

		β-,0.334(7.4) β-,0.606(89.4) β-,0.806(0.4)	γ,0.08(2.6) γ,0.284(6.1) γ,0.364(81) γ,0.636(7.3) γ,0.722(1.8)			
^{133}Xe	5.3 d	e-,0.045(52) e-,0.075(8.5) e-,0.08(2.3) β-,0.346(99.3)	X-ray,0.031(38) X-ray,0.035(8.8) γ,0.081(37)	0.01	--	0.67
^{133}Ba	10.7 y	e-,0.045(47)	X-ray,0.043(17) X-ray,0.031(97) X-ray,0.035(23) γ,0.053(2.2) γ,0.079(2.6) γ,0.081(34) γ,0.276(7.1) γ,0.302(18.4) γ,0.356(62.1) γ,0.383(8.9)	0.24	20	11
^{137}Cs	30 y	β-,0.511(94.6) β-,1.173(5.4) e-,0.624(8.2) e-,0.655(1.6) e-,0.66(0.5)	X-ray,0.032(4) X-ray,0.036(1.4) γ,0.661(90)	0.33	1.5	3

(1) Annual Limit of Intake, from GD-52 Design Guide for Nuclear Substance Laboratories and Nuclear Medicine Rooms, May 2010; Appendix A
(2) as tritiated water
(3) Radiation Safety Officer
(4) as CO_2
(5) all compounds
(6) as vapour
(7) as oxides and hydroxides
(8) as oxides, hydroxides and halides
(9) as oxides, hydroxides, halides and nitrates
(10) as carbonyl gas
(11) as oxides, hydroxides, carbides, halides and nitrates
(12) most compounds
(13) as oxides, hydroxides, halides and nitrates
(14) as vapour
Half lives: y = year; d = day; h = hour; s = second

APPENDIX D – Transportation Labels for Packages Containing Radioactive Materials

Category I (white):

Dose rate < 0.005 mSv/hr (0.5 mrem/hr) at any point on the surface of the package

Category II (yellow):

Dose rate < 0.1 mSv/hr (10 mrem/hr) at any point on the surface and < 0.005 mSv/hr (0.5 mrem/hr) at 1m. Transport Index stated on the label

Category III (yellow):

Dose rate < 2 mSv/hr (200 mrem/hr) at any point on the surface and < 0.1 mSv/hr (10 mrem/hr) at 1m. Transport Index stated on the label

McGill University

Environmental Health & Safety

Standard Operating Procedure (SOP)

Title: Receiving and Open Radioactive Packages

SOP #: RADS.302

Date: 2014/02/20

PREPARED BY: Mario Badillo ______________________ Date: yyyy/mm/dd

RSO McGill

APPROVED BY: ____________________________________ Date issued: yyyy/mm/dd

____

Purpose:

The purpose of this document is to provide guidance with respect to the McGill University Radiation Safety program for authorized users handling and open radioactive packages. This document includes elements for identify received package, instruments, screening method, checking for contamination, interpretation of results, and keeping records.

Responsibility:

All Permits Holders and authorized radioisotope users who receives a package containing nuclear substance shall act in accordance with the requirements of the Transportation of Dangerous Goods Regulations Act (TDGA) and the CNSC's Packing and Transport of Nuclear Substances Regulations (TPNS).

The Permit Holder is responsible to train someone who handle and open radioactive packages

Participants:

Only trained and authorized workers should open packages containing nuclear substances and radiation devices.
No persons, other than the consignor or the consignee of the package, shall open the package.

Procedure/ Summary of Method:

1. Inspect packages for damage or leakage immediately upon receipt;
2. Wear a lab coat and disposable gloves while handling the package;
3. Place the package in a fume hood;
4. Confirm consignor and consignee name and address on package;
5. If the package appears to be damage or leaking isolate the package to prevent further contamination and notify the RSO for notification to the CNSC;
6. If no damage is evident, identify the type of package: Excepted package or Type A package;

7. **Excepted package**:
   7.1 Verify the mention of "RADIOACTIVE" visible upon opening
   7.2 Verify the UN number on package (i.e. 2908, 2910, 2911, etc.)
   7.3 Monitor the radiation field around the package using a radiation survey meter and compare the units stated on the package. Survey meter should must be calibrated within 12 months, as indicated in the label certificate stick on the equipment. Surface radiation < 5 mSv/h (0.5 mR/h)
   7.4 Wipe test the exterior of the package for removable surface contamination.
   7.5 Remove the packaging slip.
   7.6 Open the outer package and check for possible damage to the contents, broken seal or discoloration of packaging materials.
   7.7 Wipe test the interior packaging.
   7.8 Remove the inner package or primary container, monitor the radiation field and wipe-test the container.
   7.9 Avoid direct contact with unshielded containers.
   7.10 Verify the radioisotope, the activity and other details with the information on the packaging slip and with the purchase order;
   7.11 Keep records in the Log Book for further references;
   7.12 Remove the vial/lead pig from the box and secure it for further usage;
   7.13 Remove all safety warning sign on the package and dispose/recycle the container.
8. **Type A package**:
   8.1. Verify the package is identify as "Type A" package,
   8.2. Only authorized workers trained in TDG or EHS's "Type A package training" should open a package Type A;

8.3. Verify the UN number on package (i.e. 2915, 3327, 3332, 3333, etc.)
8.4. Verify posting of the 24 Emergency number (CANUTEC operated by the TDG Directorate of Transport Canada);
8.5. Verify name of radioisotope, mass, total volume and activity
8.6. Using a survey meter, calculate the Transport Index (TI): measure the radiation field at any point at 1 meter from the container. The highest value in mR/h is the TI;
8.7. Using a survey meter, calculate the Surface Radiation Level (SRL): measure the radiation field at any point of the surface of the container, in mR/h. divide the value by 100 to convert in mSv/h. This is the SRL
8.8. If any discrepancy, do not open the package, inform the RSO for notification to the CNSC, and contact the consignor
8.9. Follow steps 7.4 to 7.13.

9. Log the radioisotope, activity and date received in myLab and note the ID number;
10. Write this ID number on the vial.

Equipment/Instrumentation:

A Survey meter calibrated within 12 months, as indicated in the label certificate stick on the equipment

Definitions:

CNSC	Canadian Nuclear Safety Commission
TDG	Transportation of Dangerous Goods
TDGA	Transportation of Dangerous Goods Act
TPNS	Packing and Transport Nuclear Substances Regulations
Consignor	Person or firm sending a package to be delivered.
Consignee	Person to whom a package is to be delivered.
Package	The complete product of the packing operation, consisting of the packaging and is contents prepared for the transport
Type A	A package used to transport material of a higher concentration than those shipped in industrial packages
CANUTEC	Canadian Transport Emergency Centre
TI	Transport Index
SRT	Surface Radiation Level
Bq	Becquerel (disintegrations per second, dps)

	MBq = Mega Becquerel (1 000 000 Bq)
	kBq = kilo Becquerel (1 000 Bq)
dps	disintegrations per second
mR/h	milli Roentgen per hour
mSv/h	millie Sievert per hour
NEW	Nuclear Energy Worker
RSO	Radiation Safety Officer

References/Documentation:

Transportation of Dangerous Goods Regulations, SOR/2001

[http://lois.justice.gc.ca/eng/regulations/SOR-2001-287/page-1.html]

Packing and Transport Nuclear Substances Regulations

[http://laws-lois.justice.gc.ca/eng/regulations/SOR-2015-145/index.html]

Regulation for the Safe Transport of Radioactive Material, IAEA SSR-6

[http://www-pub.iaea.org/MTCD/publications/PDF/Pub1570_web.pdf]

Guidelines for Handling Packages Containing Nuclear Substances

[https://www.cnsc-ccsn.gc.ca/pubs_catalogue/uploads/I0744_e.pdf]

Revision Records:

Revision #	Date:	Responsible Person	Description of Change/Amendment:
1.	yyyy/mm/dd	RSO	Initial realese
2.			

Poster: receiving radioactive packages

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire | INFO-0744

GUIDELINES FOR HANDLING PACKAGES CONTAINING NUCLEAR SUBSTANCES

Identifying Packages Containing Nuclear Substances

The packaging and labeling of nuclear substances is governed by the Canadian Nuclear Safety Commission's *Packaging and Transport of Nuclear Substances (PTNS) Regulations*. Nuclear substances may be shipped in "Excepted Packages", "Type A" or "Type B" packages, "Industrial Packages I, II, III", and packages for "Fissile Material". The "radioactive" category labels also show radiation dose rates.

On Excepted Packages, no external labeling is required, and the safety mark "RADIOACTIVE" must be visible upon opening the package. The radiation level at any point on the external surface of the package must not exceed 5 µSv/h. All other packages must be categorized by radiation level and display the corresponding radiation warning labels as follows:

Category 1-WHITE
Does not exceed 5 µSv/h at any location on the external surface of the package

Category II-YELLOW
Does not exceed 500 µSv/h at any location on the external surface of the package and the transport index does not exceed 1.

Category III-YELLOW
Does not exceed 2 mSv/h at any location on the external surface of the package and the transport index does not exceed 10.

The transport index is the maximum radiation level in microsieverts per hour at one metre from the external surface of the package, divided by 10.
Example: 1 µSv/h (0.1 mrem/h) at 1 m equals a TI = 0.1.

Upon receipt of a package containing nuclear substances, keep your distance. Examine the package for damage or leakage. If the package is damaged or leaking, contain and isolate it to minimize radiation exposure and contamination, and comply with Section 19 of the PTNS *Regulations*.

Opening Packages Containing Nuclear Substances

Radiation Safety Officer	Phone Number

1. If an appropriate survey monitor is available, monitor the radiation fields around the package. Note any discrepancies.
2. Avoid unnecessary direct contact with unshielded containers.
3. Verify the nuclear substance, the quantity, and other details with the information on the packing slip and with the purchase order. Log the shipment details and any anomalies in the inventory record.
4. Report any anomalies (radiation levels in excess of the package labeling, incorrect transport index, contamination, leakage, short or wrong shipment) to the Radiation Safety Officer.

When opening packages containing unsealed nuclear substances, additional steps should be taken:

5. Wear protective clothing while handling the package.
6. If the material is volatile (unbound iodine, tritium, radioactive gases, etc.) or in a powder form, open the package in a fume hood.
7. Open the outer package and check for possible damage to the contents, broken seals, or discoloration of packing materials. If the contents appear to be damaged, isolate the package to prevent further contamination and notify the Radiation Safety Officer.
8. If no damage is evident, wipe test the inner package or primary container which holds the unsealed nuclear substance. If contamination is detected, monitor all packaging and, if appropriate, all locations in contact with the package, for contamination. Contain the contamination, decontaminate, and dispose in accordance with the conditions of the Nuclear Substances and Radiation Devices licence.

For more information, contact: Directorate of Nuclear Substance Regulation, Canadian Nuclear Safety Commission, P.O. Box 1046, Station B, Ottawa, ON K1P 5S9. Telephone: 1-888-229-2672. Fax: (613) 995-5086.

Canada

APPENDIX F – Levels of Use of Unsealed Nuclear Substances

BASIC LEVEL use of unsealed nuclear substances

Canada's Nuclear Regulator

BASIC LEVEL

Use of Unsealed Nuclear Substances

This room has been classified as basic level for the use of unsealed nuclear substances in accordance with Canadian Nuclear Safety Commission requirements. Below is a list of safe work practices to be followed when working in this room.

24-hour emergency contact (name and phone number)

Room identification

- Do not eat, drink, store food, or smoke in this room.
- Use protective clothing and equipment when working with nuclear substances.
- Clearly identify work surfaces used for handling nuclear substances.
- Check all packages containing nuclear substances for damage upon receipt.
- Store nuclear substances in a locked room or enclosure when not in use.
- In case of a spill or incident involving a nuclear substance, inform others in the area, follow emergency procedures and notify the radiation safety officer immediately.

Notes

A room is classified as basic level for the use of unsealed nuclear substances where more than one exemption quantity is handled and where the largest quantity (in becquerels) of a nuclear substance handled by any worker does not exceed five times its corresponding annual limit of intake (in becquerels). Contact your radiation safety officer for a list of annual limits of intake.

For more information, contact:
Directorate of Nuclear Substance Regulation
Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
Ottawa, ON K1P 5S9
Telephone: 1-888-229-2672
Fax: 613-995-5086

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Canada

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INTERMEDIATE LEVEL use of unsealed nuclear substances

Canada's Nuclear Regulator

INTERMEDIATE LEVEL

Use of Unsealed Nuclear Substances

This room has been classified as intermediate level for the use of unsealed nuclear substances in accordance with Canadian Nuclear Safety Commission requirements. The following is a list of safe work practices to be followed when working in this room.

24-hour emergency contact (name and phone number)

Room identification

- Do not eat, drink, store food, or smoke in this room.
- Wear dosimetry as required by your radiation protection program.
- Wear appropriate protective clothing and equipment when working with nuclear substances.
- Clearly identify work surfaces used for handling nuclear substances.
- Wash hands regularly and monitor them for contamination frequently.
- Monitor work area for contamination after working with nuclear substances.
- Check all packages containing nuclear substances for damage upon receipt.
- Store nuclear substances in a locked room or enclosure when not in use.
- In case of a spill or incident involving a nuclear substance, inform others in the area, follow emergency procedures and notify the radiation safety officer immediately.

Notes

A room is classified as intermediate level for the use of unsealed nuclear substances where the largest quantity (in becquerels) of a nuclear substance handled by any worker does not exceed 50 times its corresponding annual limit of intake (in becquerels). Contact your radiation safety officer for a list of annual limits of intake.

For more information, contact:
Directorate of Nuclear Substance Regulation
Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
Ottawa, ON K1P 5S9
Telephone: 1-888-229-2672
Fax: 613-995-5086

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HIGH LEVEL use of unsealed nuclear substances

Canada's Nuclear Regulator

HIGH LEVEL

Use of Unsealed Nuclear Substances

This room has been classified as high level for the use of unsealed nuclear substances in accordance with Canadian Nuclear Safety Commission requirements. The following is a list of safe work practices to be followed when working in this room.

24-hour emergency contact (name and phone number)

Room identification

- Restrict access to authorized workers only.
- Do not eat, drink, store food, or smoke in this room.
- Wear dosimetry as required by your radiation protection program.
- Wear appropriate protective clothing and equipment at all times.
- Clearly identify work surfaces used for handling nuclear substances.
- Work in a ventilated enclosure when required by the radiation safety officer or by your radiation protection program.
- Wash hands regularly and monitor them for contamination frequently.
- Monitor work area for contamination after working with nuclear substances.
- Check all packages containing nuclear substances for damage upon receipt.
- Store nuclear substances in a locked room or enclosure when not in use.
- In case of a spill or incident involving a nuclear substance, inform others in the area, follow emergency procedures and notify the radiation safety officer immediately.

Notes

A room is classified as high level for the use of unsealed nuclear substances where the largest quantity (in becquerels) of a nuclear substance handled by any worker does not exceed 500 times its corresponding annual limit of intake (in becquerels). Contact your radiation safety officer for a list of annual limits of intake.

For more information, contact:
Directorate of Nuclear Substance Regulation
Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
Ottawa, ON K1P 5S9
Telephone: 1-888-229-2672
Fax: 613-995-5086

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CONTAINMENT LEVEL use of unsealed nuclear substances

Canada's Nuclear Regulator

CNSC CCSN

CONTAINMENT LEVEL

Use of Unsealed Nuclear Substances

This room has been classified as containment level for the use of unsealed nuclear substances in accordance with Canadian Nuclear Safety Commission requirements. Below is a list of safe work practices to be followed when working in this room.

24-hour emergency contact (name and phone number)

Room identification

- Restrict access to authorized workers only.
- Do not eat, drink, store food, or smoke in this room.
- Wear appropriate dosimetry at all times.
- Wear appropriate protective clothing and equipment at all times.
- Ensure a contamination meter capable of detecting the nuclear substances present in the lab is available and in working order.
- Avoid using non-essential or personal items in the room.
- Perform work only in the designated area or enclosure.
- Monitor hands for contamination frequently.
- Clearly identify areas where nuclear substances are handled.
- Check all items for contamination before removal from the designated area or enclosure.
- Monitor all items leaving the containment lab for contamination.
- Monitor work area for contamination after working with nuclear substances, in accordance with authorized procedures.
- Check all packages containing nuclear substances for damage upon receipt.
- Store nuclear substances in a locked room or enclosure when not in use.
- In case of a spill or incident involving a nuclear substance, inform others in the area, follow emergency procedures and notify the radiation safety officer immediately.
- In case of ventilation failure, follow the evacuation protocol.
- In case of radioactive release, evacuate the area and inform the radiation safety officer immediately.

Notes

A room is classified as containment level for the use of unsealed nuclear substances where the largest quantity (in becquerels) of a nuclear substance handled by any worker exceeds 500 times its corresponding annual limit of intake (in becquerels). Contact your radiation safety officer for a list of annual limits of intake.

For more information, contact:
Directorate of Nuclear Substance Regulation
Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
Ottawa, ON K1P 5S9
Telephone: 1-888-229-2672
Fax: 613-995-5086

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APPENDIX G – Proper Use and Care of Personal Dosimeters

Canada's Nuclear Regulator

PROPER CARE AND USE OF PERSONAL DOSIMETERS

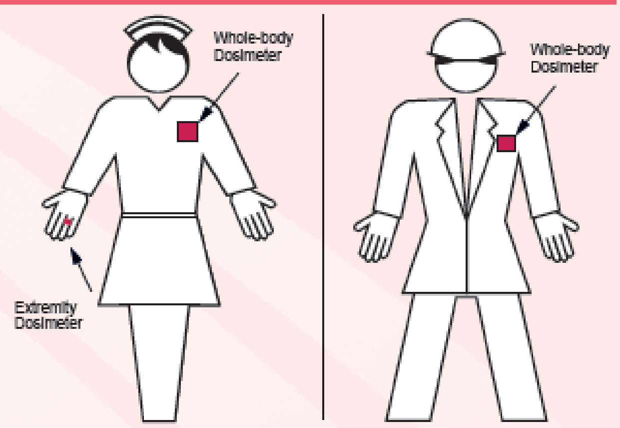
This poster gives useful tips for the proper handling, wearing and storage of whole-body and extremity dosimeters. These are commonly referred to as thermoluminescent dosimeters (TLDs) or optically stimulated luminescent (OSL) dosimeters. Your dosimeter measures the amount of radiation to which you are exposed.

Handling

1. Follow manufacturer recommendations for the care and use of your dosimeter. Do not expose the dosimeter to high temperatures, water, direct sunlight or fluorescent light.
2. Change the dosimeter plaques in a clean, dry area away from direct light, and avoid direct skin contact, if necessary.

Wearing

3. Clip your whole-body dosimeter firmly to your clothing between your waist and neck.
4. Extremity dosimeters should be worn facing the source of radiation.
5. If necessary, wear a second dosimeter on the area of your body most likely to receive the highest dose. In these cases, special arrangements must be made with the dosimetry service provider to ensure doses are assigned properly.
6. If you lose or damage your dosimeter, you should stop working with radiation until you receive a replacement.
7. Do not share your dosimeter.



Storage

8. Store your dosimeter in a manner recommended by the manufacturer when not in use.
9. It is good practice to keep extra dosimeters as replacements for lost or damaged ones and for visitors.
10. When not in use, dosimeters are best stored in a low-radiation background area. Dosimeters should be protected from direct light and heat.

For more information, contact:
Directorate of Nuclear Substance Regulation
Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
Ottawa, ON K1P 5S9
Telephone: 1-888-229-2672
Fax: 613-995-5086

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APPENDIX H-1 – Application for Internal Permit for Acquisition and Use of Radioactive Materials

McGill Environmental Health and Safety

Appendix H-1

Application for Internal Permit for Acquisition and use of Radioactive Materials
PLEASE PRINT or TYPE

1. Permit Holder

Name ______________________ **Building Name** ______________________

Position ______________________ **Street Address** ______________________

Department ______________________ **Postal Code** ______________________

E-mail ______________________ **Office room #** __________ **Tel** __________ **Voice mail: Yes / No**

Fax ______________________ **Lab room #** __________ **Tel** __________ **Voice mail: Yes / No**

(Please circle appropriate answers)

Ship to address

2. Personnel

First Name/Family Name	Position	Radiation Safety Training Yes or No	Work Load	
			Class	Principal Nuclide(s)
Example: John Doe	Graduate Student	If Yes, Where & What Year	2,3	H-3, C-14, P-32
Continue on separate sheet if necessary				

Class 1. Workload < 10 MBq (270 uCi) of unsealed radioisotopes in open areas.
Class 2. Workload < 10 MBq of unsealed radioisotopes in a fume hood.
Class 3. Workload > 10 MBq of unsealed radioisotopes in open areas.
Class 4. Workload > 10 MBq of unsealed radioisotopes in a fume hood.
Class 5. Work with sealed sources (indicate activity).
Class 6. Individual does not work with radioactive sources but normal working conditions involve presence in a room where radioactive material is used or stored. (Radiation safety training not required)

3. Open (unsealed) radioisotopes

List possession limits required for each radioisotope. For each column from 1 to 8, write the nuclide, immediately below insert the room number for storage and usage and then check one of the possession limits. For an example see table below.
***Note*: For each radioisotope, estimate the quantity (*activity*) you will possess in your laboratory at any given time. For radioisotope usage and storage, include other rooms beside laboratories, like tissue culture rooms, cold or hot rooms, centrifuge rooms, common lab facilities and liquid scintillation counting areas.**

		Nuclide							
	Example	1	2	3	4	5	6	7	8
Nuclide **Stored in Room No.** **Used in Room No.**	**H-3** **B12** **B14**								
Possession limits:									
< 400kBq (11 uCi)									
<1 MBq (27 uCi)									
< 4 MBq (108 uCi)									
< 10 MBq (270 uCi)									
< 40 MBq (1.1 mCi)	√								
< 100 MBq (2.7 mCi)									
< 400 MBq (11 mCi)									
< 1 GBq (27 mCi)									
< 4 GBq (108 mCi)									
> 4GBq (Specify)									

4. State briefly the intended use(s) of radioisotopes listed in (3).

5. Sealed sources permanently housed in equipment

Nuclide	Type of Equipment	Model or Serial no.	Manufacturer	Activity (Specify unit) And date	Location of equipment (room no.)

6. Accessible sealed sources

Nuclide	Physical form	Supplier	Activity in MBq and date	Stored in Room no.	Used in Room no.

7. State briefly the intended uses of sealed sources listed in (5) and (6).
Note: In many cases "Calibration of equipment" is sufficient.

8. Does your lab possess any field survey monitoring instruments?
If yes, please specify (example: Geiger counter, cutie pie, etc.) and provide model and serial numbers.

9. Do you use TLD (Thermoluminescent Dosimetry Radiation) badges issued by Health Canada, Bureau of Radiation and Medical Devices?

What type of TLD dosimeter do you use? (Check any box that applies)

☐ **whole body dosimeter**

☐ extremity ring dosimeter

If so, indicate your group code number:

__________ **For whole body dosimeter**

__________ **For ring dosimeter**

If you do not have access to this information, please consult your department. Or else, contact the McGill Radiation Safety Officer at 398-2245 for help.

This is to certify that the information provided is, to the best of my knowledge, accurate and complete. As Permit Holder I agree to work in accordance with the conditions specified on the internal permit and the procedures and policies specified in the McGill Radiation Safety Manual. I also agree to assume responsibility for ensuring that the personal I have listed in this application have received certification in radiation safety training and for informing them of their obligations to respect these permit conditions and radiation safety policies and procedures.

Signature of Permit Holder ____________________

Date: ____________________

Office Use:

Checked by: ____________________

Date: ____________________

Please complete and forward to:

Mario Badillo
Environmental Health & Safety Office
3610 McTavish Street, 4th Floor
Montreal, H3A 1Y2
Fax: (514) 398-8047

If you require assistance in completing this form, please call David Swan at 398-1571 or François Gouin at 398-8521. Thank you for your cooperation.

APPENDIX H-2 – Application For Internal Permit for Use of Radioactive Emitting Device in Non-Human Investigations

Application for internal permit (non-human investigations)

APPENDIX I – Declaration by Radiation Users and Nuclear Energy Workers

Declaration by Radiation Users and Nuclear Energy Workers

APPENDIX J-1 – Radioisotope Inventory

Radioisotope inventory (withdrawn)

APPENDIX J-2 – Inventory of Sealed Radioactive Materials

Inventory of sealed sources (Withdrawn)

APPENDIX K – Exemption quantities of Radioactive Prescribed Substances[1]

Exemption Quantities are the amounts, which if exceed come under the control of the Nuclear Safety and Control Act. This quantity is also used to define various regulator criteria.

Isotope	Quantity in MBq	Isotope	Quantity in MBq
Americium 241	0.01	Iodine 123	10
Americium 243	0.001	Iodine 125	1
Antimony 124	1	Iodine 129	0.1
Antimony 125	1	Iodine 131	1
Arsenic 73	10	Iridium 192	0.01
Arsenic 74	1	Iron 52	1
Arsenic 76	0.1	Iron 55	1
Barium 131	1	Iron 59	1
Barium 133	1	Krypton 77	1000
Barium 140	0.1	Krypton 85	0.01
Beryllium 7	10	Krypton 87	1000

Bismuth 206	0.1	Lead 210	0.01
Bismuth 207	1	Magnesium 28	0.1
Bismuth 210	1	Manganese 52	0.1
Bromine 82	1	Manganese 54	1
Cadmium 107	10	Mercury 203	0.1
Cadmium 109	1	Molybdenum 99	1
Cadmium 113m	1	Nickel 59	100
Cadmium 115	1	Nickel 63	100
Cadmium 115m	1	Niobium 95	1
Calcium 45	10	Nitrogen 13	1000
Calcium 47	1	Oxygen 15	1000
Carbon 11	1	Phosphorous 32	0.1
Carbon 14	10	Phosphorous 33	100
Cerium 139	1	Polonium 210	0.01
Cerium 141	10	Potassium 42	1
Cerium 144	0.1	Promethium 147	10
Cesium 134	0.01	Radium 226	0.01
Cesium 134m	0.1	Rubidium 86	0.1
Cesium 137	0.01	Samarium 153	1
Chlorine 36	1	Scandium 46	1
Chlorine 38	0.1	Scandium 47	1
Chromium 49	1	Selenium 75	1
Chromium 51	10	Selenium 79	10
Cobalt 56	0.1	Sodium 22	1

Cobalt 57	1	Sodium 24	0.1
Cobalt 58	1	Strontium 85	1
Cobalt 58m	10	Strontium 87m	1
Cobalt 60	0.1	Strontium 89	1
Copper 60	0.1	Strontium 90	0.01
Copper 64	1	Sulphur 35	100
Cooper 67	1	Technetium 99	10
Dysprosium 159	10	Technetium 99m	10
Erbium 169	10	Thallium 201	1
Erbium 171	1	Thallium 204	0.01
Fluorine 18	1	Thorium 232	0.01
Gadolinium 153	10	Tin 113	10
Gallium 67	1	Uranium 235	0.01
Gallium 68	0.1	Uranium 238	0.01
Germanium 68	0.1	Xenon 123	1000
Gold 195	10	Xenon 129m	0.01
Gold 198	1	Xenon 133	0.01
Hydrogen 3	1000	Xenon 135	10000
Indium 111	1	Yttrium 90	0.1
Indium 113m	1×10^5	Zinc 65	1
Indium 115	1×10^5	Zirconium 95	1

1. IAEA Safety Standards; General Safety Requirements (GSR) Part 3; Radiation Protection and Safety Radiation Sources: International Basic Safety Standards

APPENDIX L – S.I. Quantities and Units in Radiation Safety and Conversion Factors

The main quantities of interest to users of this manual are absorbed dose, dose-equivalent, exposure and activity. These are defined as follows:

1. **Absorbed dose** (usually referred to as *dose*) is a physical quantity that represents the energy imparted by the radiation to unit mass of any absorbing material. The 'old' unit of dose is the rad, defined as an energy absorption of 100 ergs per gram of material. The S.I. (Système International) unit of dose is the gray (symbol: Gy), where

- 1 Gy = 1 joule per kilogram, or
- 1 Gy = 100 rads

2. **Dose equivalent** (DE) may be regarded as an expression of dose in terms of its biological effect. Dose-equivalent takes account of the fact that, for a given absorbed dose such as 1 gray, a radiation of one type and/or energy may give rise to a greater biological effect than a radiation of another type and/or energy.

Dose equivalent = dose X quality factor (Q)

where the Q depends on the radiation concerned. For most radiation used in medicine Q is 1.0 so that DE is numerically equal to dose. The 'old' unit of DE is the rem, where

1 rad = Q rems

For example, an absorbed dose of 1 rad of neutrons, for which the quality factor is 10, gives rise to a dose-equivalent of 10 rems.

The S.I. unit of DE is the sievert (symbol: Sv) where

1 Gy = Q sieverts, or
1 Sv = 100 rems

Other relationships of interest are:

1 mSv = 100 mrem
10 μSv = 1 mrem
50 mSv = 5 rems

3. **Exposure** is a quantity that expresses the ability of radiation to ionise air and thereby create electric charges that can be collected and measured. The unit of exposure is the roentgen (symbol: R), which is the quantity of X- or (-rays which gives rise to 1 electrostatic unit of charge per cc of air at standard temperature and pressure, i.e. 0°C and 101 kilopascals or 760 mm Hg. The roentgen is now defined in terms of the S.I. unit of charge, the coulomb (symbol: C) as follows:

- 1 R = 2.58 X 10^{-4} Ckg^{-1} of air, or
- 1 Ckg^{-1} of air = 3876 R

  The concept of exposure is used mainly in diagnostic radiology, where we speak of an "entrance exposure of 1 R at the patient's skin" (not to be confused with an "exposure of 0.1 sec" meaning that the tube is activated for 0.1 second).

  Numerically, 1 R is equivalent to a dose of 0.87 rad for most radiation's used in medicine, but for purposes of radiation safety it is sufficient to assume that the roentgen and rad are numerically equal. However, the roentgen is not defined, and therefore cannot be used, for neutrons, charged particles, or photons of energy in excess of about 2 MeV.

4. **Activity** is the transformation (disintegration) rate of a radioactive substance. The curie (symbol: Ci) corresponds to a transformation rate of 3.7 $X10^{10}$ disintegration per second, the microcurie (μCi) to 37,000 dis/sec. The S.I. unit of activity is the becquerel (symbol: Bq), where

- 1 Bq = 1 disintegration per second
- 37,000 Bq = 1 μCi
- 3.7 X 10^7 Bq = 1 mCi
- 3.7 X 10^{10} Bq = 1 Ci

5. **Prefixes** are used to denote units which are larger or smaller than the basic unit. The preferred set of prefixes in the International System uses a factor of 1000 (10^3) between a prefix and the next one, above or below (the use of the prefix centi for 10^{-2} is an exception to this rule):

Factor	Prefix	Symbol	Factor	Prefix	Symbol
10^{18}	exa	E	10^{-2}	centi	c
10^{15}	peta	P	10^{-3}	milli	m
10^{12}	tera	T	10^{-6}	micro	μ
10^9	giga	G	10^{-9}	nano	n
10^6	mega	M	10^{-12}	pico	p
10^3	kilo	k	10^{-15}	femto	f
			10^{-18}	atto	a

For example:
1 gigabecqurel (GBq) = 10^9 Bq = 1,000,00,000 Bq = 27 millicuries (mCi)

Note that (with the exception of kilo, k) the symbols for prefixes denoting factors greater than 1 are written in upper case, whereas those for factors less than 1 are written in lower case.

APPENDIX M – Notification of Nuclear Energy Worker Status

Notification of nuclear energy worker status

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

In accordance with the Nuclear Safety and Control Act and Regulations of Canada, this is to inform you that you are a NUCLEAR ENERGY WORKER. A ***N****uclear* ***E****nergy* ***W****orker as defined in the* Nuclear Safety and Control Act *means a person who is required, in the course of the person's business, or* *occupation in connection with a nuclear substance or nuclear facility to perform duties in such circumstances that there is a reasonable probability that the person may receive a dose of radiation that is greater than the prescribed limit for the general public.*

As required by the Radiation Protection Regulations (RPR), I have been informed in writing of:

- the risks associated with radiation to which I may be exposed during the course of my work, including the risk associated with the exposure of an embryo and foetus;
- the applicable dose limits as specified in the RPR;
- my expected radiation dose levels;
- for females, my rights and obligations should I become pregnant.

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

Signature of Worker
Signature of RSO
Date

APPENDIX N – Glossary

Action Level
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.

Activation
The process of inducing radioactivity by irradiation; for example, absorption of neutrons by a stable isotope to give a radioactive isotope of the same atomic number but higher mass number.

Activity
Rate at which atoms are disintegrating. Strictly, the number of nuclear transformations in a given quantity of material per unit time.

Activity Concentration
Activity per unit volume (or mass).

ALARA (as low as reasonably achievable)
An optimization tool in radiation protection used to keep individual, workplace and public dose limits as low as reasonably achievable, social and economic factors being taken into account. ALARA is not a dose limit; it is a practice that aims to keep dose levels as far as possible below regulatory limits.

Alpha particles (α)
Positively charged particles consisting of two protons and two neutrons that are emitted by the nuclei of radioactive (unstable) elements as they decay. Alpha particles are relatively large and can be stopped by skin or a sheet of paper. An alpha particle is a helium nucleus.

Annihilation
Occurs when a particle and anti-particle meet. For the positron and electron, the result is two photons at 0.511 Mev.

Annual Limit of Intake
The annual limit of intake (ALI) corresponds to the activity in Becquerel of a radionuclide that, when taken into the body (by inhalation and/or ingestion), will deliver an effective dose of 20 milliSievert

over the next 50 years. One ALI corresponds to the handling in a single instance of the following amounts of the listed isotopes.

Atomic Number
Number of protons in the nucleus of an atom. Defines the chemical identity of the atom.

Becquerel
S.I. Unit of Activity = 1 disintegration per second.

Beta particles (β)

High-energy negatively charged electrons or positively charged positrons that are ejected by radioactive (unstable) elements as they decay. A beta particle is identical in mass and charge to an electron. Beta particles are relatively small and can be stopped by a sheet of aluminum or plastic a few millimeters thick.

Bremsstrahlung
Photon radiation produced by charged particles subject to rapid deceleration. Most often seen with electrons, producing X-rays.

Collective Dose Equivalent
The sum of the individual dose equivalents for the members of the population. Sometimes taken as a measure of the detrimental effect of low doses of radiation upon a population. Usual unit is man/rem. (S.I. unit not defined — could be man.Sv, person.Sv or just Sv).

Compton Scattering
Interaction between a photon (γ-ray) and an electron in which part of the photon energy is transferred to the electron and the rest forms a new photon of lower energy travelling in a different direction.

Cosmic Rays
High-energy charged particles, originating in outer space that travel at nearly the speed of light and strike Earth from all directions. Also called cosmic radiation.

Curie
Old unit of activity = 3.7×10^{10} disintegrations per second.

Decommission
A thorough decontamination procedure and removal of nuclear substances, certifying that the area or laboratory is free from radioactivity or radioactive surface contamination.

Delta-rays
Short range secondary electrons produced along the track of a primary ionizing particle.

Deuterium
Special name for ^{2}H, often given the chemical symbol, D.

Device
For the purposes of this guide and the application form, a device is any piece of equipment designed to use a sealed source(s) with the sealed source(s) installed and for which a Device Certification has been issued by the CNSC.

Diagnostic Nuclear Medicine
Administration of unsealed nuclear substances to humans for diagnostic purposes related to their

health care; processing of radio pharmaceuticals and laboratory studies which are part of the diagnostic studies are included.

Dismantle
To take apart prescribed equipment for the purpose of repairing, replacing, removing faulty components, which may include the nuclear substance of that device (part of the licensed activity of *servicing, installation and dismantling of devices containing radioisotopes*). **Dose**
A measure of the amount of radiation absorbed per unit mass of material (often tissue).
Old unit: rad = 100 erg/g
S.I. unit: gray = J/kg = 100 rad.

Effective Dose
The weighted average of the dose equivalent over the major organs of the body using published tables of weighting factors for the different organs (see ICRP report #60). It is the dosimetric quantity that is intended to reflect the risk of long-term effects from low doses of radiation for use in cases of non-uniform exposure. See Manual section 3.7.

Electron
A stable elementary particle associated with negative electrical charge, with the passage of electrical currents and with the chemical activity of atoms.

Electron Capture
Radioactive decay mode in which one of the orbital electrons of an atoms is absorbed by the nucleus, reducing the atomic number by 1. Usually results in the emission of characteristic X-rays.

Electron Volt (eV)
The kinetic energy acquired by an electron in passing through a potential difference of 1 volt in vacuum. 1 eV = 1.6 X 10^{-19} J (approx.)

Equivalent Dose
The radiation dose weighted to account for the different biological effectiveness of radiations = Dose X Quality Factor. Old unit: rem (dose in rads) S.I. unit: Sievert (dose in Gy). See Appendix B.

Excited State
Temporary state of a nucleus, atom or molecule intermediate in potential energy between the normal stable state and compete disintegration, ionization or decomposition respectively

Exemption Quantity
A quantity of a radioactive nuclear substance as defined Nuclear Substances and Radiation Devices Regulations.

Export
To send a nuclear substance or prescribed equipment out of Canada.

Exposure
A measure of the amount of ionizing radiation present. See Roentgen.

Fission
Splitting of an atomic nucleus into two or more lighter nuclei (fission products). Can either be spontaneous or induced (by neutron capture).

Five-Year Dosimetry Period
The period of five calendar years beginning on January 1 of the year following the year in which the CNSC Regulations come into force, and every period of five years thereafter.

Flux
Number of particles crossing a unit area, or Flux Rate the number crossing unit area in unit time. The units used distinguish the two cases.

Gamma Radiation
High energy electromagnetic (photon) radiation emitted by an atomic nucleus.

Gamma Ray Constant
Empirical quantity (K) that allows one to predict the exposure rate at a distance from a source of activity A. Exposure = AK/d^2. If exposure is measured in R/h, activity in Curies and d in metres the K = 0.6 X E (approx.) where E is the total gamma ray energy per disintegration in Mev.

Gray (Gy)
S.I. unit of radiation dose = J/kg.

Half-life
Time for the activity of an isotopically pure radioactive source to fall to half its initial value.

Half Value Layer
Thickness of material required to halve the intensity of X- or γ-ray beam.

Heavy Water
Deuterium oxide, D_2O = ^2H_2O

Human Research Studies
Administration of unsealed nuclear substances to or external irradiation of humans for purposes not related to their personal health care; processing of radio pharmaceuticals and laboratory studies which are part of the human research study are included.

ICRP, ICRU
International committees concerned with recommending practices in radiation protection. See Bibliography.

Internal Conversion
Atomic process whereby a nucleus in an excited state decays to its stable state by transferring the excess energy to one of the orbital electrons of the atom. Usually results in the emission of characteristic X-rays as well as the conversion electron.

Import
To bring a nuclear substance or prescribed equipment into Canada.

Internal Conversion
Atomic process whereby a nucleus in an excited state decays to its stable state by transferring the excess energy to one of the orbital electrons of the atom. Usually results in the emission of characteristic X-rays as well as the conversion electron.

Ion, Ionisation
An ion is an atom or molecule with more (negative ion) or less (positive ion) electrons than needed for electric neutrality. The process of creating ions is ionisation.

Isotopes
Atomic species (nuclides) with the same atomic number (chemical identity) and differing mass numbers. The singular, isotope, is also used as an equivalent of nuclide (q.v.).

LET
Linear Energy Transfer = density of ionization along the track of radiation.

Licensed Activity

For the purpose of this licensing guide an activity, in relation to a nuclear substance or a radiation device described below, that a licence authorises the licensee to:
(a) possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information;
(b) mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance; or
(c) produce or service prescribed equipment.

Licensed Use Type
A particular use of nuclear substances as described in the *Cost Recovery Fees Regulations*.

Location
Any land, base(s) of operations, or premises the licensee occupies, where the licensee uses or stores nuclear substances for more than 90 consecutive days.

M-Isomer
Long-lived excited state of an atomic nucleus. Usually decays to the normal (ground) state by emission of a γ-ray.

Man.rem
Commonly used unit for Collective Dose Equivalent (q.v.).

Mass Number
Total number of nucleons (protons and neutrons) in the nucleus of an atom.

Maximum Specific Activity
Specific activity of pure isotope in elemental form = γNBq/mol, where

$\gamma = .693/T^1/_2$ (S^{-1})
$N = 6 \times 10^{23}$ mol^{-1}
$T^1/_2$ = half life (q.v.)

Meson
General term for particles with a mass intermediate between an electron and a proton or neutron. Produced by accelerators and cosmic rays.

Nuclear Energy Worker (NEW)
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.

Nuclear Substance
(a) deuterium, thorium, uranium or an element with an atomic number greater than 92;
(b) a derivative or compound of deuterium, thorium, uranium or of an element with an atomic number greater than 92;
(c) a radioactive nuclide;
(d) a substance that is prescribed as being capable of releasing nuclear energy or as being required for the production or use of nuclear energy;
(e) a radioactive by-product of the development, production or use of nuclear energy; and

(f) a Radioactive substance or radioactive thing that was used for the development or production, or in connection with the use, of nuclear energy.

Nucleus
Central volume of an atom, consisting of protons and neutrons and accounting for most of the atomic mass.

Nuclide
A particular atomic species distinguished by both its atomic number and mass number.

Neutrino
Light unchanged particle emitted during α-decay.

Neutron
One of three elementary particles, which is part of all nuclei heavier than hydrogen.

One-year Dosimetry Period
The period of one calendar year beginning on January 1 of the year following the year in which these Regulations come into force, and every period of one calendar year thereafter.

Package
To put a nuclear substance or prescribed equipment into a form of containment for purposes of transport.

Pair Production
The reverse of annihilation. An interaction between a γ-ray and an atomic nucleus in which 1.022 MeV of the photon energy is used to form an electrons-positions pair.

Photo-electron
Produced when an electron totally absorbs a high energy photon (γ-ray) and acquires sufficient energy to escape from its atoms.

Photon
Particle of electromagnetic radiation.

Planck's Law
$E = hf$
where E = energy of photon; f = frequency of electromagnetic radiation; and h = Planck's constant = 4.14×10^{-15} v.s.

Positron
Light positively charged particle, anti-particle of the electron, emitted during beta-decay.

Possess
To have the care and control of a nuclear substance or prescribed equipment.

Permit Holder (PH)
Is the person responsible for the safe procurement, storage, use and disposal of specific radiation sources. The person is usually in charge of research or teaching operations.

Proton
Elementary particle, part of the mass of an atomic nucleus, associated with the positive electrical charge.

Quality Factor
Nominal biological effectiveness of radiation as set by regulatory bodies. Value is 1 for β, γ and X-rays; 20 for α; depends on energy for neutrons.

Rad
Old unit of radiation dose = 100 erg/gram.

Radiation Device
(a) 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; and
(b) a device that contains a radium luminous compound.

Radiation Survey Metre
An instrument that is capable of measuring radiation dose rates (mrem/h or mSv/h).

Relative Biological Effectiveness (RBE)
Ratio of the doses of different radiations required to give the same biological effect. Reference radiation is usually X-rays or γ-rays.

Rem
Old unit of Dose Equivalent

Roentgen
Unit of exposure; that quantity of X- or γ-radiation that results in the production of 1 e.s.u. of charge in 1 cm^3 of air at S.T.P. = 258 mC/kg air (S.I. definition).

Sealed Source
A radioactive nuclear substance in a sealed capsule or in a cover to which the substance is bonded, where the capsule or cover is strong enough to prevent contact with or the dispersion of the substance under the conditions for which the capsule or cover is designed.

S.I.
Système International. Internationally-agreed system of metric units.

Sievert (Sv)
S.I. unit of dose equivalent.

Source in Device
A sealed source which remains in a device giving mechanical protection from damage during use

Specific Activity
Ratio of radioactive atoms (or molecules) to total of chemically similar atoms (or molecules) [Ci/mole or Bq/mol).

Store
To lay away for future purposes.

Therapeutic Nuclear Medicine
Administration of unsealed nuclear substances to humans for therapeutic purposes related to their

health care; processing of radio pharmaceuticals and laboratory studies which are part of the therapy are included.

Transfer
To change the possession of a nuclear substance or prescribed equipment from one person to another.

Transport
To handle, carry, store in transit and receive goods at the final destination. Transport includes normal and accident conditions encountered in carriage and in storage during transit.

Tritium
Special name for ^{3}H, often given the chemical symbol T.

Ultra-violet
Electromagnetic radiation more energetic (higher frequency) than visible light but insufficiently energetic to cause ionisation.

Unsealed Source
A source other than a sealed source.

Use
To put into operation.

Worker
A person who performs an activity that is referred to in the licence.

Working Level
A special unit to describe the activities of the short-lived daughters of radon in air. Defined as any combination that results in emission of 1.3 X 105 MeV/L of α energy in decaying to lead-210.

X-rays
High energy electromagnetic (photon) radiation emitted by electrons: -when changing energy levels within an atom (characteristic or fluorescence X-rays) -when rapidly decelerated, usually by hitting a solid target (conventional X-ray set — Brensstrahlung).

APPENDIX O – Bibliography

Note: Note: This bibliography lists only publications of general interest to university professors and researchers. Publications relating specifically to the use of radiation sources in clinical medicine are omitted.

A. Publications of the International Commission on Radiological Protection (ICRP)

1. Publication #25 (1976). The handling, storage, use and disposal of unsealed radionuclides in hospitals and medical research establishments.
2. Publication #26 (1977). Recommendations of the International Commission on Radiological Protection.
3. Publication #27 (1977). Problems involved in developing an Index of Harm.
4. Publication #28 (1977). The principles and general procedures for handling emergency and accidental exposure of workers.
5. Publication #30 (1982). Limits of intakes of radionuclides by workers.
6. Publication #35 (1982). General principles of monitoring for radiation protection of workers.

7. Publication #36 (1983). Protection against ionising radiation in the teaching of science.
8. Publication #46 (1985). Radiation protection principles for the disposal of solid radioactive waste.
9. Publication #53 (1987). Individual monitoring for intakes of radionuclides by workers: design and interpretation.
10. Publication #54 (1987). Data for use in protection against external radiation.
11. Publication #60 (1991). Recommendations of the International Commission on Radiological Protection.

B. Reports of the National Council on Radiation Protection & Measurements (NCRP) (Washington, DC)

1. Report #32 (1966). Radiation protection in educational institutions.
2. Report #39 (1971). Basic Radiation protection criteria.
3. Report #43 (1975). Review of current state of radiation protection philosophy.
4. Report #51 (1977). Radiation protection design guidelines for 0.1 — 100 MeV particle accelerator facilities.
5. Report #53 (1977). Review of NCRP radiation dose limit for embryo and foetus in occupationally exposed women.
6. Report #57 (1978). Instrumentation and monitoring methods for radiation protection.
7. Report #58 (1978). A handbook of radioactivity measurements procedures.
8. Report #59 (1978). Operational radiation safety program.
9. Report #65 (1980). Management of persons accidentally contaminated with radionuclides.
10. Report #71 (1983). Operational radiation safety.
11. Report #72 (1983). Radiation protection and measurement for low voltage neutron generators.
12. Report #82 (1985). SI units in radiation protection and measurements.
13. Report #87 (1987). Use of bioassay procedures for assessment of internal radionuclide deposition.
14. Report #93 (1987). Ionising radiation exposure of the population of the United States.

C. Health and Welfare Canada Publications

1. Safety Code #PPB-SC-12 (1976). Laboratory facilities for handling radioisotopes.
2. Publication #79-EHD-27 (1978). The thermoluminescent dosimetry service of the radiation protection bureau.
3. Publication #81-EHD-56 (1980). Bioassay guideline 1: General guidelines for bioassay programs.

D. Regulations

3. Canada:
    1. Nuclear Safety and Control Act (SOR/2000 201).
4. Quebec:
    1. Public Health Act (S.Q. 2001, c.60)
    2. Act respecting Occupational Health and Safety (R.S.Q. 1979, c.63).
    3. Environmental Quality Act (R.S.Q. 2001, c.Q-2).

E. Textbooks

5. Marilyn E. Noz and Gerald Q. Maguire. *Radiation Protection in the Radiological and Health Sciences*. 2nd edition, 1985 (Lea and Febiger, Philadelphia).
6. Jacob Shapiro. *Radiation Protection. A Guide for Scientists and Physicians*. 2nd edition, 1981 (Harvard University Press, Cambridge MA).
7. Nicholas P. Cheremisinoff, Paul N. Cheremisinoff and Michael F. Teresinski. Industrial Radiation Hazards — deskbook. 1st edition, 1987 (Technomic Publishing, Lancaster, PA).

8. Bernard Shleien. Radiation Safety Manual for Users of Radioisotopes in Research and Academic Institutions. 1st edition, 1987 (Nucleon lectern Associates, Olney, MD).
9. C.H. Wang, David L. Willis, Walter D. Loveland. Radiotracer Methodology in Biological, Environmental and Physical Sciences. 1975 (Prentice-Hall, Inc., Toronto).

F. Other Publications

1. Astra Research Centre Montreal, Radiation Safety Manual (January 1998)
2. Concordia University, Radiation Safety Manual (January 1999)
3. Dalhousie University, Radiation Safety Program Policy and Procedure Manual (September 1997)
4. University of Montreal, Radiation Safety Manual (April 1997)
5.

APPENDIX P – Document Change Record for the McGill's Radiation Safety Manual Version 7.0

A change log is used to provide an audit trail of all approved changes made to the Radiation Safety Manual (RSM) after initial approval and posting. Changes will be reviewed and approved by the ULSC and the CNSC prior to incorporating into the RSM document.

Updated revisions of this document will be made as approved changes impact the page number or content. This information will also be logged in the change control log. For columns not applicable, enter "N/A"

Control Log for Document Changes Record for the McGill's RSM version 7.0

Published Date	Status (Baseline, Revision, Cancelled)	Document Version Number	Page(s) Affected	Description of Revision (Include Document Name and Reason for Change)	Author
	revision	Ed.7.0	24	Section 6.3.3 using electronic tracking system myLab. Remove last paragraph in this section	MB
	revision	Ed 7.0	25		

APPENDIX Q – Administrative Monetary Penalties Regulation – List of Violations

(Extract from the CNSC document SOR/2013-139 June 18, 2013) http://canadagazette.gc.ca/rp-pr/p2/2013/2013-07-03/html/sor-dors139-eng.php

DESIGNATIONS

Violations

2. (1) The contravention of a provision of the Act or any of its regulations that is set out in column 1 of the schedule is designated as a violation that may be proceeded with in accordance with sections 65.01 to 65.21 of the Act.

Short-form descriptions

(2) In the event of a discrepancy between the short-form descriptions in the schedule and the provision to which it pertains, the provision prevails.

CLASSIFICATION

Classification

3. The classification of a violation of a provision that is set out in column 1 of the schedule as a Category A, Category B or Category C violation is as set out in column 3.

PENALTIES

Individual

4. (1) The amount payable as the penalty in respect of a violation that is committed by an individual is

- (*a*) $300 to $3,000, for a Category A violation;
- (*b*) $300 to $10,000, for a Category B violation; and
- (*c*) $300 to $25,000, for a Category C violation.

Person other than an individual

(2) The amount payable as the penalty in respect of a violation that is committed by a person other than an individual is

- (*a*) $1,000 to $12,000, for a Category A violation;
- (*b*) $1,000 to $40,000, for a Category B violation; and
- (*c*) $1,000 to $100,000, for a Category C violation.

Determination of amount

5. The amount of a penalty is determined by the Commission having regard to

- (*a*) the compliance history of the person who committed the violation;
- (*b*) the degree of intention or negligence on the part of the person;
- (*c*) the harm that resulted or could have resulted from the violation;
- (*d*) whether the person derived any competitive or economic benefit from the violation;
- (*e*) whether the person made reasonable efforts to mitigate or reverse the violation's effects;
- (*f*) whether the person provided all reasonable assistance to the Commission; and
- (*g*) whether the person brought the violation to the attention of the Commission.

SCHEDULE
(sections 2 and 3)

VIOLATIONS

PART 1

NUCLEAR SAFETY AND CONTROL ACT

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
1.	26	Carrying on a prescribed activity without or contrary to a licence	B
2.	27(*a*)	Failure to properly keep, retain or disclose prescribed records	A
3.	27(*b*)	Failure to make prescribed reports and file them in the prescribed manner	A
4.	36	Failure to assist an inspector in carrying out their duties	B
5.	41	Failure to comply with an order within the time specified	B
6.	45	Failure to notify the Commission when a place or vehicle is contaminated or when an event has occurred that is likely to result in an exposure	B
7.	48(*a*)	Alteration or misuse of things, otherwise than pursuant to the regulations and licence	B
8.	48(*b*)	Disclosure of prescribed information, except pursuant to the regulations	A
9.	48(*c*)	Failure to comply with a condition of a licence	C
10.	48(*d*)	Making a false or misleading statement	B
11.	48(*e*)	Failure to comply with an order of the Commission, a designated officer or an inspector	C

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
12.	48(*f*)	Failure to assist or give information requested by an inspector, or interfering with the inspector's duties	C
13.	48(*g*)	Taking disciplinary action against a person who assists or gives information to the Commission, designated officer or inspector	B
14.	48(*h*)	Terminating or varying the terms of employment of a nuclear energy worker who has exceeded their radiation dose limit, except in the prescribed manner and circumstances	B
15.	48(*i*)	Falsifying a record	B
16.	48(*j*)	Failure to comply with an order of a court	C
17.	49(*a*)	Failure to ensure required staff is present to maintain a nuclear facility in a safe condition	B
18.	49(*b*)	Failure to report for duty or withdrawal of services other than in accordance with procedures	B
19.	50	Possession of nuclear substance, or prescribed information or equipment, capable of being used for nuclear weapons or explosive devices	C

PART 2

GENERAL NUCLEAR SAFETY AND CONTROL REGULATIONS

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
1.	12(1)(*a*)	Failure to ensure the presence of a sufficient number of qualified workers to carry out the licensed activity	B
2.	12(1)(*b*)	Failure to train workers to carry on the licensed activity, as required	B
3.	12(1)(*c*)	Failure to take all reasonable precautions to protect the environment and the health and safety of persons and to maintain security	B
4.	12(1)(*d*)	Failure to provide and maintain required devices	B
5.	12(1)(*e*)	Failure to require use of equipment, devices, clothing or procedures, as required	B
6.	12(1)(*f*)	Failure to take reasonable precautions to control release of radioactive nuclear substances or hazardous substances	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
7.	12(1)(*g*)	Failure to implement measures to be alerted to the illegal use or removal of a nuclear substance or prescribed information or equipment, or the illegal use of a nuclear facility	B
8.	12(1)(*h*)	Failure to implement measures to be alerted of sabotage or attempted sabotage	B
9.	12(1)(*i*)	Failure to take measures to facilitate Canada's compliance with any safeguards agreement	A
10.	12(1)(*j*)	Failure to instruct workers on physical security program and their obligations	B
11.	12(1)(*k*)	Failure to keep the *Nuclear Safety and Control Act* and regulations available to workers	A
12.	12(2)	Failure to file a report responding to a Commission request within the specified time and with the prescribed information	B
13.	13	Transfer of a nuclear substance, prescribed information or prescribed equipment to a person who does not hold the required licence	B
14.	14(1)(*a*)	Failure to post copy of licence	A
15.	14(1)(*b*)	Failure to post notice	A
16.	14(2)	Failure to have copy of licence in field	A
17.	15(*a*)	Failure of applicant or licensee to notify the Commission of the persons acting for them	A
18.	15(*b*)	Failure of applicant or licensee to notify the Commission of the persons responsible for the management and control of the activity, substance, facility, equipment or information encompassed by licence	A
19.	15(*c*)	Failure of applicant or licensee to notify the Commission on time about change in contact persons or responsible persons	A
20.	16	Failure to make health and safety information available to workers, as required	B
21.	17(*a*)	Failure of worker to properly use equipment, devices, facilities and clothing	B
22.	17(*b*)	Failure of worker to comply with licensee's measures to protect the environment and the health and safety of persons, maintain security, control radiation doses and	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
		levels and control releases of nuclear substances and hazardous substances	
23.	17(*c*)(i)	Failure of worker to promptly inform licensee or supervisor of increase in risk to the environment or health and safety of persons	B
24.	17(*c*)(ii)	Failure of worker to promptly inform licensee or supervisor of threat to maintenance of nuclear facility or substances or an incident with respect to security	B
25.	17(*c*)(iii)	Failure of worker to promptly inform licensee or supervisor of non-compliance with the *Nuclear Safety and Control Act*, its regulations or licence	B
26.	17(*c*)(iv)	Failure of worker to promptly inform licensee or supervisor of sabotage, theft, loss or illegal use or possession of nuclear substance or prescribed information or equipment	B
27.	17(*c*)(v)	Failure of worker to promptly inform licensee or supervisor of release of radioactive nuclear substances or hazardous substances	B
28.	17(*d*)	Failure of worker to obey notices and warning signs	B
29.	17(*e*)	Failure of worker to take all reasonable precautions to ensure safety	B
30.	18	Failure to present an import or export licence to customs officer	B
31.	23(1)	Transfer or disclosure of prescribed information without legal requirement or to an unauthorized person	B
32.	23(2)	Failure to take precautions to prevent unauthorized transfer or disclosure of prescribed information	B
33.	27	Failure to keep record of licence information submitted to the Commission	A
34.	28(1)	Failure to retain record for the period specified	A
35.	28(2)	Improper disposal of a record	A
36.	28(3)	Failure to file a requested record with the Commission prior to disposal of that record	A
37.	29(1)	Failure to immediately make a preliminary report to the Commission of a specified situation and of actions taken by the licensee	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
38.	29(2)	Failure to file full report on time and with the prescribed information	A
39.	30(1)(*a*)	Failure to immediately make a preliminary report to the Commission on interference with or interruption in operation of safeguards equipment or alteration of safeguards seal	B
40.	30(1)(*b*)	Failure to immediately make a preliminary report to the Commission on theft, loss or sabotage of safeguards equipment or samples	B
41.	30(2)	Failure to file full report within the specified period and with the prescribed information	A
42.	31	Failure to file a report with the Commission within the specified period of an inaccuracy or incompleteness in a record that the licensee is required to keep	A
43.	32(1)	Failure to include name and address of sender or date in report	A

PART 3

RADIATION PROTECTION REGULATIONS

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
1.	3	Failure to inform therapy patients of methods for reducing the exposure of others to radiation	B
2.	4(*a*)(i)	Failure to keep exposure to radiation to persons as low as reasonably achievable through the implementation of management control over work practices	B
3.	4(*a*)(ii)	Failure to keep exposure to radiation to persons as low as reasonably achievable through the implementation of personnel qualification and training	B
4.	4(*a*)(iii)	Failure to keep exposure to radiation to persons as low as reasonably achievable through the implementation of control of occupational and public exposure to radiation	B
5.	4(*a*)(iv)	Failure to keep exposure to radiation to persons as low as reasonably achievable through the implementation of planning for unusual situations	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
6.	4(*b*)	Failure to ascertain the quantity and concentration of nuclear substance released as a result of a licensed activity	B
7.	5	Failure to ascertain and record as required	B
8.	6(2)(*a*)	Failure to conduct an investigation after becoming aware that action level is reached	B
9.	6(2)(*b*)	Failure to identify and take action to restore the effectiveness of the radiation protection program after becoming aware that action level is reached	B
10.	6(2)(*c*)	Failure to notify the Commission within the specified period after becoming aware that action level is reached	B
11.	7(1)(*a*)	Failure to inform nuclear energy workers in writing that they are nuclear energy workers	A
12.	7(1)(*b*)	Failure to inform nuclear energy workers in writing of the risks associated with exposure to radiation	A
13.	7(1)(*c*)	Failure to inform nuclear energy workers in writing of the effective and equivalent dose limits	A
14.	7(1)(*d*)	Failure to inform nuclear energy workers in writing of their radiation dose levels	A
15.	7(2)	Failure to inform female nuclear energy workers in writing of the rights and obligations of pregnant nuclear energy workers	B
16.	7(3)	Failure to obtain written acknowledgement from nuclear energy workers that the specified information was received	A
17.	8	Failure to use licensed dosimetry service to measure doses of radiation received by nuclear energy workers	B
18.	9	Failure to inform person of purpose for collecting their personal information	A
19.	10	Failure of a nuclear energy worker to provide the specified information at request of the licensee	A
20.	11(1)	Failure of female nuclear energy worker to immediately notify the licensee in writing upon becoming aware of pregnancy	A
21.	11(2)	Failure to accommodate pregnant nuclear energy worker	B
22.	13	Failure to ensure that the effective dose limit is not exceeded	C

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
23.	14	Failure to ensure that the equivalent dose limit is not exceeded	C
24.	15	Failure to limit doses during an emergency and the consequent immediate and urgent remedial work	B
25.	16(*a*)	Failure to immediately notify person and the Commission after a dose limit is exceeded	B
26.	16(*b*)	Failure to require the person to leave any work that is likely to add to the dose after a dose limit is exceeded	B
27.	16(*c*)	Failure to conduct an investigation after a dose limit is exceeded	B
28.	16(*d*)	Failure to take action to prevent similar incidents after a dose limit is exceeded	B
29.	16(*e*)	Failure to report the results of the investigation on the exceeded dose limit to the Commission within the specified period	B
30.	19	Failure of licensee operating a dosimetry service to file information on nuclear energy workers with the National Dose Registry	A
31.	20(1)	Possession of container or device containing a radioactive nuclear substance without proper labelling	B
32.	21	Failure to post radiation warning signs	B
33.	22	Use of improper radiation warning symbol	A
34.	23	Frivolous posting of radiation warning signs	A
35.	24	Failure to keep record of the name and job category of each nuclear energy worker	B

PART 4

CLASS I NUCLEAR FACILITIES REGULATIONS

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
1.	14(1)	Failure to keep record of the results of effluent and environmental monitoring programs	A
2.	14(2)	Failure to keep operation record	A
3.	14(3)	Failure to keep decommissioning record	A
4.	14(4)	Failure to retain record for the specified period	A

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
5.	14(5)	Failure to retain record relating to a nuclear energy worker for the specified period	A

PART 5

CLASS II NUCLEAR FACILITIES AND PRESCRIBED EQUIPMENT REGULATIONS

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
1.	10(*a*)	Use of uncertified Class II prescribed equipment	B
2.	10(*b*)	Failure to use Class II prescribed equipment in accordance with a licence	B
3.	15(2)(*a*)	Failure to equip entrance door to Class II prescribed equipment room with device that stops the equipment when door is opened	B
4.	15(2)(*b*)	Failure to equip entrance door to Class II prescribed equipment room with device that prevents the equipment from being used	B
5.	15(2)(*c*)	Failure to design entrance door to Class II prescribed equipment room to prevent persons from being locked in	B
6.	15(3)(*a*)	Failure to equip entrance to Class II prescribed equipment room with device that stops the equipment when someone passes through the entrance	B
7.	15(3)(*b*)	Failure to equip entrance to Class II prescribed equipment room with device that prevents the equipment from being used	B
8.	15(4)	Failure to equip room where Class II prescribed equipment that is used on persons is located with a viewing system	B
9.	15(5)	Failure to equip entrance to Class II prescribed equipment room with an irradiation state display	B
10.	15(6)	Failure to equip room where Class II prescribed equipment is located with an area radiation monitoring system, as required	B
11.	15(7)	Failure to equip room where Class II prescribed equipment that is not used on persons is located with a pre-irradiation alarm	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
12.	15(8)	Failure to equip room where Class II prescribed equipment is located with emergency stop buttons or devices	B
13.	15(9)	Failure to provide emergency stop buttons or devices that are unobstructed and accessible	B
14.	15(10)	Failure to provide emergency stop buttons or devices in the specified places	B
15.	15(11)	Failure to post emergency contact information at every entrance to a Class II nuclear facility	A
16.	15(12)	Failure to equip Class II equipment with device to prevent unauthorized use	B
17.	15(13)	Failure to verify normal operation after servicing of device or system	B
18.	15.01	Failure to appoint a radiation safety officer	B
19.	15.02	Appointing an uncertified radiation safety officer	B
20.	15.06(2)	Failure to notify the Commission of name of radiation safety officer and Class II prescribed equipment subject to certificate	B
21.	15.1	Failure to designate in writing radiation safety officer as replacement	B
22.	15.11	Replacing a radiation safety officer for more than the specified period	B
23.	16(1)	Failure to ascertain that radiation field is safe upon entering a room	B
24.	16(2)	Failure to verify that radiation survey meter is working immediately before entering a room	B
25.	16.1(1)	Failure to ensure patients are surveyed and free of nuclear substances following treatment using brachytherapy remote afterloader	B
26.	16.1(2)(*a*)	Failure to equip brachytherapy remote afterloader treatment room with a remote alarm system to warn of treatment interruptions	B
27.	16.1(2)(*b*)	Failure to equip brachytherapy remote afterloader treatment room with a shielded storage container of sufficient size	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
28.	16.1(2)(*c*)	Failure to equip brachytherapy remote afterloader treatment room with the necessary remote handling tools	B
29.	17(1)	Failure to measure radiation dose rates after installing a sealed source in Class II prescribed equipment or to notify the Commission in writing if dose rate exceeds manufacturer's specifications	B
30.	17(2)	Failure to measure dose rates at all accessible locations outside the room after the installation of a sealed source in a radioactive source teletherapy machine	B
31.	18(1)(*a*)	Failure to make available to each worker a calibrated radiation survey meter	B
32.	18(1)(*b*)	Failure to make available to each worker a radiation survey meter that can measure radiation from sealed source and Class II prescribed equipment	B
33.	18(1)(*c*)	Failure to make available to each worker a radiation survey meter that indicates the power level of batteries	B
34.	18(2)	Use of a radiation survey meter that has not been calibrated within the specified period	B
35.	19(1)	Failure to conduct leak test on sealed source or shielding as required	B
36.	19(2)	Failure to take required action when a leak on a sealed source or shielding is detected	B
37.	20	Use of Class II prescribed equipment on a person without being directed by a qualified medical practitioner	B
38.	21(1)	Failure to keep record of measurements of radiation dose rates and retain record for the specified period	A
39.	21(2)(*a*)	Failure to keep record of daily outputs of radiation resulting from operation of Class II prescribed equipment	A
40.	21(2)(*b*)	Failure to keep record of training received by workers	A
41.	21(2)(*c*)	Failure to keep record of inspections, verifications, servicing, measurements or tests required	A
42.	21(3)	Failure to retain training record for the specified period	A
43.	21(4)	Failure to keep record of transfer of Class II prescribed equipment	A

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
44.	21(5)	Failure to keep record of leak tests conducted on sealed source or shielding and to retain it for the specified period	A
45.	21(6)	Failure to keep record of measurements of radiation dose rates, as required, and to retain them for the specified period	A
46.	21(7)	Failure to keep servicing record of Class II prescribed equipment	A
47.	21(8)	Failure to retain servicing record for the specified period	A

PART 6

URANIUM MINES AND MILLS REGULATIONS

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
1.	9	Failure to post code of practice where it is accessible to all workers in uranium mine or mill	A
2.	10(*a*)	Failure to establish, implement and maintain written operating procedures	B
3.	10(*b*)	Failure to train workers to perform their work in accordance with operating procedures	B
4.	10(*c*)	Failure to audit workers to verify compliance with operating procedures	B
5.	11(*a*)	Failure to ensure each main fan is equipped with a fan malfunction warning signal device	B
6.	11(*b*)	Failure to ensure person is designated to receive and respond to main fan failure warning signal	B
7.	11(*c*)	Failure to implement measures to prevent interference by persons or activities with proper operation of ventilation systems	B
8.	12(1)(*a*)	Failure to implement alternative measures to protect worker health and safety when ventilation system malfunctions	B
9.	12(1)(*b*)	Failure to ensure that only work necessary to restore ventilation system is performed in work place when ventilation system malfunctions	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
10.	12(2)	Failure to inform worker of protective measures in connection with restoration of ventilation system	B
11.	13	Improper reliance on respirator	B
12.	14(*a*)	Failure to post signs where gamma radiation dose rate exceeds the specified limit	A
13.	14(*b*)	Failure to provide direct-reading dosimeter to workers entering an area where gamma radiation dose rate exceeds the specified limit	B
14.	15(1)	Failure to provide radiation health and safety training certificate to worker	A
15.	15(2)	Failure to provide copy of radiation health and safety training program to worker's representative	A
16.	16(1)(*a*)	Failure to keep record of operating and maintenance procedures	B
17.	16(1)(*b*)	Failure to keep record of mine plans	B
18.	16(1)(*c*)	Failure to keep record of schedules for planned mining operations	A
19.	16(1)(*d*)	Failure to keep record of plans of waste management systems	A
20.	16(1)(*e*)	Failure to keep record of design of uranium mine or mill, or of design of components and systems installed at the mine or mill	A
21.	16(1)(*f*)	Failure to keep record of method and data used to ascertain radiation dose and intake of radioactive nuclear substances by workers	A
22.	16(1)(*g*)	Failure to keep record of measurements	A
23.	16(1)(*h*)	Failure to keep record of inspections and maintenance	A
24.	16(1)(*i*)	Failure to keep record of quantity of air delivered by each main fan	A
25.	16(1)(*j*)	Failure to keep record of performance of each dust control system	A
26.	16(1)(*k*)	Failure to keep record of training received by each worker	A
27.	16(2)	Failure to make required records available to worker or to worker's representative	A
28.	16(3)	Failure to retain training record for the specified period	A

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
29.	16(4)	Failure to post record of work place measurements at an accessible location in the uranium mine or mill	B

PART 7

NUCLEAR SUBSTANCES AND RADIATION DEVICES REGULATIONS

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
1.	11(1)(*a*)	Use of uncertified radiation device	B
2.	11(1)(*b*)	Use of radiation device contrary to development licence	A
3.	11(2)	Transfer of uncertified radiation device for use within Canada	B
4.	16	Use of radioactive nuclear substance or radiation device on a person otherwise than as directed by a qualified medical practitioner	B
5.	17	Failure to make instructions concerning radiation safety and accidents available to workers	B
6.	18(1) and 18(2)	Failure to conduct leak tests on sealed source or shielding	B
7.	18(3)(*a*)	Failure to discontinue use of sealed source or shielding when leakage detected	B
8.	18(3)(*b*)	Failure to discontinue use of radiation device when leakage detected	B
9.	18(3)(*c*)	Failure to take measures to limit the spread of radioactive contamination when leakage detected	B
10.	18(3)(*d*)	Failure to immediately notify the Commission that leakage was detected	B
11.	19(1)	Failure to provide required instructions for dealing with accidents upon transfer of a radiation device	A
12.	19(2)	Failure to provide most recent leak test record upon transfer of sealed source or shielding	A
13.	20	Use of a radiation survey meter that has not been calibrated within the specified period	B
14.	21	Use of a radiation device that was not tested or inspected after accident	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
15.	22	Use of radiation device in field operation that does not have attached label with contact information	A
16.	23(*a*)	Failure to post emergency contact information where the radioactive nuclear substance is used or stored	B
17.	23(*b*)	Failure to post warning sign and personnel entry procedures to be followed at every personnel access opening to any equipment fitted with a radiation device	B
18.	24	Operation of an exposure device by an uncertified operator or by an unsupervised trainee	B
19.	29	Failure of exposure device operator to immediately surrender certificate to the Commission upon decertification	A
20.	30(1)(*a*)	Failure of licensee to ensure exposure device is equipped with source tag	A
21.	30(1)(*b*)	Failure of licensee to lock exposure device when not in use	B
22.	30(1)(*c*)	Failure of licensee to return dosimeter within the specified period	B
23.	30(2)	Failure of licensee to immediately notify the Commission about loss, theft, damage or malfunction of exposure device	A
24.	30(3)(*a*)	Failure of licensee to provide the specified radiation survey meter	B
25.	30(3)(*b*)	Failure of licensee to provide the specified emergency equipment and material when a guide tube is used	B
26.	30(3)(*c*) to (*e*)	Failure of licensee to provide dosimeter that meets the specified requirements	B
27.	30(3)(*f*)	Failure of licensee to provide sufficient number of radiation warning signs for posting	B
28.	30(3)(*g*)	Failure of licensee to provide sufficient number of forms to keep records	A
29.	30(4)	Authorizing operation of exposure device that does not appear to be functioning normally or of exposure device with radiation dose rate on its surface greater than the specified limit	B
30.	30(5)	Failure of licensee to provide written authorization for sealed source change	A

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
31.	30(6)	Failure of licensee to limit dose of radiation to persons other than nuclear energy workers	C
32.	30(7)	Authorizing a person to respond to exposure device or sealed source assembly malfunctions without proper training	B
33.	31(1)(*a*)	Failure of exposure device operator to use the specified radiation survey meter	B
34.	31(1)(*b*)	Failure of exposure device operator to have the specified emergency equipment and material immediately available when using a guide tube	B
35.	31(1)(*c*), (*d*) and (*f*)	Failure of exposure device operator to properly wear the required dosimeter	B
36.	31(1)(*e*)	Failure of exposure device operator to keep daily radiation dose records	A
37.	31(1)(*g*)	Failure of exposure device operator to ensure exposure device functions within manufacturer's specifications	B
38.	31(1)(*h*)	Failure of exposure device operator to use radiation survey meter to confirm sealed source assembly returned to shielded position	B
39.	31(1)(*i*)	Failure of exposure device operator to limit radiation dose to persons other than nuclear energy workers	C
40.	31(1)(*j*)	Failure of exposure device operator to place persons or erect barriers to prevent entry into radiation area	B
41.	31(1)(*k*)	Failure of exposure device operator to post radiation warning signs to prevent entry into radiation area	B
42.	31(1)(*l*)	Failure of exposure device operator to lock exposure device when not in use	B
43.	31(1)(*m*)	Failure of exposure device operator to immediately report to licensee a specified situation and actions taken	B
44.	31(2)	Failure of exposure device operator to return dosimeter to licensee at the specified time	A
45.	31(3)	Failure of exposure device operator to submit dose record to licensee at the specified time	A
46.	31(4)	Operating malfunctioning exposure device or exposure device with radiation dose rate on its surface greater than the specified limit	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
47.	31(5)	• (*a*) Failure of exposure device operator to ensure that dose limit of radiation is not exceeded during shift • (*b*) Failure of exposure device operator to stop work and notify licensee when dose limit is exceeded during shift	B B
48.	31(6)	Responding to exposure device or sealed source assembly malfunctions without proper training	B
49.	32	Improper appointment of exposure device operator to supervise trainees	A
50.	33(1)	Authorizing a trainee lacking sufficient knowledge to operate an exposure device	B
51.	33(2)	Failure of exposure device operator to directly supervise and continuously observe trainee operating an exposure device	B
52.	34(1)	Removal or insertion of sealed source without written authorization of the licensee	A
53.	34(2) and 34(3)	Failure to measure, record and report to the licensee radiation dose rates and doses of radiation when removing or inserting sealed sources	A
54.	35(1)	Failure to notify the Commission before conducting tracer or subsurface tracer studies	A
55.	35(2)	Failure to file a tracer study report with the specified information within the specified time	A
56.	36(1)(*a*)	Failure to keep record of specified information in respect of any nuclear substance in licensee’s possession	A
57.	36(1)(*b*)	Failure to keep record of name of workers who use or handle nuclear substances	A
58.	36(1)(*c*)	Failure to keep record of any transfer, receipt, disposal or abandonment of a nuclear substance	A
59.	36(1)(*d*)	Failure to keep record of training received by each worker	A
60.	36(1)(*e*)	Failure to keep record of every inspection, measurement, test or servicing of radiation device	A
61.	36(1.1)	Failure to keep record of servicing another licensee’s radiation device	A

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
62.	36(2)	Failure to retain worker training record for the specified period	A
63.	36(3)	Failure to retain record of every inspection, measurement, test or servicing of radiation device for the specified period	A
64.	36(4)	Failure to keep record of leak tests conducted on a sealed source or shielding and retain it for the specified period	A
65.	37	Failure to keep record of specified information in respect of exposure devices in licensee's possession	A
66.	38(1)	Failure to immediately notify the Commission regarding a loss or theft, as required	B
67.	38(2)	Failure to file full report regarding a loss or theft within the specified time and including the specified information	A

PART 8

PACKAGING AND TRANSPORT OF NUCLEAR SUBSTANCES REGULATIONS

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
1.	11(1)	Production of certified design package contrary to specifications	B
2.	11(2)	Failure to mark package with specified information	A
3.	12(1)	Production of special form radioactive material that is not of certified design or in accordance with specifications	B
4.	12(2)	Failure to identify special form radioactive material by marking it in a legible and durable manner	A
5.	12(3)	Possession of special form radioactive material that is not of certified design or has not been approved by a foreign competent authority as required	A
6.	12(4)	Failure of person who produces or possesses special form radioactive material to act in accordance with paragraph 818 of the *IAEA Regulations*	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
7.	12(5)	Production of low dispersible radioactive material that is not of certified design or in accordance with certificate specifications	B
8.	12(6)	Failure to identify low dispersible radioactive material by marking it in a legible and durable manner	A
9.	12(7)	Possession of low dispersible radioactive material that is not of certified design	A
10.	13(*a*)	Failure to implement and maintain a written quality assurance program in accordance with paragraph 310 of the *IAEA Regulations*	B
11.	13(*b*) and (*c*)	Failure to keep record of quality assurance program and retain it for the specified period	A
12.	14(1)	Use of package of certified design without confirmation that the use of package is registered by the Commission	A
13.	15(1)	Failure to act in accordance with *Transportation of Dangerous Goods Regulations*	C
14.	15(2)	Failure of consignor to act in accordance with paragraphs 550 to 561 of the *IAEA Regulations*	B
15.	15(3)	Failure of consignor of excepted package to act in accordance with paragraph 554 of the *IAEA Regulations*	B
16.	15(4)	Failure of consignor of radioactive material to advise consignee of transport of material	A
17.	15(5)	Failure of carrier to act in accordance with paragraphs 562 to 569 and 571 to 580 of the *IAEA Regulations*	B
18.	15(6)	Failure of carrier to transport radioactive material in accordance with consignor’s instructions	B
19.	15(7)	Failure of carrier to implement, maintain or keep record of work procedures	A
20.	16(1)(*a*)	Presentation for transport or transport of radioactive material in package that does not meet the specified requirements	B
21.	16(4)	Failure of consignor or carrier to act in accordance with paragraphs 501 to 547 of the *IAEA Regulations*	B
22.	16(5)(*a*)	Failure of consignor or carrier to comply with exemption requirements for transport of an exposure device	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
23.	16(5)(*c*)	Failure of consignor or carrier to comply with exemption requirements for transport of LSA-I material other than uranium hexafluoride	B
24.	17(1)	Failure of consignor to include in transport documents the information referred to in paragraph 549 of the *IAEA Regulations*	A
25.	17(3)	Transportation of consignment of radioactive material without the required transport documents	B
26.	18(1)(*a*)	Failure to keep exposure and effective and equivalent doses as low as reasonably achievable through the implementation of a radiation protection program	B
27.	18(1)(*b*)	Failure to prevent persons from receiving radiation doses higher than prescribed dose limits through the implementation of a radiation protection program	B
28.	18(1)(*c*)	Failure to train specified persons on the application of a radiation protection program	B
29.	18(2)	Failure to keep radiation protection program records or retain the records for the specified period	A
30.	19(1) to (3)	Failure to immediately make preliminary report with the specified information to the Commission and licence holder following a dangerous occurrence	B
31.	19(4)	Failure to take immediate required action after a dangerous occurrence	B
32.	19(5)	Failure to file full report with the Commission of the dangerous occurrence within specified period and with the required information	B
33.	21(1)	Opening a package without taking measures to prevent persons from receiving radiation doses higher than dose limits or without the presence of an expert in radiation protection	B
34.	21(2)	Failure to restore the package to a condition that meets requirements before forwarding it to consignee	B
35.	21(3)	Failure to verify package integrity on receipt	B
36.	21(4)	Failure to file report within the specified period if package is damaged or if any fissile material is outside the confinement system	A

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
37.	21(5)	Failure to immediately make preliminary report to the Commission if package shows evidence of having been tampered with or if any portion of its contents has escaped	A
38.	21(6)	Failure to include specified information in preliminary report of tampered package	A
39.	21(7)	Failure to file a report with the Commission within specified period regarding package that shows evidence of having been tampered with	A
40.	22(*a*)	Failure to notify consignor, consignee and the Commission of undeliverable package	B
41.	22(*b*)	Failure to place the undeliverable package in access-controlled area until its delivery	B
42.	23(1)	Failure to keep records with the specified information and documents concerning packages of Type IP-2, Type IP-3 and Type A	A
43.	23(2)	Failure to retain records concerning packages of Type IP-2, Type IP-3 and Type A for the specified period	A

PART 9

NUCLEAR SECURITY REGULATIONS

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
1.	7(1)	Failure to process, use or store Category I nuclear material in an inner area	B
2.	7(2)	Failure to process, use or store Category II nuclear material in a protected area	B
3.	7(3)(*a*)	Failure to process, use or store Category III nuclear material in a protected area	B
4.	7(3)(*b*)	Failure to process, use or store Category III nuclear material in an area under direct visual surveillance	B
5.	7(3)(*c*)	Failure to process, use or store Category III nuclear material in an area controlled by the licensee and designed and constructed to prevent unauthorized access	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
6.	7.1(1)(*a*) to (*d*)	Failure to equip controlled access area for Category III nuclear material with specified devices	B
7.	7.2(1)	Failure to make written arrangements with off-site response force capable of making effective intervention at area where Category III nuclear material is processed, used or stored	B
8.	7.2(2)(*a*) and (*b*)	Failure to include the specified provisions in arrangements with off-site response force	B
9.	7.2(3)	Failure of alarm monitoring service under contract to notify the licensee and off-site response force on receipt of an alarm signal	B
10.	7.5(1)	Failure to conduct threat and risk assessment at the specified interval	B
11.	7.5(2)	Failure to modify physical protection system to counter identified credible threat	B
12.	7.5(3)	Failure to keep written record of each threat and risk assessment conducted	A
13.	7.5(4)	Failure to provide the Commission with record of threat and risk assessment and statement of actions within prescribed period	A
14.	9(1)	Failure to enclose protected area by a barrier at its perimeter	B
15.	9(2) and (3)	Failure to construct protected area barrier that meets requirements	B
16.	9(6)	Failure to construct means of entry or exit that can be closed and locked	B
17.	9(7)	Failure to keep means of entry or exit closed and locked unless under direct visual surveillance of nuclear security officer	B
18.	9.1(1)	Failure to confine entry and exit of land vehicles to vehicle portals	B
19.	9.1(2)	Failure to ensure that gates of vehicle portal are not both open at the same time	B
20.	9.1(3)	Permitting a land vehicle to enter protected area without operational requirement	B
21.	9.1(4)	Failure to implement physical protection measures to reduce risk of forced land vehicle penetration	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
22.	10(1), 10(2)(*a*) and (*b*)	Failure to maintain specified unobstructed area around protected area	B
23.	11(*a*)(i) to (iv) and 11(*b*)	Failure to equip protected area with required devices or keep protected area under the direct visual surveillance of a nuclear security officer with a device that sets off a continuous alarm signal	B
24.	13(1) and (2)	Failure to enclose inner area with a structure or barrier that meets requirements	B
25.	13(3)	Failure to keep means of entry or exit closed and locked with device that can only be unlocked by two authorized persons	B
26.	13(4)	Entering and remaining in an inner area without another authorized person	B
27.	13(5)	Permitting a land vehicle to enter an inner area without operational requirements	B
28.	14(*a*)(i) to (iv) and 14(*b*)	Failure to equip inner area with required devices or keep inner area under the direct visual surveillance of a nuclear security officer with a device that sets off a continuous alarm signal	B
29.	14.1	Failure to identify vital areas and implement physical protection measures	B
30.	15(1)(*a*) to (*c*)	Failure to monitor the protected area devices, inner area devices and physical protection measures from a security monitoring room	B
31.	15(2)	Failure to meet security monitoring room requirements	B
32.	15(3)	Failure to monitor the alarm devices as required	B
33.	15.1(*a*) and (*b*)	Failure to provide uninterrupted power supply for required devices and equipment	B
34.	15.2(1) and (2)	Failure to maintain records of access control devices with the specified information	A
35.	15.2(3)	Failure to restore integrity of defective, lost, stolen or unlawfully transferred access control device	B
36.	15.2(4)	Issuing an access control device or combination to unauthorized person	B
37.	16	Failure to maintain site plan	B
38.	17(1)	Entering protected area without authorization	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
39.	17(2)	Failure to prepare identification report as required	A
40.	17(3)	Issuing an authorization to enter protected area without proof of name and address and without condition that person be escorted	B
41.	17(4)	Permitting unescorted person to enter or remain in protected area	B
42.	17(6)	Failure to give person copy of requested information or documents	A
43.	17.1	Failure to verify person’s identity by two separate personnel identity verification systems when person enters protected area	B
44.	18(1)	Entering inner area without recorded authorization	B
45.	18(2)	Acting as a nuclear security officer without recorded authorization	A
46.	18(3)	Acting as a physical protection system support person without recorded authorization	A
47.	18.1	Failure to conduct required checks before granting authorization to enter protected area or act as physical protection system support person	A
48.	18.2	Failure to conduct required checks, obtain proof of status in Canada or obtain required certificates prior to issuing an authorization to a nuclear security officer	A
49.	18.5	Failure to give person copy of requested information or documents	A
50.	19(1)	Failure to establish or maintain a list of persons authorized to enter an inner area or to act as a nuclear security officer or physical protection system support person	A
51.	19(2)	Failure to provide list of persons authorized to enter inner area, or to act as a nuclear security officer or physical protection system support person, to the Commission or the inspector requesting it	A
52.	20(1)	Entering inner area without required authorization	B
53.	20(2)	Acting as physical protection system support person without required authorization	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
54.	20.1	Failure to obtain required information prior to issuing an authorization to enter inner area or act as physical protection system support person	A
55.	20.2(1) and (2)	Failure to include condition that the person must be escorted for authorization to enter inner area, or to act as physical protection system support person	B
56.	20.2(3)	Permitting person with authorization to enter or remain in inner area or to act as a physical protection system support person without being escorted	B
57.	21(2)	Failure to notify the Commission in writing of revocation of authorization	A
58.	23(1)	Permitting means of entry or exit into inner area to be unlocked, opened or kept open longer than required and without direct visual surveillance of a nuclear security officer	B
59.	23(2)	Permitting the means of entry or exit in structure or barrier to inner area to be unlocked by unauthorized persons	B
60.	24(1)	Permitting an unauthorized person to enter or remain in protected area or inner area	B
61.	24(2)	Failure to immediately report unauthorized person in protected area or inner area to nuclear security officer	B
62.	25	Failure to ensure that weapons and explosives only enter protected or inner area under the control of an authorized person	B
63.	26	Failure to ensure Category I, II and III nuclear material is only removed from a protected area or inner area in accordance with a licence	B
64.	27(1)	Failure to post required advisory notices at entrance of protected and inner areas	A
65.	27(2)	Failure to search a person and their possessions on entering and leaving protected area or inner area	B
66.	27(4)	Permitting a person to remain in protected area or inner area without the person and their possessions being searched	B
67.	27(5)	Failure to conduct search in accordance with the requirements	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
68.	28(1)	Entering or leaving a protected area or inner area after refusing to submit to a search	C
69.	28(2)(*a*)	Taking weapons or explosive substances, unless under the control of an authorized person, into protected area or inner area	C
70.	28(2)(*b*)	Unauthorized removal of Category I, II and III nuclear material from protected or inner area	C
71.	30	Failure to provide sufficient number of nuclear security officers required to carry on the specified activities	B
72.	31	Failure to provide nuclear security officer with required equipment to perform the specified duties	B
73.	32	Failure to maintain on-site nuclear response force capable of making effective intervention	B
74.	34(1)	Failure to train nuclear security officers regarding their security duties and responsibilities	B
75.	34(2)	Failure to examine nuclear security officer candidate’s familiarity with security duties and responsibilities within the specified period	B
76.	35(1)	Failure to make written arrangements with off-site response force to provide for protection of facility	B
77.	35(2)	Failure to include specified provisions in arrangements with off-site response force	B
78.	36(1)	Failure to develop and maintain contingency plan with off-site response force to ensure effective intervention	B
79.	36(2)	Failure to conduct security exercise at the specified interval	B
80.	36(3)	Failure to notify the Commission about security exercise within the specified period	A
81.	36(4)	Failure to conduct security drill at the specified interval	B
82.	37(1)(*a*)	Failure to keep record of persons authorized to enter protected or inner area	A
83.	37(1)(*b*)	Failure to retain record of persons authorized to enter protected or inner area for the specified period	A
84.	37(1)(*c*)	Failure to make copy of record of persons authorized to enter protected or inner area available to nuclear security officers	A

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
85.	37(2)	Failure to keep record of duties and responsibilities of nuclear security officers and to give a copy of record to nuclear security officer	A
86.	37(3)	Failure to keep record of training received by each nuclear security officer	A
87.	38	Failure to develop and implement supervisory awareness program	B
88.	42(1)	Permitting a person without a facility-access security clearance to enter or remain in a nuclear facility	B
89.	42(1)	Permitting an unescorted or unauthorized person to enter or remain in a nuclear facility	B
90.	42(2)	Failure to verify criminal record, personal history or information relating to trustworthiness before granting facility-access security clearance	B
91.	43(1)	Failure to establish and maintain list of persons granted facility-access security clearance	A
92.	43(2)	Failure to provide list of persons granted facility-access security clearance to the Commission or the inspector requesting it	A
93.	44(2)	Failure to notify the Commission in writing about revocation of facility-access security clearance	A
94.	45(*a*)	Permitting a land vehicle to enter a nuclear facility without operational requirement and without searching it for explosive substances, weapons or unauthorized persons	B
95.	45(*b*)	Permitting entry of an unauthorized land vehicle at a nuclear facility	B
96.	46(1)	Processing, using or storing nuclear substances or radioactive material in an area that is not under the visual surveillance of the licensee or an area that is not designed and constructed to prevent unauthorized access	B
97.	46(2)	Failure to equip area with specified devices where nuclear substances or radioactive material is processed, used or stored	B
98.	47(1)	Failure to make written arrangements with an off-site response force capable of making an effective intervention at nuclear facility	B

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
99.	47(2)	Failure to include specified provisions in arrangements with off-site response force	B
100.	47(3)	Failure of alarm monitoring service under contract to notify the licensee and off-site response force on receipt of an alarm signal	B
101.	48	Failure to develop and implement supervisory awareness program	B

PART 10

NUCLEAR NON-PROLIFERATION IMPORT AND EXPORT CONTROL REGULATIONS

Item	Column 1 Provision	Column 2 Short-form Description	Column 3 Category
1.	4(3)	Failure to submit a written report to the Commission concerning the export of a controlled nuclear substance within the specified period and with the specified information	B

(...)

4.A. Designation of provisions subject to administrative monetary penalties

The AMP Regulations establish a schedule (the Schedule) that clearly sets out which provisions of the NSCA and its regulations will be designated as violations for the purposes of the AMP system. Column 1 of the Schedule identifies the section, subsection or paragraph of the NSCA or the regulations for which an AMP may be issued. Column 2 contains a short-form description of the violation. Column 3 contains a classification of the violation (A, B or C) that establishes the penalty range for the violation.

It should be noted that, although any designated violation is subject to an AMP, other enforcement tools may be preferred for assuring compliance. Once established, the CNSC will integrate the AMPs into the CNSC's graduated enforcement policy as an additional enforcement tool. Guidance to CNSC staff on when to use each enforcement tool will be established in amendments to the CNSC's graduated enforcement policy. Information on the implementation of the AMP system, including guidelines on enforcement to ensure consistent application of the AMP tool under a range of circumstances, is available on the CNSC's Web site and upon request.

4.B. Determination of the penalty amount

4.B.1 Penalty ranges

The NSCA prescribes that the maximum penalty shall not be more than $25,000 for an individual and $100,000 for any other person (corporation).

The AMP Regulations classify violations into three general categories, designated as A, B and C in these Regulations. The purpose of the categories is to associate the penalty value of a violation with its level of regulatory significance, while considering the health and safety of Canadians and their environment. Each category will have a baseline penalty (minimum penalty) that will be evaluated based on aggravating and/or mitigating factors.

Category A Individual $300–$3,000	**Category A** Corporation $1,000–$12,000
Category B Individual $300–$10,000	**Category B** Corporation $1,000–$40,000
Category C Individual $300–$25,000	**Category C** Corporation $1,000–$100,000

4.B.2 Criteria for establishing penalties

For each case, determining the penalty amount will begin with identifying the violation and its associated category. Once the category and its related monetary penalty range are identified, the penalty amount will be determined, using a graded approach — that is, increasing or decreasing the penalty amount by taking into account the factors listed in section 5 of the Regulations. During the 30-day period covering the prepublication of the Regulations in the *Canada Gazette*, Part I, industry stakeholders noted that mitigating factors, including a consideration for self-reporting to mitigate a penalty amount, should be taken into account when determining a penalty amount. As a result, self-reporting has been added as a determining factor in section 5 of the Regulations. The criteria to be considered in section 5 of the Regulations are now

- the compliance history of the person who committed the violation;
- the degree of intention or negligence on the part of the person;
- the harm that resulted or could have resulted from the violation;
- whether the person derived any competitive or economic benefit from the violation;
- whether the person made reasonable efforts to mitigate or reverse the violation’s effects;
- whether the person provided all reasonable assistance to the Commission; and
- whether the person brought the violation to the attention of the Commission.

If there are no determining factors, then the baseline penalty amount (minimum penalty) will be applied and a notice of violation issued.

Radiation Standard Operating Procedures

McGill University
Environmental Health & Safety
Standard Operating Procedure (SOP)

Title: How to Write Standard Operation Procedure (SOP)

SOP #: RADS.000
Date: YYYY/MM/DD
Page 1 of X

PREPARED BY: ______________________________ Date: yyyy/mm/dd
____

APPROVED BY: ______________________________ Date issued: yyyy/mm/dd
____

Purpose:
This procedure provides a guideline on how to write a Standard Operation Procedure (SOP), including how to format the document, area covered, exclusions.

- A SOP should restate and expand a written title;
- Provide detailed instructions on how to carry out a task so that any employee can carry out a task correctly every time;
- A SOP will facilitate training;
- Having complete instructions help trainers;
- Provide a reference resource for trainees.

Responsibility for implementing SOP:

- Specify who will implement the procedure.

Procedure/ Summary of Method:

-List sequentially exactly what must to be done;
- Note exceptions

Definitions:

- List acronyms and definitions

References/Documentation:

- List documents to be used with the procedure

Guidance for preparing Standard Operation Procedures (SOPs); EPA QA/G-6, April 2006
How and When to write Policies and Procedures; Maree Dyson, 1999

Revision Records:

Revision #	Date:	Responsible Person	Description of Change/Amendment:
1.	yyyy/mm/dd	RSO	Initial release
2.			

Numbering SOPs:

- The first part of the SOP should refers the category:
  - Radiation Safety (RADS)
  - Biological Safety (BIOS)
  - General Health and Safety (GEHS)
  - …
- The second part are numbered sequentially based on assignments to a specific category, such as:

000-099	General Information;
100-199	routine procedures
200-299	specialized procedures
300-399	instrument and Equipment Calibration, Maintenance and Testing;
400-499	miscellaneous

McGill University
Environmental Health & Safety
Radiation Standard Operating Procedure (RSOP)

Title: Decommissioning Lab rooms or equipment

SOP #: RADS.001
Date: 2017/06/02

PREPARED BY: __Mario Badillo______________________ Date: 2017/06/02
RSO McGill

APPROVED BY: ___________________________________ Date issued: 2017/06/02
____

Purpose:

The purpose of this document is to provide guidance with respect to the McGill University Radiation Safety program for decommission laboratories or equipment where authorized users handling open radioactive sources. This document help to certify that a lab or any piece of equipment is free of radioactivity or radioactive surface contamination. This document includes elements for identify instruments, screening method, checking for contamination, interpretation of results, and keeping records.

Responsibility:

All Permits Holders and authorized radioisotope users who vacant a laboratory or discontinue work with radioactive in accordance with the requirements of the CNSC.
The Permit Holder is responsible to perform the decommissioning, if this is not possible, it will done by the RSO and the department will be charged for the service.

Participants:

Only trained and authorized workers should perform the laboratory or equipment decommission.

Procedure/ Summary of Method:

1. Inform the RSO the interest to decommission the laboratory or equipment;
2. Develop a contamination survey map;
3. Choose appropriate method for assessing contamination based on radioisotope of interest;
4. Cease work involving radioisotopes;

5. Wear a lab coat and disposable gloves while handling the radioactive sources or potentially contaminated equipment;
6. Remove/transfer and/or disposal all nuclear substances in accordance with the McGill's RSM;
7. When possible, using appropriate contamination meter for survey for contamination;
8. Monitoring for contamination using the wipe test technique;
9. Decontaminate, if survey result exceed non-fixed contamination criteria specified on the McGill's RSM;
10. Survey for contamination after decontamination has been completed;
11. The release of any equipment, area, room or enclosure containing fixed contamination must be approved in writing by the CNSC or person authorized by the CNSC;
12. Remove or deface all radiation warning signs;
13. Submit decommissioning report to the RSO for review including the following information:
    a. Internal permit number;
    b. Date of decommissioning;
    c. Radioisotope used in the decommissioned area or equipment;
    d. Confirmation of transfer of radioisotope, specifically the name of the permit holder and the number of the internal permit were the radioisotope were transferred;
    e. Diagram of the decommissioned area;
    f. Survey results and instrument used;
    g. Survey results expressed in Bq/cm^2;
14. Prior to produce a Decommissioning Report the RSO should confirm that radiation warning signs have been removed or defaced;
15. The internal permit will be amended or cancelled;
16. If necessary, RSO will request an amendment to the CNSC's McGill University's Licence;
17. Maintain decommissioning records for a period ending one year after the expiry of the licence.

Equipment/Instrumentation:

A Survey meter and/or contamination meter calibrated within 12 months, as indicated in the label certificate stick on the equipment;

Definitions:

CNSC	Canadian Nuclear Safety Commission
Bq	Becquerel (disintegrations per second, dps)
	MBq = Mega Becquerel (1 000 000 Bq)
	kBq = kilo Becquerel (1 000 Bq)
dps	disintegrations per second
mR/h	milli Roentgen per hour
mSv/h	millie Sievert per hour

RSM	Radiation Safety Policy Manual
RSO	Radiation Safety Officer

References/Documentation:

Regulatory Guide G-219, Decommissioning Planning for Licensed Activities [http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/G219_e.pdf]

McGill University, Environmental Health & Safety Radiation Safety Policy Manual; Ed. 6.

Revision Records:

Revision #	Date:	Responsible Person	Description of Change/Amendment:
1.	2017/06/02	RSO	Initial release
2.			

McGill University
Environmental Health & Safety
Radiation Standard Operating Procedure (RSOP)

Title: Contamination Control Procedures

PREPARED BY: Mario Badillo ______________________ Date: 2017/06/02
RSO McGill

APPROVED BY: ___________________________________ Date issued: 2017/06/02

____

Purpose:

The purpose of this document is to provide guidance with respect to the McGill University Radiation Safety program for authorized users performing contamination controls. This document includes elements for instruments, screening method, checking for contamination, interpretation of results, and keeping records.

Responsibility:

All Permits Holders and authorized radioisotope users who work with open sources and performing contamination control of suspected contaminated surfaces.
The Permit Holder is responsible to train anyone who handle open sources

Participants:

Only trained and authorized workers should work with open sources and radiation devices.

Procedure/ Summary of Method:

Direct Measurement (portable survey/contamination meter)
Direct measurement is often the most convenient method for monitoring larges surfaces and used for detecting of both, fixed and non- fixed contamination, except for H-3 and Ni-63. Non-fixed contamination is the surface contamination that can easily be removed with simple decontamination methods, thus transferable to other surfaces. This can result in the spread of contamination. On the other hand, fixed surface contamination is contamination quite firmly attached to the surface and cannot remove by normal housekeeping methods and may pose an external radiation hazard. Direct method measure the radiation levels directly at the site of contamination:

1. To monitor the working area (surface, equipment, etc.) slowly pass the detector over;
2. The distance between the detector and surface should be as small as possible without letting them touch, which could contaminate the detector;
3. Keep the detector face towards the surface being monitored;

4. If contamination is detected, stop and obtain a measurement and record it;
5. Mark the contaminated area on a floor plan.
6. Apply the decontamination methods (see section 7.5 of the RSM) until reading is less 0.5 μSv/h, measured at a distance of less than 0.5 m from the surface
7. Record the final reading after decontamination
8. If decontamination methods are unsuccessful, segregate the area, equipment/part and it market with a radiation warning sign.
9. Contact the RSO for further instructions.
10. If the equipment/part is to be disposed and the level of contamination cannot be reduce below the CNSC criteria, the equipment/part will be disposed as radioactive waste, otherwise the equipment/part will be disposed as regular waste.

Indirect Measurement (Wipe Test Technique)

The most effective method for measuring radioactive surface contamination is the wipe test technique. This procedure will indicate only the levels of removable contamination. No removable contamination is tolerated. Begin the wipe test with a sketch of the area or laboratory that includes marked and numbered locations for examination. Usually, 10 to 20 locations are adequate for most laboratories. The wipe test method includes the following steps:

1. Moisten a filter paper (2 cm) with alcohol or water (or dry wipes can be used), and wipe over an area approximately 100 cm^2 (10 cm x 10cm).
2. Place the filter paper in a vial and count in a gamma well counter (for gamma and/or X-ray contamination) or in a vial containing scintillation fluid, shake and count in a liquid scintillation counter for alpha and/or beta contamination. For a single radioisotope used in the laboratory, then appropriate window settings and a quench curve (only for liquid scintillation counting) are recommended. However, if several radioisotopes are being handled or contamination is unknown, then operate at full spectrum with no quench correction. It is suggested that before counting, the vials be set aside for liquid scintillation counting for 24 hours to reduce chemiluminescence.
3. Contamination is present if wipes exceed 0.5 Becquerel per centimetre squared (Bq/cm^2). The contaminated area must be cleaned with water and detergent or with a commercial decontamination solution such as Decon75, Count-Off, Rad-Con or Contrad 70. Begin with the perimeter of the spill area and work towards the centre, being careful not to spread the contamination during cleaning. Repeat the wipe testing until the measurements are at or below 0.5 Bq/cm^2.

The formula used to calculate "Bq/cm^2" is:

Bq/cm^2 = CPM net / [C.E. x 60 x 100 x W_{eff}]

where

Bq/cm^2	=	Becquerel per centimetre squared
CPM net	=	CPM gross (CPM) – Normal Background count (CPM)
C.E	=	Counting Efficiency (use the counter C.E. for that radioisotope, or for simplicity use a C.E. of 50% for all radioisotopes)
60	=	is for 60 seconds and related to counts per second (cps)
100	=	for a maximum surface area of 100 cm^2 (10 cm x 10 cm)
Weff	=	Wipe Efficiency (use 10% or 0.1 for wet wipes, and 1% or 0.01 for dry wipes)

Equipment/Instrumentation:

A Survey meter calibrated within 12 months, as indicated in the label certificate stick on the equipment
A Liquid Scintillation Counter

Definitions:

CNSC	Canadian Nuclear Safety Commission
RSM	McGill Radiation Safety Manual
Bq	Becquerel (disintegrations per second, dps)
	MBq = Mega Becquerel (1 000 000 Bq)
	kBq = kilo Becquerel (1 000 Bq)
dps	disintegrations per second
RSO	Radiation Safety Officer

References/Documentation:

McGill University Radiation Safety Manual, Ed. 6

Revision Records:

Revision #	Date:	Responsible Person	Description of Change/Amendment:
1.	2017/06/02	RSO	Initial release
2.			

McGill University
Environmental Health & Safety
Radiation Standard Operating Procedure (RSOP)

Title: Leak Test Procedures

PREPARED BY: Mario Badillo
RSO McGill
Date: 2017/06/02

APPROVED BY: ____________________________________
Date issued: 2017/06/02

____

Purpose:

In accordance with CNSC regulations, leak test shall be performed on all sealed nuclear sources containing 50 MBq or greater of radioactive material to assess the integrity of the material containing the source.
Sealed sources are nuclear substances that are encapsulated or encased and the nuclear substance cannot escape and result in contamination, therefore present only an external radiation hazard. Unfortunately, due to age, use or damage the integrity of the housing material can be compromised resulting in a potential serious situation.

Responsibility:

The RSO ensures leak testing of sealed radioactive sources. If a source is leaking, it must be contained.

Participants:

McGill's RSO.

Procedure/ Summary of Method:

The frequency for leak test is specified in the Appendix AA of the REGDOC-1.6.1 Licence Application Guide: *Nuclear Substances and Radiation Devices* follows:

- Where the sealed source or shielding is used after being stored for 12 or more consecutive months, immediately before using it;
- Where the sealed source or shielding is being stored , every 24 months;
- Where an event that may have damaged the sealed source or the shielding has occurred, immediately after the event;
- Every 12 months for sealed sources incorporated into a radiation device; and
- Every 6 months for sealed sources in use and not incorporated into a radiation device.

Should the leak test detect a leaking of 200 Bq or greater, the following action must be taken:

a) Discontinue using the sealed source;
b) Discontinue using the radiation device in which the sealed source is located or may have been located;
c) Take measures to limit the spread of radioactive contamination from the sealed source;
d) Immediately after complying with the above actions, notify the CNSC that the leakage has been detected.

Leak Test-Wipe method:

a) Use a filter paper (Whatman 1 "wipe") or cotton swab ("Q-tip" or "Swab") to perform the sample wipe. Use 1 numbered wipe per source or radiation device.
b) Lightly moisten the swab with alcohol or water.
c) Using uniform and constant pressure. Roll the swab to ensure that all swab surfaces have been in contact with source or housing.
d) Carefully dry the swab to prevent any loss of activity. The swab should not be touched or allowed to contact other objects to prevent potential spread of contamination.
e) Label the swab with the sample number.
f) Sampling and measuring process should be completed within 10 days of each other.

Instruments used for counting of leak samples, such as liquid scintillation counters, should be serviced according to the manufacturer's instructions.

Removable activity is calculated using the following equation:

Removable Activity (Bq) = CPM net / [C.E. x 60 x W_{eff}]

where

Bq	=	Becquerel
CPM net	=	CPM gross (CPM) – Normal Background count (CPM)
C.E	=	Counting Efficiency (use the counter C.E. for that radioisotope, or for simplicity use a C.E. of 50% for all radioisotopes)
60	=	is for 60 seconds and related to counts per second (cps)
Weff	=	Wipe Efficiency (use 10% or 0.1 for wet wipes)

Equipment/Instrumentation:

A Survey meter calibrated within 12 months, as indicated in the label certificate stick on the equipment
A Liquid Scintillation Counter

Definitions:

CNSC	Canadian Nuclear Safety Commission
RSM	McGill Radiation Safety Manual

Bq	Becquerel (disintegrations per second, dps) MBq = Mega Becquerel (1 000 000 Bq) kBq = kilo Becquerel (1 000 Bq)
dps	disintegrations per second
RSO	Radiation Safety Officer

References/Documentation:

McGill University Radiation Safety Manual, Ed. 6

Appendix AA
http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/REGDOC-1-6-1-Licence-Application-Guide-Nuclear-substances-and-Radiation-Devices-version2-eng.pdf

Revision Records:

Revision #	Date:	Responsible Person	Description of Change/Amendment:
1.	2017/06/02	RSO	Initial release
2.			

McGill University
Environmental Health & Safety
Radiation Standard Operating Procedure (RSOP)

Title: Receiving and Open Radioactive Packages

PREPARED BY: Mario Badillo ______________________ Date: 2017/06/02
RSO McGill

APPROVED BY: ____________________________________ Date issued: 2017/06/02
____

Purpose:

The purpose of this document is to provide guidance with respect to the McGill University Radiation Safety program for authorized users handling and open radioactive packages. This document includes elements for identify received package, instruments, screening method, checking for contamination, interpretation of results, and keeping records.

Responsibility:

All Permits Holders and authorized radioisotope users who receives a package containing nuclear substance shall act in accordance with the requirements of the Transportation of Dangerous Goods Regulations Act (TDGA) and the CNSC's Packing and Transport of Nuclear Substances Regulations (TPNS).
The Permit Holder is responsible to train someone who handle and open radioactive packages

Participants:

Only trained and authorized workers should open packages containing nuclear substances and radiation devices.
No persons, other than the consignor or the consignee of the package, shall open the package.

Procedure/ Summary of Method:

1. Inspect packages for damage or leakage immediately upon receipt;
2. Wear a lab coat and disposable gloves while handling the package;
3. Place the package in a fume hood;
4. Confirm consignor and consignee name and address on package;
5. If the package appears to be damage or leaking isolate the package to prevent further contamination and notify the RSO for notification to the CNSC;

6. If no damage is evident, identify the type of package: Excepted package or Type A package;

7. **Excepted package**:
7.1 Verify the mention of “RADIOACTIVE” visible upon opening
7.2 Verify the UN number on package (i.e. 2908, 2910, 2911, etc.)
7.3 Monitor the radiation field around the package using a radiation survey meter and compare the units stated on the package. Survey meter should must be calibrated within 12 months, as indicated in the label certificate stick on the equipment. Surface radiation < 5 mSv/h (0.5 mR/h)
7.4 Wipe test the exterior of the package for removable surface contamination.
7.5 Remove the packaging slip.
7.6 Open the outer package and check for possible damage to the contents, broken seal or discoloration of packaging materials.
7.7 Wipe test the interior packaging.
7.8 Remove the inner package or primary container, monitor the radiation field and wipe-test the container.
7.9 Avoid direct contact with unshielded containers.
7.10 Verify the radioisotope, the activity and other details with the information on the packaging slip and with the purchase order;
7.11 Keep records in the Log Book for further references;
7.12 Remove the vial/lead pig from the box and secure it for further usage;
7.13 Remove all safety warning sign on the package and dispose/recycle the container.
8. **Type A package**:
8.1 Verify the package is identify as “Type A” package,
8.2 Only authorized workers trained in TDG or EHS’s “Type A package training” should open a package Type A;
8.3 Verify the UN number on package (i.e. 2915, 3327, 3332, 3333, etc.)
8.4 Verify posting of the 24 Emergency number (CANUTEC operated by the TDG Directorate of Transport Canada);
8.5 Verify name of radioisotope, mass, total volume and activity
8.6 Using a survey meter, calculate the Transport Index (TI): measure the radiation field at any point at 1 meter from the container. The highest value in mR/h is the TI;
8.7 Using a survey meter, calculate the Surface Radiation Level (SRL): measure the radiation field at any point of the surface of the container, in mR/h. divide the value by 100 to convert in mSv/h. This is the SRL
8.8 If any discrepancy, do not open the package, inform the RSO for notification to the CNSC, and contact the consignor
8.9 Follow steps 7.4 to 7.13.
9. Log the radioisotope, activity and date received in myLab and note the ID number;
10. Write this ID number on the vial.

Equipment/Instrumentation:

A Survey meter calibrated within 12 months, as indicated in the label certificate stick on the equipment

Definitions:

CNSC	Canadian Nuclear Safety Commission
TDG	Transportation of Dangerous Goods
TDGA	Transportation of Dangerous Goods Act
TPNS	Packing and Transport Nuclear Substances Regulations
Consignor	Person or firm sending a package to be delivered.
Consignee	Person to whom a package is to be delivered.
Package	The complete product of the packing operation, consisting of the packaging and is contents prepared for the transport
Type A	A package used to transport material of a higher concentration than those shipped in industrial packages
CANUTEC	Canadian Transport Emergency Centre
TI	Transport Index
SRT	Surface Radiation Level
Bq	Becquerel (disintegrations per second, dps) MBq = Mega Becquerel (1 000 000 Bq) kBq = kilo Becquerel (1 000 Bq)
dps	disintegrations per second
mR/h	milli Roentgen per hour
mSv/h	millie Sievert per hour
NEW	Nuclear Energy Worker
RSO	Radiation Safety Officer

References/Documentation:

Transportation of Dangerous Goods Regulations, SOR/2001
[http://lois.justice.gc.ca/eng/regulations/SOR-2001-287/page-1.html]

Packing and Transport Nuclear Substances Regulations
[http://laws-lois.justice.gc.ca/eng/regulations/SOR-2015-145/index.html]

Regulation for the Safe Transport of Radioactive Material, IAEA SSR-6
[http://www-pub.iaea.org/MTCD/publications/PDF/Pub1570_web.pdf]

Guidelines for Handling Packages Containing Nuclear Substances
[https://www.cnsc-ccsn.gc.ca/pubs_catalogue/uploads/I0744_e.pdf]

Revision Records:

Revision #	Date:	Responsible Person	Description of Change/Amendment:
1.	2017/06/02	RSO	Initial release
2.			