FOREWORD

This manual was prepared with the premise that the success of any program in Radiation Safety for the prevention of exposures and avoidance of accidents, must necessarily rely on the experience, ability, and forethought of the professional user of radio nuclides.

The policies and procedures contained herein are designed to achieve a reasonable and practical standard of safety in compliance with government regulations and codes, while allowing investigators the maximum possible freedom in establishing and implementing their own individual experimental programs.

The manual is intended to provide a ready reference to legislative requirements and procedures, a guide to acceptable methods of practice, and a degree of safety awareness contributory to self-regulation for those who work with nuclear substances.

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SECTION 1: PROGRAM ORGANIZATION & ADMINISTRATION

1.1 NUCLEAR SAFETY CONTROL ACT & REGULATIONS

In Canada, there are several government bodies which have jurisdiction over the use of ionizing radiation. The Canadian Nuclear Safety Commission (CNSC) licences the acquisition and use of all nuclear substances and radiation emitting equipment such as nuclear reactors and accelerators. Recommendations from the International Commission on Radiological Protection (ICRP) are also used to formulate the rules and conditions under which radioisotopes or radiation emitting devices are used.

In addition, the Health Protection Branch of Health & Welfare Canada formulates regulations related to the manufacture and functioning of new radiation equipment under the Radiation Emitting Devices Act. Many of the provinces also have their own regulations for the use of radiation emitting equipment (e.g. x-ray emitting equipment).

On March 20, 1997, the federal Nuclear Safety and Control Act were passed by Parliament, replacing the 50 year old Atomic Energy Control Act. The Act and new Regulations came into force on May 31, 2000. The University of Western Ontario (Western University or Western) is licenced by the Canadian Nuclear Safety Commission to possess, transfer, import, export, use and store the nuclear substances and the prescribed equipment listed on the consolidated licence and particle accelerator licences.

1.2 UNIVERSITY HEALTH & SAFETY COMMITTEE

The University Health & Safety Committee is the senior safety committee of the University. It has the responsibility for reviewing the overall safety performance of the University, for recommending health & safety policy, and for overseeing the activities of any sub-committees reporting to it. This advisory committee reports directly to the President.

1.2.1 MEMBERSHIP

_Voting Members_

Vice-President (Resources & Operations), Chair
Provost Vice-President (Academic)
Vice-President (Research)
Assistant Vice-President-Human Resources Division
Two Deans, one from Engineering Science, Medicine, or Science, appointed by the Provost for a three years renewable term.

_Non-Voting Members_

Director, OHS
Resource Persons
Senior Director, Facilities Management
Chairs, Subcommittees
1.2.2 WESTERN SAFETY POLICY & UHSC TERMS OF
REFERENCE http://www.uwo.ca/humanresources/

1.3 RADIATION SAFETY PROGRAM

1.3.1 RESPONSIBILITIES FOR RADIATION SAFETY

CNSC license applicant(s) must be legal, corporate entities, as The University of Western
Ontario (Western). Once licensed, these entities must ensure that they and their activities
comply with all license conditions and CNSC Regulations. There are three required elements
to the Radiation Safety Program (RSP):

1. **Senior Management** with overall responsibility for regulatory compliance, radiation safety
   matters, and positive safety culture. A Senior Manager must have adequate authority and
   resources to ensure effective operations of the Radiation Safety Program.

2. **Radiation Safety Coordinator** who is competent and trained in all radiation safety matters to
   run the day to day operations of the Radiation Safety Program. The Radiation Safety Coordinator
   is accountable and communicates directly to the Senior Management.

3. **Radiation Safety Committee** which is composed of individuals with expertise or a stake in
   radiation safety matters. The individuals are approved by Senior Management and act to advise
   Senior Management and the Radiation Safety Coordinator on matters of radiation safety.

1.3.2 SENIOR MANAGEMENT

The Senior Manager (VP - Resources & Operations) has overall corporate responsibility for CNSC
regulatory compliance and radiation safety matters. The Senior Manager is responsible to:

1. Submit the application for a radioactive license to the CNSC on behalf of the University of
   Western Ontario (Western), with the required supporting documentation.

2. Ensure the implementation of the Radiation Safety Program, the designation of the Radiation
   Safety Coordinator and Radiation Safety Committee.

3. Ensure that essential physical, human and financial resources are provided, as required for
   the operation of the Radiation Safety Program. Note: as stated in G-121, monies that are
   isolated and protected from competing demands should fund these resources.

4. Ensure that activities proposed in the radioactive license are conducted in accordance with
   regulatory requirements and licence requirements.

5. Assure the safety of staff, workers and the public during the conduct of licensed activities,
   promoting a positive safety culture and encouraging effective communication amongst all
   levels of workers and managers within the program.

6. Ensure that the Radiation Safety Coordinator is not assigned competing duties or priorities
   that might detract significantly from his/her ability to participate in or supervise radiation
   safety matters.

7. Ensure the qualifications and training of any individual who is to use or oversee the use of
   nuclear substances.
8. Ensure that the Radiation Safety Coordinator and/or the Radiation Safety Committee have adequate equipment and facilities to operate the Radiation Safety Program.
9. Monitor the effectiveness of Radiation Safety Program and correct significant deficiencies in the Radiation Safety Program when such deficiencies are detected.
10. Report significant events to the CNSC and other agencies as required by the act, regulations and license conditions. Notify the CNSC any change in the information regarding the Radiation Safety Coordinator within 15 days after the change occurs.
11. Initiate, undertake or coordinate investigations to determine the cause of significant events, as required to mitigate or to prevent future incidents or effects.

1.3.3 RADIATION SAFETY COMMITTEE

The Radiation Safety Committee-Radioisotopes is a sub-committee of the University Health & Safety Committee. This Committee is composed of individuals with expertise or a stake in ionizing and non-ionizing radiation safety matters. The individuals advise the Senior Management and the University Radiation Safety Coordinator on matters of all radiation safety including nuclear substances and radiation devices, particle accelerators, X-ray equipment, lasers/laser systems and other non-ionizing radiation sources. This Committee is a requirement of the Canadian Nuclear Safety Commission regulations.

1.3.3.1 MEMBERSHIP & APPOINTMENT

The Radiation Safety Committee will consist of a minimum of eight members with expertise in radiation safety matters. The Committee members are appointed by the Deans of Faculties. Appointment will be a three-year renewable term.

Voting Members
Vice President, Research and International Relations, Chair or Designate (1)
Faculty of Science (4)
Faculty of Medicine and Dentistry (2)
Faculty of Engineering (1)
Faculty of Social Science (1)
Faculty of Health Sciences (1)

Non-Voting Members
Director, Occupational Health and Safety
Radiation Safety Coordinator
Facility Safety Coordinator
Environmental Safety Coordinator
A representative from the Division of Physical Plant & Capital Planning Services (PP & CPS) appointed by the Associate Vice-President of PP & CPS, to advise on matters concerning laboratory design and construction.
A Departmental Chair from one of the departments in which radioactive materials are in use, to provide advice and present concerns on departmental issues involving the safe use of radioactivity.
A representative from Society of Graduate Students (SOGS) appointed by the President of SOGS.
A representative from the Postdoctoral Association (PAW) appointed by the President of PAW

1.3.3.2 DUTIES

The Radiation Safety Committee will:

1. Meet three times a year or as required to review the Radiation, X-ray and Laser Safety Programs and report these findings to the University Health and Safety Committee.
2. Advise the Senior Manager and the Radiation Safety Coordinator on all radiation safety matters, including the safe use of radioactive materials during licensed activities.
3. Review proposed or existing University radiation protection programs and procedures to determine if they assure that radiation exposures will comply with regulatory limits and will be as low as reasonably achievable (ALARA).
4. Review proposed uses of nuclear substances, and their proposed locations of use to determine whether these proposals comply with corporate procedures and regulatory requirements.
5. Assess the adequacy, in terms of the contents and schedules of delivery, of the University's radiation safety training programs.
6. Assess the results and determine the effectiveness of the University's radiation safety training program.
7. Review the results of internal inspections that are designed to assess whether nuclear substances are used safely in licensed areas.
8. Review annual summaries of the occupational radiation exposures received by permitted workers to assess whether these respect the ALARA principle of dose limitation.
9. Review reports concerning incidents or unusual occurrences at the University that involve nuclear substances.
10. Recommend, to the Radiation Safety Coordinator and Senior Manager, possible corrective measures or improvements when their review or assessment identifies deficiencies in a proposal, program, practice, procedure, equipment, record or report.
11. Recommend corrective measures or possible improvements to prevent recurrences of any incident that exposed persons to unnecessary radiation.
12. Advise Senior Manager of any need for additional resources to establish, maintain or improve radiation protection program.
13. Maintain written records of their activities, decisions, advice and recommendations concerning radiation safety, including details of meetings and reviews of data, reports, programs, procedures, circumstances, incidents or unusual occurrences.
14. Cancel Internal Permit(s) in situations of non-compliance as recommended by the Radiation Safety Coordinator.

1.3.4 RADIATION SAFETY COORDINATOR

The Radiation Safety Coordinator is a specialist in all aspects of radiation safety who provides day-to-day administration and control of the radiation safety program on behalf of the employer.
The Radiation Safety Coordinator should:
   A. Possess both relevant work experience and formal training in radiation safety.
   B. Understand methods and technology to control use, handling, storage and disposal
   of nuclear substances and to monitor and control radioactive contamination, radiation
   fields and radiation exposures.
   C. Understand pertinent regulatory processes and requirements.

The Radiation Safety Coordinator is appointed by and reports directly to Senior Management. To
ensure radiation safety and compliance with regulatory requirements on behalf of Senior
Management, the Radiation Safety Coordinator will:

1. Communicate with Senior Managers, Radiation Safety Committee, Permit Holders and nuclear
substance users on all matters relevant to radiation safety.
2. Act as a signing authority and prepare annual reports in accordance with conditions contained
in the license issued to the University by the CNSC. Report to the CNSC any changes to the
Radiation Safety Program.
3. Review and authorize requests to purchase or use nuclear substances to ensure that the proposed
uses and locations of use comply with relevant legislation, license conditions and the radiation
safety program.
4. Assess the proposed use of nuclear substances in laboratories, and designate laboratories for use
of nuclear substances.
5. Maintain a record of the status of all designated laboratories that use nuclear substances.
6. Authorize the decommissioning of laboratories in which radioactive use has been terminated.
7. Develop and implement administrative controls or procedures to ensure radiation safety and
compliance with regulatory requirements.
8. Assess the qualifications and competence of persons who apply to use or handle nuclear
substances and authorize the use of nuclear substances by these individuals. Designate Nuclear
Energy Workers in accordance with CNSC Regulations.
9. Verify that persons who handle nuclear substances are adequately trained in radiation safety
and the institution's radiation safety policies.
10. Authorize the disposal of nuclear substances in accordance with legislation, the CNSC and
institutional policies.
11. Assess, in conjunction with the Radiation Safety Committee, the effectiveness of radiation
protection programs.
12. Verify that person(s) who may be exposed to radiation in the course of their duties receive
appropriate radiation safety training (e.g. secretaries, shippers & receivers, maintenance &
service workers).
13. Develop and implement programs under the direction of Senior Manager to inspect and
critically review the conduct of licensed activities, the adequacy of locations and facilities
where nuclear substances are used and stored, and the adequacy of personnel training and
safety procedures.
14. Implement remedial actions to correct deficiencies identified upon inspection program
referred to in (13) above.
15. Under the direction of Senior Manager initiate revisions to procedures, changes to equipment
and facilities, and amendments to the CNSC license(s) to ensure compliance with regulatory requirements.

16. Design and implement appropriate personnel monitoring and bioassay programs to measure exposures to ionizing radiation.

17. Administer or control the issue, use and maintenance of radiation monitoring devices and equipment and the recording of results.

18. Monitor the occupational radiation exposures received by persons by reviewing, at least twice a year, their records of exposure.

19. Where the above reviews of radiation exposure indicate that exposures are unnecessarily high, recommend to Senior Manager and/or the individuals concerned, measures to reduce exposure.

20. Investigate and follow with appropriate recommendations to prevent reoccurrence, reports of over exposures to ionizing radiation, accidents involving nuclear substances, and losses of nuclear substances.

21. Report all incidents or accidents involving nuclear substances to the CNSC and other relevant authorities in accordance with legislation and the license.

22. Assess the adequacy of survey programs for measuring or managing radiation fields and radioactive contamination during licensed activities, such as during the use, storage and disposal of nuclear substances.

23. Ensure that the results of programs to reduce or remove radioactive contamination meet regulatory requirements.

24. Ensure that sealed radiation sources are leak tested in accordance with the institution's policies and regulatory requirements.

25. Consult with necessary safety committees and or personnel to ensure that the use of nuclear substances is conducted in a manner meeting institutional policies.

26. Prepare or review proposed or existing radiation safety procedures in cooperation with the Radiation Safety Committee.

27. Coordinate, or participate in, emergency responses to accidents involving nuclear substances.

28. Ensure that records and reports that are required of the institution by legislation and licenses are prepared, maintained or submitted as required.

29. Ensure that any nuclear substances that are to be transported are packaged in accordance with regulations.

1.4 INTERNAL PERMIT HOLDER RESPONSIBILITIES

The Permit Holder is designated as a Nuclear Energy Worker (NEW). In addition to the Nuclear Energy Worker’s responsibilities, the Permit Holder must ensure that NEWs listed on the permit:

1. Attend all required safety training sessions, comply with the Nuclear Safety and Control Act (NSCA), Canadian Nuclear Safety Commission (CNSC) regulations, CNSC licence conditions, internal permit conditions, and that safe laboratory practices are followed.

2. Are designated as nuclear energy workers to use nuclear substances and radiation devices.

3. Receive adequate radiation safety training from Western, and have been informed of the risks associated with exposure to ionizing radiation. Permit Holder is also responsible for providing the specific hands-on training to all nuclear substance/radiation device users in his/her
laboratories.
4. Perform weekly monitoring when radioisotopes are handled, and maintain records.
5. Maintain radioisotope inventories, storage and waste disposal records. The Permit Holder must authorize and limit the release of nuclear substances only in the quantities specified in the regulations under guidance and approval of the Radiation Safety Coordinator.
6. Report incidents of loss, theft, sabotage, illegal use or possession of any nuclear substance/radiation device immediately to the Radiation Safety Coordinator;
7. Are provided with adequate facilities, equipment and supervision to ensure workers or students follow the rules and regulations set out by the CNSC and Western policies and procedures.
8. Must designate a responsible-trained individual to oversee radioisotope work during any absence (4 weeks), and a stand-in Permit Holder during extended absences (>4 weeks). The latter will be reported to the Radiation Safety Coordinator in advance of the extended leave.

1.5 NUCLEAR ENERGY WORKER’S RESPONSIBILITIES

Every Nuclear Energy Worker shall:

1. Be familiar with the Western radiation safety manual, attend all required safety training sessions, comply with the Nuclear Safety and Control Act (NSCA), Canadian Nuclear Safety Commission (CNSC) regulations, CNSC licence conditions and internal permit conditions.
2. Use equipment, devices, facilities and clothing for protecting the environment or health and safety of persons, or for determining doses of radiation, dose rates or concentrations of radioactive nuclear substances in accordance with the NSCA, CNSC regulations and the licence.
3. Comply with the measures established by Western to protect the environment and health and safety of persons, maintain security, control of levels and doses of radiation, and control releases of radioactive nuclear substances and hazardous substances into the environment.
4. Inform the Permit Holder and/or the Radiation Safety Coordinator immediately of any situation involving the following: a risk environment or health and safety of persons, a threat of security or incident with respect to security, a failure to comply with the NSCA, CNSC regulations, CNSC licence, Western permit or Western radiation safety manual, an act of sabotage, theft, loss, illegal use or possession of a nuclear substance/radiation device, a release of an authorized quantity of nuclear substance or hazardous substance.
5. Report the Permit Holder and/or the Radiation Safety Coordinator any incident involving known or suspected radiation exposure, personal contamination, any contamination or spill exceeding permissible limits prescribed in the Western radiation safety manual.
6. Observe and obey all notices and warning signs posted by Western.
7. Take all reasonable precautions to ensure the worker’s own safety, the safety of the other persons at the site of the licensed activity, the protection of the environment, the protection of the public and the maintenance of security.
8. Wear the required monitoring dosimeters and participate in the required bioassay programs.
9. Perform all regular contamination checks and clean up contamination.
10. (A female worker) shall inform her supervisor and/or the Radiation Safety Coordinator of a pregnancy as soon as she becomes aware of it.
SECTION 2: POLICIES & REGULATIONS

2.1 ALARA POLICY

All occupational exposures shall be limited in accordance with the ALARA Principle and within the CNSC prescribed dose limits in Section 4 of the Radiation Protection Regulations. All work associated with nuclear substances shall be governed by considerations for the risk of radiation.

Western is committed to taking every reasonable precaution, as is practical, to maintain radiation exposures to staff, students and the public to ALARA (As Low As Reasonably Achievable). The Western University Radiation Safety Program is designed to keep exposures to ALARA by:

1. Management control over work practices
2. Personnel qualification and training
3. Control of occupational and public exposure to radiation
4. Planning for unusual situations
5. Ascertain the quantity and concentration of any nuclear substance released as a result of the licenced activity

2.2 RADIATION PERMIT POLICY

The University is issued a Consolidated Licence by the Canadian Nuclear Safety Commission (CNSC) in the name of the University. This Licence authorizes the University to issue Internal Radioisotope Permits only to Western employees, for the use of radioisotopes on the campus. In this manual the word "licence" refers to the authority granted by the CNSC; the word "permit" refers to the document issued by Western University.

The Radiation Safety Coordinator and Radiation Safety Committee Chair review and approve all uses and operations involving radioisotopes on university property. The University issues an Internal Permit to the applicant who is then held responsible for ensuring that all CNSC Regulations and Western Policies and Procedures are in full compliance. Where the Regulations or Permit Conditions of Approval are violated and/or in non-compliance, the Radiation Safety Coordinator will recommend suspension, cancellation or disciplinary action on any Internal Permit.

2.3 NUCLEAR SUBSTANCE PURCHASE, SHIPPING, RECEIPT & INVENTORY POLICY

The purchase of all nuclear substances must be performed by authorized staff within the Western Purchasing Department, on behalf of the Internal Permit Holder. All purchases/acquisitions are reviewed and approved by the Radiation Safety Coordinator (RSC) or OHS personnel authorized by the RSC prior to receipt by the Internal Permit Holder. Nuclear substances must not be purchased via the University's Low Value Purchase Order procedures or by calling directly to any supplier. Acquisitions may include gifts, loans, purchases, transfers from external off-campus Licensees, and internal on-campus transfers. All acquisitions must be documented and traceable on the Western Inventory Record Form. Any work requiring the use of more than 10,000
exemption quantities of a nuclear substance at a single time must be must be approved by the Canadian Nuclear Safety Commission.

All radioactive materials to be shipped must meet the current CNSC Packaging and Transportation of Nuclear Substances Regulations, International Atomic Energy Agency Regulations and other applicable regulations. No radioactive materials to be transported without consultation with the Radiation Safety Coordinator in Occupational Health and Safety.

All ordered nuclear substances must be delivered, and received at Loading Dock 11, Chemistry Building by ChemBioStores Staff. No other location is authorized for receiving of these materials unless it is authorized by the Radiation Safety Coordinator. Only personnel listed on the permit, will be allowed to pick-up nuclear substances and bring the materials to the approved laboratory.

Each individual stock vial must be assigned a bar code number when received. Prepared aliquots of nuclear substances must be similarly numbered and recorded (for tracking purposes). A corresponding Inventory Report Form must be maintained and available in the laboratory, at all times.

Records shall be maintained in the Purple Binder provided by the Radiation Safety Coordinator. Under no circumstances shall the inventory exceed the possession limits as defined in the Internal Permit.

An annual accounting of total inventory, waste disposal and other required records for the previous year must be submitted to the Radiation Safety Coordinator as requested.

2.4 NUCLEAR ENERGY WORKER POLICY

The University informs all those working with nuclear substances, radiation devices or class II prescribed equipment as Nuclear Energy Workers including permit holders, faculty, staff, students, etc.

High school students are not allowed to handle nuclear substances, radiation devices or class II prescribed equipment.

2.5 PERSONAL EXPOSURE POLICY

All occupational exposures shall be limited in accordance with the CNSC Radiation Protection Regulations, Effective Dose Limits Section 13 (1) and the ALARA principle. Nuclear Energy Workers will be monitored with TLD monitors from a CNSC approved agency. The nominal cost for this service is provided by the user's Department. All actual or suspected exposures must be reported to the Radiation Safety Coordinator.

A pregnant woman must inform in writing the Internal Permit Holder and the Radiation Safety Coordinator as soon as she is aware of her condition.
Nuclear Energy Workers are also required to participate in a bioassay program, as specified in the conditions of the Internal Permit.

2.6 RADIOISOTOPE FACILITY POLICY

All rooms designed for the use of nuclear substances must approved by the Radiation Safety Coordinator. Any area or enclosure where more than one exemption quantity of an unsealed nuclear substance is used at a single time must be classified as basic, intermediate, high or containment level according to RD-52 Design Guide for Nuclear Substance Laboratories and Nuclear Medicine Rooms. Except for the basic level classification, all other levels must be approved by the CNSC.

Nuclear substances or radiation devices may only be used in those laboratories/areas which are identified on the Internal Permit.

2.6.1 RADIATION WARNING SIGN AND NOTICE POLICY

The use and posting of all types of radioactive warning labels and signs shall be in accordance with the CNSC Radiation Protection Regulations Section 20, 21, 22, 23.

Radioactive warning signs shall NOT be posted in locations or on equipment where radiation is not present. Section 23, Radiation Protection Regulations prohibits the frivolous posting of signs. All such signs and labels shall be removed.

2.6.2 DECOMMISSIONING POLICY

The Department Chair is responsible for ensuring that all rooms, areas or enclosures that have been licenced for nuclear substance use, are decommissioned before being released for non-radioactive use or renovation.

The Internal Permit Holder is responsible for completing the Decommissioning Report prior to releasing his/her responsibility for the area. In the absence of the Internal Permit Holder, the Department Chair will assume these duties.

2.7 CONTAMINATION MONITORING and LEAK TESTING POLICY

Regular monitoring by wipe test of radioisotope laboratories is required for the detection and then clean-up of contamination. Monitoring must be done on all normally accessible working surfaces in areas where unsealed nuclear substances are handled or stored. It must be completed (1) immediately after each use or at least weekly (2) after spills or incidents, (3) before equipment is released for non-radioactive use, and (4) before a decommissioned room is released for non-radioactive use. Values in excess of the regulatory quantity must be reported immediately to the Radiation Safety Coordinator.
Each operating area must have ready access to an approved contamination meter for performing direct contamination monitoring after each use or at the end of the day (e.g. P-32, I-125). Sealed sources must be monitored for leakage at the frequency identified in the Internal Permit. Leak testing must be done before using a sealed source that is returning to use after 12 months in storage. Leak testing must be done after an event that may have caused damage to the source.

Records for the current year of all survey and contamination test results must be maintained in a binder. Previous year's records must be retained and available upon request. The survey/contamination records are required to be maintained for 1 year following the expiry of the licence.

2.8 USE & MAINTENANCE OF RADIATION DETECTION INSTRUMENTS

All radiation detection instruments must be approved prior to purchasing registered and inventoried by the Radiation Safety Coordinator.

2.9 ACCIDENT AND EMERGENCY POLICY

When damage to sealed sources and/or spillage of open source isotopes occurs, the Internal Permit Holder is responsible for taking immediate action to contain the radiation, decontaminate personnel and equipment, and where necessary, to evacuate personnel from the affected area. The Radiation Safety Coordinator must be informed immediately of any such damage and of any spills. After hours: contact Western Police at 911.

Those instances where any person is suspected of having been or is likely to be exposed to a dose exceeding maximum permissible levels, the Radiation Safety Coordinator must be informed immediately.

2.10 RADIOACTIVE WASTE DISPOSAL POLICY

Disposal of all radioactive wastes must be in accordance with regulations under the NSC Act. Waste must be handled and disposed of in a way that prevents unreasonable risk to the public or the environment. CNSC Regulations and Internal Permit Conditions require appropriate and specific disposal for each radio nuclide, and that records be retained for each method of disposal. Annual reporting of usage and waste disposal quantities is required.

For specific waste procedures, refer to Section 3

2.11 LOSS, THEFT & UNAUTHORIZED USE POLICY

Loss, theft or unauthorized use of any nuclear substances, prescribed equipment or prescribed information must be reported immediately to the Radiation Safety Coordinator. Contact Western Police at 911 after hours.
2.12 RECORD KEEPING & REPORTS POLICY

All records and reports must be available for inspection at the site where the nuclear substance, radiation device or class II prescribed equipment is used. Records and reports which are compulsory under Section 27 of the NSC Act and applicable regulations will be followed, maintained and provided at the request of the CNSC. All records must be maintained as required in the Nuclear Substances and Radiation Devices Regulations section 36 and General Nuclear Safety and Control Regulations section 28. The CNSC will be notified 90 days prior to the disposal of any documents kept for the licence.

2.13 RADIATION SAFETY TRAINING POLICY

All radiation users must be properly trained and informed of the hazards/risks associated with exposure to ionizing radiation and transportation of dangerous (TDG) class 7 before handling and working with nuclear substances, radiation devices or class II prescribed equipment.

Radiation users including permit holders must complete the University radiation safety training session which includes TDG class 7 training. The permit holder is responsible to provide hands-on training on any specific procedures or particular radiation sources to radiation users if required. Permit holder must ensure that all radiation users under the permit complete the University radiation safety training course before handling any nuclear substances, radiation devices or class II prescribed equipment. The basic responsibility for the safe use of nuclear substances, radiation devices or class II prescribed equipment rests with radiation users. Radiation users including permit holders are retrained every three years.

Any person (visitor, student, staff, etc.) who is in a radiation room and has not received radiation safety training must take the radiation safety awareness. A permit holder or an authorized radiation user needs to provide the radiation safety awareness to these people. A list of people who take the radiation safety awareness must be documented and kept in a logbook with other radiation documentation for verification by the Radiation Safety Coordinator and/or CNSC inspector.

2.13.1 UNDERGRADUATE TEACHING PROGRAM POLICY

All undergraduate students handling nuclear substances in group teaching laboratories must attend the radiation safety training session (or its equivalent) scheduled by the Department Course Coordinator and work under direct supervision at all times. Compliance is the responsibility of the Deans and Department Chairs.

2.14 LABORATORY INSPECTION/INTERNAL COMPLIANCE POLICY

Monitoring and inspection of laboratories is necessary to maintain the credibility and authority of an Internal Permit System. Internal Permit Holders are responsible for their own in-house inspections ensuring that licenced materials are being used in accordance with the Regulations,
Licence Conditions and Internal Permit Conditions.

Radiation Safety Coordinator will inspect at least annually for each permit using the Western radiation safety inspection checklist posted on Human Resources website. An inspection can be announced or un-announced. In an announce inspection, the checklist will be sent to each permit for completion and the radiation safety coordinator will perform the inspection after that. Any non-compliance items will be communicated for corrective actions. The inspection results for each permit will be recorded with graded A (exceeds requirements), B (meets requirements), C (below requirements), D (significantly below requirements) or E (Unacceptable). Operations which are considered unsafe will be suspended immediately.

All University personnel shall give CNSC inspector and/or Radiation Safety Coordinator all reasonable assistance to enable the inspector(s) to carry out his/her duties and functions under the Nuclear Safety and Control Act and Regulations.

2.15 COMPLIANCE ENFORCEMENT POLICY

Western assumes the responsibility of ensuring to the CNSC that any use of nuclear substances and radiation devices will be used in strict compliance with the NSC Act & Regulations and the Conditions of the University's Consolidated Licence. To aid in determining the level of risk or immediate danger to safety and health, all compliance violations will be categorized as major or minor offences. This policy is intended as a means to categorize and give guidance for the anticipated response that is needed, when issues of non-compliance are identified by the Radiation Safety Coordinator. All deficiencies must be corrected and reported in writing to the Radiation Safety Coordinator. Any offence occurring twice in any 1 year period will be considered as a second offence and so on.

A major offence would result from violations which cause immediate risk or danger to safety, health, release to the environment of reportable quantities, doses of substantial amount to staff, or place the CNSC Licence in jeopardy. For example, a major offence would be one of the following deficiencies:

1. Contamination above licence criteria
2. Inadequate monitoring program (wipe test or contamination meter monitoring)
3. Use or storage of food/drink or smoking in the laboratory
4. Inadequate training of new staff
5. Non-participation in the TLD or Bioassay Program
6. Unauthorized possession/use of nuclear substances or radiation devices.
7. Inadequate or unsafe storage areas for radioactive waste
8. Records are inadequate or incomplete (usage, waste, monitoring)

A minor offence would be an infraction which poses no immediate risk or threat to safety, health, the environment or the Licence. Examples of a minor offense would be one of the following deficiencies:

1. Inadequate signage
2. Inadequate posting (permit, CNSC poster)
3. Inappropriate use of radiation warning labels
4. Inappropriate segregation and/or identification of radioactive waste for disposal/decay

Major Offence Actions:

1. First Offence: A written notification will be sent to the Permit Holder and/or Permit Contact by the Radiation Safety Coordinator. Immediate correction action of the violation is required, written reply in 7 days. If the written reply is not received after 7 days, the second notice will be copied to Department Chair, OHS Director, Radiation Safety Committee Chair and Dean of Faculty. A meeting will be arranged with the Permit Holder, Department Chair, OHS Director, Radiation Safety Committee Chair and Radiation Safety Coordinator if there is no response from the Permit Holder after 7 days of second notice.
2. Second Offence: The Permit Holder will be notified in writing by the Radiation Safety Coordinator that the permit will be suspended until a meeting with the Radiation Safety Committee can be held.
3. Third Offence: The Radiation Safety Coordinator will recommend permit cancellation to the Radiation Safety Committee.

Note: For the second and third occurrences, notification of the above actions will be copied to the Dean of Faculty, Department Chair, Director OHS and Radiation Committee Chair.

Minor Offence Actions:

1. First Offence: A written notification will be sent to the Permit Holder and/or Permit Contact by the Radiation Safety Coordinator. Corrective action of the violation is required, written reply in 21 days. If the written reply is not received after 21 days, the second notice will be copied to Department Chair, OHS Director, Radiation Safety Committee Chair. A meeting will be arranged with the Permit Holder, Department Chair, OHS Director, Radiation Safety Committee Chair and Radiation Safety Coordinator if there is no response after 14 days of second notice.
2. Second Offence: A meeting will be arranged with the Permit Holder, Department Chair, OHS Director, Radiation Safety Committee Chair and Radiation Safety Coordinator to review the issues.
3. Third Offence: The Permit Holder will be notified in writing by the Radiation Safety Coordinator that the permit will be suspended until a meeting with the Radiation Safety Committee can be held.

Note: For the second, third and fourth occurrences, notification of the above actions will be copied to the Dean of Faculty, Department Chair, OHS Director, and Radiation Committee Chair.
SECTION 3: STANDARD OPERATING PROCEDURES

3.1 RADIATION PERMIT

3.1.1 NEW PERMIT

1. Complete in full the "Application for Radioisotope Internal Permit" and forward to: Radiation Safety Coordinator. Application forms are available from Human Resources website.
2. The application is reviewed and approved by the Radiation Safety Coordinator and the Radiation Safety Committee Chair or the designate.
3. All projects requiring more than 10,000 EQ must be approved by the CNSC.
4. Internal Permit Holders must be employees of Western University.
5. Internal Permits will not be issued to private companies renting or otherwise occupying space on University property.

NOTE: Strict adherence to the conditions of approval for each and every internal permit is critical. Failure to comply will not only result in cancellation of individual permits but will seriously jeopardize the continuance of the University's Licence.

3.1.2 AMENDMENTS

Any changes (personnel, rooms, radioisotope limits, etc.) are submitted to the Radiation Safety Coordinator by the Permit Holder or Permit Contact. A copy of the amended permit is mailed to the Permit Holder for posting in all approved locations.

3.1.3 RENEWAL OF PERMIT

1. All radiation permits must be renewed according to the CNSC licence period.
2. Permit Holder may meet with the Radiation Safety Coordinator to review his/her current radioisotope projects, records and any outstanding compliance issues. All pertinent changes to the Regulations will be reviewed as well as any added responsibilities of the Permit Holder.
3. The Radiation Safety Coordinator will renew the permit.
4. A renewal permit will be sent to the Permit Holder.

3.1.4 SABBATICAL/EXTENDED LEAVE

Permit Holders leaving for an extended period of time (sabbatical or longer than a 4 week period) shall advise the Radiation Safety Coordinator in writing, prior to leaving. The Permit Holder must arrange for another Permit Holder to assume the permit responsibilities during his/her absence. The Radiation Safety Coordinator will confirm acceptance with the newly appointed Permit Holder and his/her Departmental Chair.
3.1.5 PERMIT EXPIRY/TERMINATION

The Permit Holder must request termination of the Permit when his/her employment is terminated or when there are no further plans to continue with radioactive work. Notice must be given at least 4 weeks prior to leaving the University to ensure that the laboratories are decommissioned and all the records are released to the Radiation Safety Coordinator. Records must be kept 3 years past employment/termination/expiry of the Internal Permit. The Department Chair will be held responsible in the absence of the Internal Permit Holder.

3.1.6 PERMIT SUSPENSION/CANCELLATION

An Internal Permit suspension or cancellation may result when the CNSC Regulations or Internal Permit conditions of approval are violated according to the "Compliance Enforcement Policy". Suspension or cancellations will be at the discretion of the Radiation Safety Coordinator and Senior Manager in charge of the Radiation Safety Program. Appeals will be reviewed by the Radiation Safety Committee.

3.1.7 PERMIT RECORDS

Records in respect of any nuclear substance in the Permit Holder's possession shall be kept of the following:

1. The name, quantity, form and location of the nuclear substance,
2. Model, serial number of a sealed source or where the nuclear substance is contained in radiation device, model and serial number of a radiation device and location of the sealed source or radiation device,
3. The quantity of the nuclear substance used and the manner in which the nuclear substance was used
4. A record of the name of each worker who uses or handles a nuclear substance;
5. A record of any transfer, receipt, disposal or abandonment of a nuclear substance, including
   - The date, name and address of the supplier or the recipient
   - The number of the licence of the recipient
   - The name, quantity and form of the nuclear substance where the nuclear substance is a sealed source, the model and serial number of the source and where the nuclear substance is contained in a radiation device, the model and serial number of the device.
6. Record of the training received by a worker for 3 years after termination of the worker's employment
7. Record of every inspection, measurement, test or servicing in accordance with the Act

Records must be kept for 3 years after the expiry date of the last Internal Permit that was issued to the Permit Holder.
3.1.8 PERMIT WITH NUCLEAR SUBSTANCES USED IN ANIMALS

Nuclear substance used in animal protocols must be submitted to the University Animal Use Subcommittee (AUS) together with the nuclear radiation safety form provided by AUS for approval by the Committee and the Radiation Safety Coordinator.

3.2 PURCHASING AND RECEIVING RADIOISOTOPES

3.2.1 PURCHASING/ACQUISITIONS

1. Nuclear substances and radiation devices orders must be placed through the University purchasing department using its online system and approved by the Radiation Safety Coordinator or OHS personnel authorized by the Radiation Safety Coordinator. The purchase requisition must identified with name of Permit Holder, Permit Number, name and quantity of nuclear substance, chemical compound and the word "RADIOACTIVE".

2. A University purchasing agent will send a copy of the purchase order to the Radiation Safety Coordinator and Chemistry Stores staff once it is generated.

3.2.2 RECEIVING RADIOACTIVE SHIPMENTS

1. Radioactive nuclear substance shipments entering the campus are delivered and received at Dock 11, Chemistry Stores in Chemistry Building by Chemistry Stores staff unless it is authorized by the Radiation Safety Coordinator to be delivered and received at a different location.

2. Shipping documents and purchase order numbers are verified and a visual inspection of the package for damage or tampering by the Receiving Agent is completed upon arrival. The Permit Holder or their designate is contacted immediately by phone/e-mail. Shipments must be picked up by the Permit Holder or a worker listed on the permit.

3. Each shipment will be issued a bar code number and a corresponding Inventory Record Form by Chemistry Stores staff.

4. Personnel picking up the shipment must be pre-authorized by the Radiation Safety Coordinator. Personnel must present their Western ID card for identification at Chemistry Stores Receiving. The package must be taken on an uninterrupted route, directly to the approved nuclear substance room.

5. Shipments must be inspected as soon as possible upon arrival in the nuclear substance room using the guidance of CNSC poster INFO-0744 "Guidelines for Handling Packages Containing Nuclear Substances" The bar code number must be affixed to the stock vial when it is unpacked or the number hand written onto the vial. The Inventory Form must be kept in the Radiation Record Binder.

NOTE: Report any anomalies (contamination, leakage, incorrect shipment) to the Permit Holder/Supervisor/Radiation Safety Coordinator immediately.
3.2.3 TRANSFERS OF NUCLEAR SUBSTANCES

3.2.3.1 TO/FROM OUTSIDE INSTITUTIONS

No nuclear substances or radiation devices containing nuclear substances to be transferred to an institution or person outside the University, without written notice and approval from the Radiation Safety Coordinator.

1. Contact the Radiation Safety Coordinator for permission to transfer. Provide the name, address, and CNSC Licence Number of the receiver. When approved for transfer the consignor must ensure that the goods are properly classified, packaged, labeled and documented according to Transport Canada, CNSC, and International Regulations, before they are shipped.

2. All exports of nuclear substance from the University require a permit from the Department of Foreign Affairs and International Trade. Allow a minimum of 3-5 weeks for processing the application. For additional information or assistance contact the Radiation Safety Coordinator.

3.2.3.2 TRANSFERS WITHIN THE UNIVERSITY

1. Contact the Radiation Safety Coordinator. The Radiation Safety Coordinator will verify that the "Borrower" is authorized to use the radioisotope and the quantity that is being requested.
2. Record the quantity, the name of the person "borrowing" and their Permit Number on your Inventory Record Form (see 3.3).
3. Provide a new Inventory Record Form for the "borrower" with the bar code number of the stock vial. Label the borrowed sample with the bar code number, isotope and quantity.
4. The "borrower" must complete the new Inventory Record Form for their use and disposal of the borrowed nuclear substance. All inventory records must be retained in the Radiation Record Binder and available upon request.

3.3 INVENTORY/POSSESSION OF NUCLEAR SUBSTANCES

All nuclear substances and radiation devices are registered in the Radiation Enhanced Management System (REMS) database via purchasing and receiving control procedures to ensure they are within possession of permits’ limits and CNSC limits.

3.3.1 INVENTORY RECORD FORM

The Inventory Record Form authorizes the Internal Permit Holder to have the material in his/her possession and is a tracking record for both the use and disposal of the material. Possession of any nuclear substance is not allowed without a corresponding Inventory Record Form and a bar code number identifying the stock vial. The Inventory Form must be kept in the Radiation Record Binder and be available at all times for inspection purposes.

1. The Inventory Record Form is generated upon receipt of the material in Chemistry Stores. A unique bar code number is assigned to each stock vial when it is received. All receipt records are
maintained in the Chemistry Store.
2. All subsequent aliquots that are created by the user from the stock vial must be identified by the bar code number and traceable to the original stock vial. Additional Inventory Forms may need to be created to record the use and disposal of all the aliquot material.
3. Final disposal must be dated and signed by the user on the Inventory Record Form.
4. All Internal Permit Holders must provide a written summary of all their radioisotope purchases, current year-end inventory and waste disposal data for the previous year. This information is essential for preparing the University's Annual Report to the CNSC. All inventory records must be retained as in 3.1.8 above.

### 3.3.2 STORAGE OF NUCLEAR SUBSTANCES

A radionuclide storage area or container is defined as that area within a licenced facility that provides appropriate shielding, ventilation and security for the materials. The area may be a lead or plexiglass box, refrigerator, cupboard, or fume hood. Access is restricted to only those by the Permit Holder and persons on the permit. All storage areas or containers must be supervised by a Nuclear Energy Worker or otherwise secured from public areas. The area/container must be labeled with the designated Western Nuclear substance Label. The dose rate at any occupied location outside the storage area, room or enclosure resulting from the substances or devices does not exceed 2.5 μSv/hr (0.25 mR/hr). All radionuclides (stock, aliquots, products, waste) must be stored in approved containers within approved areas/laboratories. All approved containers must be labeled with the date, type and quantity of radionuclide.

### 3.3.3 SECURITY AND CONTROL ACCESS OF NUCLEAR SUBSTANCES AND/OR RADIATION DEVICES

All radiation rooms are restricted areas and must be kept secure and locked at all times when unattended. Only Permit Holder and authorized radiation users listed on the permit are allowed to be left alone in a radiation room with radioactive material that is not locked and stored away. All radiation rooms must meet the CNSC security requirements.

All visitors must be accompanied by Permit Holder or authorized radiation users listed on the permit and follow all applicable regulations, policies, guidelines and procedures.

### 3.3.4 LICENCE TO SERVICE RADIATION DEVICE & PRESCRIBED EQUIPMENT

Permit Holder must ensure that a company or person who performs any maintenance of a device, including installation, repair or dismantling other than routine operating procedures as indicated in the manufacturer’s operating manual for the device or class II prescribed equipment has a CNSC servicing licence. Contact the Radiation Safety Coordinator if you have any questions with regard to the CNSC servicing licence.
3.4 NOTIFICATION & TRAINING of NUCLEAR ENERGY WORKER

3.4.1 NUCLEAR ENERGY WORKER (NEW)

Only a registered and trained Nuclear Energy Worker is authorized to handle nuclear substances, radiation devices or class II prescribed equipment. A Nuclear Energy Worker will be required to attend a Radiation Safety Refresher every three years. The Radiation Safety Coordinator may direct any individual to re-train at any time.

A Nuclear Energy Worker must:
1. Be familiar with, and practice safe laboratory handling techniques.
2. Have attended a formal Radiation Safety Training session at Western and be able to demonstrate an understanding of the following:
   (i) The hazards and risks associated with the uses of radio nuclides and the particular chemical forms to be used and
   (ii) General and specific safety procedures to be followed during the use, storage and disposal of all radioactive products to be used or generated.
3. Attend other safety courses as determined by Western safety training policies.
4. Provide given names, SIN, date of birth, country of birth, and previous dosimetry history if requested.
5. Sign the current NEW form

3.4.2 PREGNANT NUCLEAR ENERGY WORKER

A pregnant worker must inform in writing, her Internal Permit Holder and the Radiation Safety Coordinator as soon as she is aware of her condition.

3.5 PERSONAL DOSIMETRY

3.5.1 RADIATION EXPOSURE LIMITS

<table>
<thead>
<tr>
<th></th>
<th>A person who is not a nuclear energy worker</th>
<th>Nuclear Energy Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual (mSv)</td>
<td>Pregnant (mSv)</td>
</tr>
<tr>
<td>Whole Body</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hands and Feet</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Lens of an Eye</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Skin</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

* One-year dosimetry period is 50 mSv and five-year dosimetry period is 100 mSv. The average annual in 5 year period is 20 mSv.
** Every nuclear energy worker who becomes aware that she is pregnant shall immediately inform the Permit Holder and the Radiation Safety Coordinator in writing.

*** Balance of the pregnancy: the period from the moment the Permit Holder and the Radiation Safety Coordinator is informed, in writing, of the pregnancy to the end of the pregnancy.

### 3.5.2 EXTERNAL MONITORING: TLD BADGES

1. Dosimetry badges must be worn as designated by the conditions of the CNSC licence condition and/or Internal Permit condition.
2. Contact the Radiation Safety Coordinator for dosimetry service registration. The nominal cost for this service is provided by the user's Department or the Internal Permit Holder. Applicants must have received radiation safety training and be registered as a Nuclear Energy Worker.

   Typical Badge Monitoring: Procedure Requirements

<table>
<thead>
<tr>
<th>ISOTOPE</th>
<th>QUANTITY/PROCESS</th>
<th>WHOLE BODY (Semi-annual)</th>
<th>RING (Semi-annual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3H, C14, S35</td>
<td>N/A</td>
<td>None required</td>
<td>None required</td>
</tr>
<tr>
<td>Ca45, Fe55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P32, Sr89,Y90</td>
<td>&lt; 50 MBq</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Sm153, Re186</td>
<td>&gt; 50 MBq</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Gamma Emitters</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

All records of dosimetry are reviewed and retained by the Radiation Safety Coordinator and a copy of each report is mailed to the Department's Dosimetry Coordinator. All actual or suspected exposures must be reported to the Radiation Safety Coordinator. Pregnant Nuclear Energy Workers will receive the same monitoring as a Nuclear Energy Worker or at the discretion of the Radiation Safety Coordinator.

### 3.5.3 INTERNAL MONITORING: BIOASSAY

Surveys/Bioassays and/or Whole Body Counter monitoring of individuals will be performed according to the conditions of the Internal Permit or at the discretion of the Radiation Safety Coordinator.

#### 3.5.3.1 RADIO IODINE

**Thyroid Monitoring**

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

(b) Every person who in any 24-hour period uses a total quantity of Iodine-123 exceeding:
(i) 200 MBq in an open room;
(ii) 20,000 MBq in a fume hood;
(iii) 2,000,000 MBq in a glove box; or
(iv) any approved quantity in any room, area or enclosure authorized in writing by the
CNSC shall undergo thyroid screening within a period more than 8 hours after the last use
that resulted in any of the above limits being exceeded and less than 48 hours after the
limits was exceeded.

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

Thyroid screening is performed in the Nuclear Medicine Department of LHSC-University
Hospital Campus, during regular working hours. All results must be reported by e-mail to the
Radiation Safety Coordinator on the same day and send a copy of the results by campus mail.

**Validation of Screen Results**

1. A direct measurement of the thyroid with an instrument that can detect 1 kBq of I-125 or I-
131 or I-124 or 10 kBq of I-123; or a bioassay procedure approved by the CNSC or a person
authorized by the CNSC.
2. If thyroid screening measurement results are greater than 1 kBq and less than 10 kBq of I-
124, I-125 or I-131; or greater than 10 kBq and less than 100 kBq of I-123 the Radiation Safety
Coordinator will follow appropriate steps in section 10.1 & 10.2 of the RD-58 Thyroid
Screening of Radioiodine. If thyroid screening measurement results is greater than 10 kBq of I-
124, I-125 or I-131; or greater than 100 kBq of I-123, the Radiation Safety Coordinator will
follow appropriate steps in section 10.3 of the RD-58 Thyroid Screening of Radioiodine and
immediately inform the CNSC and have bioassay performed within 24 hours by a person
approved by the CNSC to provide internal dosimetry.

**3.5.3.2 OTHER BIOASSAYS**

Use of any other radioisotopes in a quantity which would require a bioassay by the CNSC is
forbidden without the express written permission of the Radiation Safety Coordinator. Bioassay
requirements are identified as a condition of use in the internal permit.
3.5.3.3 WHOLE BODY COUNTER

The Radiation Safety Coordinator may require any Nuclear Energy Worker to have a whole body count to determine internal or external contamination.

3.6 ALARA (As Low As Reasonably Achievable)

ALARA is the acronym used in radiation protection for ensuring that every possible effort is used to keep radiation exposures as far below the regulated dose limit as practical. It is consistent with the purposes for which the licenced activity is undertaken, taking into account existing technology, the economics of improvements in relation to the benefits to the public health and safety, and other socioeconomic considerations. Western is committed to maintaining radiation exposures to staff, students and the public resulting from the use of radioisotopes and radiation emitting devices to ALARA.

1. All personnel are expected to practice ALARA in their work practices.
2. Each Permit Holder must establish, implement, and maintain procedures designed to reduce exposures of radiation to ALARA. These procedures will be required in the Internal Permit Application process.

3.6.1 General Laboratory Safe Handling Precautions:

1. External exposures are minimized by reducing the TIME, increasing the DISTANCE, and using appropriate SHIELDING materials. TLD badge must be worn when provided.
2. Using appropriate shielding to protect eyes and the trunk of the body. Wearing polycarbonate plastic safety goggles when handling high energy beta emitters (>700 keV such as P-32). Avoid viewing or manipulating a radioactive source closer to the head than to the rest of the body.
3. Internal exposures are minimized by preventing INGESTION, INHALATION, and ABSORPTION through the skin.
4. Eating, drinking or smoking in areas where nuclear substances are used or stored, is prohibited.
5. Never pipette radioactive solutions by mouth.
6. Personal Protective Clothing must be worn to prevent exposure through skin contact. Laboratory coats must be worn in radiation work areas. Lab coats, disposable gloves and safety goggles must be worn when handling unsealed nuclear substances. Sandals or open-toed shoes are not permitted when handling unsealed nuclear substances.

3.6.2 ACTION LEVELS

Action level is defined as "a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee's radiation protection program, and triggers a requirement for specific action to be taken". The primary goal of the action to be taken is to prevent a re-occurrence of the event.
### Table of Action Levels

Action levels have been identified as required for the following activities:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Initial Responsibility</th>
<th>Action Level</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel Dosimetry Nuclear Energy Worker</td>
<td>Radiation Safety Coordinator</td>
<td>2 mSv/yr or 1 mSv/semi-annual (whole body)</td>
<td>Investigate cause of exposure.</td>
</tr>
<tr>
<td>Thyroid Bioassay</td>
<td>Radiation Safety Coordinator</td>
<td>- &gt; 1000 Bq</td>
<td>- Investigation - Report to CNSC</td>
</tr>
<tr>
<td>Package Receipt</td>
<td>Receiving Staff/Radiation Safety Coordinator</td>
<td>Damaged Package or radiation level &gt; than package designation.</td>
<td>CNSC INFO 0744 &quot;Guidelines for Handling Packages Containing Nuclear Substances&quot;</td>
</tr>
<tr>
<td>Contamination Levels</td>
<td>Nuclear Energy Worker</td>
<td>3 Bq/cm²</td>
<td>Assess, decontaminate, re-monitor, record results</td>
</tr>
</tbody>
</table>

### 3.7 DESIGNATING, POSTING & DECOMMISSIONING OF ROOMS

#### 3.7.1 ROOM DESIGNATION FOR NUCLEAR SUBSTANCES

All locations for the use and store of nuclear substances must be pre-approved by the Radiation Safety Coordinator, identified and listed on the radiation permit. The area classification and room design for unsealed nuclear substances must follow the CNSC radioisotope laboratory classification (section 4.4.2) and the CNSC Regulatory Document GD-52 Design Guide for Nuclear Substance Laboratories and Nuclear Medicine Rooms.

#### 3.7.2 POSTING
All approved designated nuclear substance rooms must be posted with an approved Radiation Warning Sign or in any area where the activity may exceed 100 EQ or exposure may exceed 25 uSv/hour or as required by the Radiation Safety Coordinator. Required signs and labels are according to the following chart:

<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Posting</th>
</tr>
</thead>
<tbody>
<tr>
<td>All points of entry to a designated nuclear substance room including radioactive storage room</td>
<td>Radiation Warning Sign with Permit Holder name and office phone number, Radiation Safety Coordinator office phone number, and Western Campus Police 24 hour contact number</td>
</tr>
<tr>
<td>Inside a designated nuclear substance room, in a prominent location</td>
<td>Copy of the Internal Permit, CNSC safety poster which corresponds to the room classification, CNSC spill procedures poster, CNSC guidelines for handling packages containing nuclear substances</td>
</tr>
<tr>
<td>Specific storage location inside a designated nuclear substance room (i.e. fridge, freezer)</td>
<td>Radiation Warning Sign</td>
</tr>
<tr>
<td>Work area/bench/equipment</td>
<td>Radiation Warning Sign or radiation tape identifying the workstation</td>
</tr>
</tbody>
</table>

### 3.7.3 DECOMMISSIONING RADIOISOTOPE AREAS/LABORATORIES

The Internal Permit Holder shall ensure that all areas/rooms identified on his/her Internal Permit are decommissioned upon the expiry or termination of the Permit or no longer used for radioactive work. Decommissioning would include but not limited to the following:

1. Transfer or removal of all nuclear substances or devices to an approved site
2. Appropriate disposal of all radioactive waste
3. Removal of all radioactive warning signs and labels
4. Monitor all areas and decontaminate to meet the Western contamination limit for decommissioning.
6. Update all records
7. Records must be retained for the period ending three years after the expiry date of the last Internal Permit issued.

**CNSC Licence Contamination Criteria for Decommissioning**
### Classification* Non-fixed Contamination Limit

<table>
<thead>
<tr>
<th>Classification</th>
<th>Non-fixed Contamination Limit (averaged over an area not to exceed 100 cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A</td>
<td>0.3 Bq per square centimeter</td>
</tr>
<tr>
<td>Class B</td>
<td>3.0 Bq per square centimeter</td>
</tr>
<tr>
<td>Class C</td>
<td>30 Bq per square centimeter</td>
</tr>
</tbody>
</table>

Note: * See Section 4.4.3 for Classification of Selected Radionuclides
Non-fixed contamination at Western prior to decommissioning does not exceed 0.3 Bq/cm² for all class A radionuclides and 3 Bq/cm² for all class B & C radionuclides.

### 3.7.4 FRIVOLOUS POSTING OF RWS

Radioactive Warning Signs (RWS) may not be used in a place where the radiation or nuclear substance is not present.

### 3.8 LABORATORY MONITORING

#### 3.8.1 RADIOACTIVE CONTAMINATION & CONTROL

All Internal Permits require regular monitoring for contamination. To ensure compliance, wipe testing or using a properly functioning contamination meter (for P-32 or I-125 only) must be performed once per week or when work is completed, in all active areas by a Nuclear Energy Worker. *Wipe testing or using contamination meter needs not be performed, if no nuclear substance was handled for any specific week.* A floor plan of the areas being tested must be used and records of wipe test measurements must be kept in the record binder. Inventory records indicating the date of use of a radioisotope, must correspond to the appropriate frequency or date of the wipe test records. The action level for non-fixed contamination limit of unsealed nuclear substances used or stored in a permitted laboratory at Western is 3.0 Bq/cm².

#### 3.8.2 MEASUREMENT OF SURFACE CONTAMINATION BY WIPE TEST

1. Select an absorbent grade of filter paper with a diameter of about 5 centimetres.
2. Hold the filter paper on the edge with thumb and index finger and rub lightly but firmly over the surface, using the pads of the other fingers to apply light pressure - try to obtain the contamination on centre of the paper. Estimate the area that you have smeared, usually 100 cm² with an S-shaped pattern.
3. Place wipe in a vial, add scintillation fluid, and cap the vial. Count 1 to 2 minutes on a liquid scintillation counter with a channel setting of wide open window that detect all types of radiation.
4. Include a blank wipe to determine the net count-rate above background and standard with each set of wipes. Record the wipe test measurements and keep the printout from the counter in the record binder.
5. When using the wipe method of measurement, only a fraction of the contamination will be
removed, assume a smear efficiency of 10% and the counter efficiency of 50% a conservative approach for most radioactive nuclear substances used). The net count rate equals to 3 Bq/cm² is 900 cpm.

6. Any wiped area has a net count rate greater than 900 cpm, decontaminate the area and re-wipe the area. Record the results before and after the decontamination including the printout in the record binder.

**CNSC Licence Contamination Criteria:**

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Controlled Area Wipes: Bq/cm²</th>
<th>Public Area Wipes: Bq/cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Br-82</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>C-14</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>Ca-45</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>Co-57</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>Co-58</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>Co-60</td>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>Cr-51</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>F-18</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>Fe-59</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>Ga-67</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>H-3</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>I-123</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>I-125</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>I-131</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>In-111</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>Na-22</td>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>P-32</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>P-33</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>Ra-226</td>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>S-35</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>Sb-124</td>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>Sr-85</td>
<td>30</td>
<td>3</td>
</tr>
<tr>
<td>Tc-99m</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>Tl-201</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>Alpha emitter and their Daughter isotopes</td>
<td>3</td>
<td>0.3</td>
</tr>
</tbody>
</table>

(For radionuclide not listed above, contact the Radiation Safety Coordinator)

A wipe test result that exceeds the Western contamination criteria of 3 Bq/cm² must be cleaned/decontaminated and re-wiped. The re-wipe results must be recorded as well. The wipe test method is also preferable when background radiation is high in the area being checked or a portable radiation instrument is not suitable for the nuclides being used.

**3.8.3 MAINTENANCE & USE OF RADIATION DETECTION INSTRUMENTS**

All radiation monitoring instruments (portable and non-portable) must be registered with the Radiation Safety Coordinator and met the manufacturer’s specifications.
1. All radiation monitoring instruments must be maintained to ensure their properly functioning.
2. All portable meters will be inspected by the Radiation Safety Coordinator during a regular lab inspection. Any meter is not functioning properly must be removed from service until it is repaired.
3. A properly functioning portable contamination meters shall be available to workers at all times at the site of the licensed activity. Workers use high energy beta (e.g. P-32) or gamma radiation (e.g. I-125) shall have a properly functioning contamination meter available while performing the work, and monitor the workspace upon completion of the work.
4. A radiation survey meter shall be provided at all times where nuclear substances, except H-3 and Ni-63, are handled or stored. No person shall use, for the purpose of the Act, the regulations made under the Act or an order or a licence, a radiation survey meter that has not been calibrated within the 12 months preceding its use.

3.8.3.1 MEASUREMENT OF CONTAMINATION USING A PROPERLY FUNCTIONING CONTAMINATION METER

1. Check the contamination meter sticker for detector efficiency, minimum detectable activity and net cpm or cps equal to 3 Bq/2 and sticker date within one year.
2. Perform an operation check (i.e. battery, high voltage, response, etc), measure and record the background count rate in the contamination monitoring record form. Background should be measured in an area well away from the surfaces to be monitored.
4. Hold the detector close to the surface to be monitored at the distance of 1 cm, taking care not to touch the surface, and move the detector slowly across the surface.
5. Record all results in the contamination monitoring record form.
6. Any location is greater than 3 Bq/cm² (see meter sticker for net count rate in cpm or cps equal to 3 Bq/2), decontaminate the area and re-monitor. Record the results before and after decontamination.
7. If the reading is still higher than 3 Bq/cm² after repeated cleaning then it is a fixed contamination. The level of contamination remaining shall be posted at the contaminated area with radiation tape and report to the Radiation Safety Coordinator.

3.8.4 EFFICIENCY DETERMINATION OF CONTAMINATION METERS

1. Obtain desired radioactive standard.
2. Prepare a clean, flat surface which is free from all detectable radioactive contamination.
3. Place the radioactive standard on the clean surface with active side up (toward the detector).
4. Position the detector probe directly over the source at some reproducible distance (about 1 cm).
5. Observe and record the count rate on the meter.
6. Calculate the detection efficiency of the probe as follows:

Efficiency (4pi geometry) = \( \frac{\text{Detector count rate} - \text{Background count rate}}{\text{Known activity of standard source}} \)
3.8.5 LEAK TESTING SEALED SOURCES BY WIPE TEST

3.8.5.1 Every sealed source containing 50 MBq or more of a nuclear substance or a nuclear substance as shielding must receive a wipe test as follows:
1. Every six months for a sealed source or shielding is not located in a radiation device.
2. Every 12 months for sealed source or shielding in a radiation device.
3. Every 24 months for sealed source or shielding in storage.
4. Immediately before using the sealed source or shielding after being stored for 12 months or more consecutive months.
5. Immediately after the event that have damaged the sealed sources or shielding.
6. Valid leak testing certificate must be accompanied with other TDG documentation during transportation.
7. All of leak testing sealed sources are reviewed by the Radiation Safety Coordinator.
8. If a sealed source is leaking (the measured activity on the wiped sample is greater than 200 Bq), immediately discontinue use of the sealed source, shielding or radiation device in which the sealed source or shielding is located. Wipe test other areas near the sealed sources, and control the spread of radioactive contamination from the sealed source if necessary. Notify the CNSC that the leakage has been detected.
9. If the source is indeed leaking, the most likely resolution to the problem is to have the sealed source to be disposed of.

3.8.5.2 Subsection 3.8.5.1 does not apply in respect of a sealed source that is
1. Gaseous;
2. Contained in a static eliminator that has been retained by the licensee for less than 15 months;
3. Exempted under section 5, 6, 8 or 8.1 of Nuclear Substances and Radiation Devices regulations or
4. Used or stored underwater in a nuclear facility that is equipped with a device capable of detecting waterborne contamination of 200 Bq or less of a nuclear substance.

3.9 RADIOACTIVE WASTE DISPOSAL

Radioactive waste must be kept secured while in the laboratory (e.g. do not leave any container labeled as radioactive waste at the loading dock or any public area, unattended while waiting for pick-up). It is the responsibility of a Permit Holder to release all nuclear substances for disposal from his/her designated laboratories.

Determine the quantity of radioactivity used and disposed of according to experiment protocols. Record the quantity and method of disposal, date of disposal and the user name on the Inventory & Waste Record Form. The Inventory & Waste Record Forms must be completed and kept current at all times. The Inventory & Waste Record Form must be signed and dated when disposal is complete. Waste container or pail must have radiation warning sign, nuclear substance name, activity and date of activity at all times.

Radioactive wastes (liquid scintillation vials, solids, liquids, etc.) are normally submitted to
Environmental Safety personnel in the radioactive waste pail for disposal through delay and decayed process or within the CNSC disposal limits in the licence or through a licensed waste disposal companies as authorized by the Radiation Safety Coordinator. All wastes must not contain any viable bio-hazardous agents. Each radioactive waste pail contains only one nuclear substance and one type of waste and must have the following:

1. A completed Radioactive Waste Label Sticker on liquid waste container, solid waste bag or liquid scintillation vials bag. The radioactive labeled waste container or radioactive labeled bag must be contained in a radioactive waste pail. The radioactive waste pail must have the completed Radioactive Waste Label Sticker on it.
2. A radioactive pail must be checked for non-fixed contamination on surfaces (mainly outside) using a wipe test procedure then complete a Safe Transport of Radioactive Material form.

No radioactive waste shall be disposed to a sewer or regular garbage without consultation with the Radiation Safety Coordinator.

3.9.1 LIQUID SCINTILLATION VIALS

Solvent liquid scintillation vials and environmental biodegradable scintillation vials must be collected separately in the laboratory. Vials must be placed in a clear plastic bag in the radioactive waste pail. Vials must have caps that are securely fastened. Vials must not be leaking or show evidence of leaking.

Non-contaminated vials from wipe test can be submitted to Environmental Safety personnel as regular chemical waste.

Environmentally safe biodegradable scintillation fluid is highly recommended for wipe test and experimental procedures if possible.

Vials are normally disposed of via commercial waste company by Environmental Safety personnel.

3.9.2 LIQUID RADIOACTIVE WASTE

Aqueous (water soluble) liquid waste and organic solvent liquid waste must be collected separately in the laboratory. All liquid radioactive wastes must be collected in 4 litre plastic containers with Radioactive Waste Label on it. Close the cap tightly on the container when not being used and place it behind an appropriate shielding material if required.

When close to full and/or prior to disposal, count an aliquot of the solution and determine the activity in mCi or MBq. The outside of containers must be free of any contamination before submitted to Environmental Safety personnel. The liquid waste container must be placed in the clear plastic bag inside the radioactive waste pail.
The wash water from the normal, daily, glassware may be disposed via the sewer. No liquid containing radioactive materials shall be discharged to the laboratory sanitary sewer.

### 3.9.3 RADIOACTIVE STOCK SHIPMENT VIALS

All empty stock vials (no radioactivity) are submitted to Environmental Safety personnel as solid waste. Ensure that the bar code number is on the vial at the time of disposal. All shipment vial radioactive warning signs must be defaced or destroyed.

All vials with some residual activity must affix radioactive waste labels, indicating the date and the amount of activity remaining in the vial, and dispose of as liquid waste.

All environmentally hazardous materials such as lead, used in shielding containers should be disposed separately via Environmental Safety personnel.

### 3.9.4 SOLID COMBUSTIBLE RADIOACTIVE WASTE

All solid combustible radioactive waste must be collected in a clear plastic bag and contained in a radioactive pail or behind an appropriate shielding material (if required). Radioactive warning signs/labels must be destroyed or defaced before discarded into the clear plastic bag.

### 3.9.5 RADIOACTIVE SHARPS (needles and syringes)

All sharps used for dispensing radioactive materials must be placed in a Western approved sharps container with a Radioactive Waste Label on it. The container must be monitored and shielded if necessary.

The outside of sharps containers must be free of any contamination before submitted to Environmental Safety personnel.

### 3.9.6 RADIOACTIVE GLASS

All radioactive glass waste (glass test tubes, glass pipettes, etc.) from radioactive experiments must be collected in a clear plastic bag and contained in a radioactive pail.

Radioactive warning signs/labels must be destroyed or defaced before discarded into the clear plastic bag.

### 3.9.7 RADIOACTIVE ANIMAL CARCASSES & TISSUES

All radioactive contaminated animal carcasses and tissues must be frozen, held for the appropriate decay period and then incinerated. It is the responsibility of the researcher to provide freezer space for the animal material during this decay period. Animal materials may be incinerated when the
activity is decayed to background level or below the CNSC regulatory limits for solid waste.

At disposal, the animal material must be double bagged in an opaque bag and labeled with the appropriate "Incinerator approved label". Bags must not weigh more than 20 kg each.

### 3.9.8 SEALED SOURCES

Contact the Radiation Safety Coordinator for the disposal of all sealed sources and radiation devices containing sealed sources. A sealed source that contains more than the exemption quantity must be transferred to a radioactive waste company licensed by the CNSC. A sealed source that contains less than the exemption quantity of a radioactive nuclear substance may be disposed as regular waste.

### 3.9.9 SMOKE DETECTORS

Smoke detector may contain a small radioactive source. For more information, contact the Radiation Safety Coordinator.

### 3.9.10 MIXED BIOLOGICAL/RADIOACTIVE CONTAMINATED WASTE

The biological hazard must be treated first. For additional information, please refer to the Biological Waste in the U.W.O. Hazardous Materials Management Handbook. In some cases, contaminated biological/radioactive hazardous materials may be incinerated when the activity is decayed to background level or below the CNSC regulatory limits for solid waste.

Note: Do not autoclave contaminated biological/radioactive waste.

<table>
<thead>
<tr>
<th>Unsealed Nuclear Substance</th>
<th>Solids to Municipal Garbage System</th>
<th>Liquids (Water Soluble) to Municipal Sewer System</th>
<th>Gases to Atmosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MBq/kg</td>
<td>MBq/yr/Bldg</td>
<td>kBq/m³</td>
</tr>
<tr>
<td>Calcium 45</td>
<td>0.37</td>
<td>10000</td>
<td>n/a</td>
</tr>
<tr>
<td>Carbon14</td>
<td>3.7</td>
<td>10000</td>
<td>n/a</td>
</tr>
<tr>
<td>Chromium 51</td>
<td>3.7</td>
<td>100</td>
<td>n/a</td>
</tr>
<tr>
<td>Gold 198</td>
<td>0.1</td>
<td>100</td>
<td>n/a</td>
</tr>
<tr>
<td>Hydrogen-3</td>
<td>37</td>
<td>1000000</td>
<td>37</td>
</tr>
<tr>
<td>Indium 111</td>
<td>0.037</td>
<td>100</td>
<td>n/a</td>
</tr>
<tr>
<td>Iodine-123</td>
<td>3.7</td>
<td>100</td>
<td>n/a</td>
</tr>
<tr>
<td>Iodine-125</td>
<td>0.037</td>
<td>100</td>
<td>n/a</td>
</tr>
<tr>
<td>Iron 55</td>
<td>3.7</td>
<td>10000</td>
<td>n/a</td>
</tr>
<tr>
<td>Phosphorus 32</td>
<td>0.37</td>
<td>1</td>
<td>n/a</td>
</tr>
<tr>
<td>Phosphorus-33</td>
<td>1</td>
<td>10</td>
<td>n/a</td>
</tr>
<tr>
<td>Scandium 46</td>
<td>0.1</td>
<td>0.1</td>
<td>n/a</td>
</tr>
<tr>
<td>Sulfur-35</td>
<td>0.37</td>
<td>1000</td>
<td>n/a</td>
</tr>
</tbody>
</table>
Technetium-99 0.37 10000 n/a
Technetium 99m 3.7 1000 n/a

Note: No radioactive waste shall be disposed to a sewer or regular garbage without consultation with the Radiation Safety Coordinator.

3.10 ACCIDENTS AND EMERGENCIES

3.10.1 OPEN SOURCE RADIOACTIVE SPILLS

**Minor Spills**: typically less than 100 exemption quantities of a nuclear substance. Report the spill to the Permit Holder immediately or person in charge and, if necessary, to the Radiation Safety Coordinator.

**Major Spills**: involve more than 100 exemption quantities, or contamination of personnel, or release of volatile material. Notify the Permit Holder or person in charge and the Radiation Safety Coordinator immediately.

**Spill Procedures**
1. Inform persons in the area and keep them away from the contaminated area.
2. Cover the spill with absorbent material to prevent the spread of contamination.
3. Clear the area. Persons not involve in the spill should leave the immediate area. Limit the movement of all personnel who may be contaminated until they are monitored.
4. If the spill occurs in a laboratory, leave the fume hood running to minimize the release of any volatile nuclear substances to adjacent rooms and hallways.
5. Close off and secure the spill area to prevent entry. Post radiation warning sign(s).
6. Permit Holder or person in charge or the Radiation Safety Coordinator will direct personnel decontamination and will decide about decay or cleanup operations.
7. Persons who may have been contaminated should be monitored immediately with an appropriate contamination meter. Contaminated clothing should be removed and contaminated skin surfaces washed and re-surveyed. In general, decontamination personnel by removing contaminated clothing and flushing contaminated skin with lukewarm water and mild soap. For more information, please see Section 3.10.2 Personnel Contamination.
8. Wear protective clothing, disposal gloves and, if necessary, disposable foot covers during cleaning up of the spill.
9. Mark the location of the spill with a wax pencil or maker. Avoid spreading contamination.
10. Clean up the spill using absorbent paper and decontamination solution (ie soap and water). Work from the outside of the spill towards the centre. For more information, see Section 3.10.5 Decontamination Techniques.
11. Place contaminated clean-up materials in labeled plastic bags for transfer to a labeled waste container.
12. Following decontamination, wipe test the area, decontamination is complete when wiped samples are less than twice the background level.
14. Record spill details and contamination monitoring results. Adjust inventory and waste records.

3.10.2 PERSONNEL CONTAMINATION
1. If possible, locate contaminated area with an appropriate contamination meter.
2. If skin is intact, wet area and wash with a mild, non-abrasive soap. Rub gently into a lather for about three minutes and rinse thoroughly with lukewarm water. Repeat as necessary.
3. If skin is broken, wet-swab the area taking care not to spread the activity into the wound. Use warm water. Encourage bleeding to flush the wound if appropriate.
4. If contamination persists, inform the Radiation Safety Coordinator.
5. Take care not to spread the contamination over a larger area of skin.
6. Decontamination staff should wear disposable clothing to prevent personal contamination.
7. Place all contaminated clothing in materials in a plastic bag, seal and label.
8. Inform the Internal Permit Holder, the Radiation Safety Coordinator and submit a Western Accident/Incident Report Form to the Department of Occupational Health & Safety.

3.10.3 RELEASE OF AIRBORNE CONTAMINATION, LEAKAGE OF SEALED SOURCES, EXPLOSIONS OR FIRE

1. If possible, cut off the release of radioactivity material from the source to the environment.
2. Close windows, shut off fans, air conditioners, close lab doors and any air outlets to other areas. Open fume hoods to the maximum.
3. Evacuate personnel and prevent further personnel access to radiation area by closing and locking doors. Emergency personnel responding to the scene should be advised that radioactive materials may be present.
4. Monitor all persons who may be contaminated and determine which persons may have been exposed to external radiation and/or inhalation of radionuclides and to what degree.
5. Perform simple decontamination and contact the Radiation Safety Coordinator immediately. After hours call Western Police at 911, ask to page the OHS person on call.
6. The Internal Permit Holder will prepare a formal written report of the incident and forward to the Radiation Safety Coordinator.

3.10.4 DECONTAMINATION OF AREAS AND EQUIPMENT

Good working habits and good-housekeeping will prevent most contamination incidents and circumvent the need for decontamination.

Steps to follow if contamination occurs:
1. Decontaminate using processes listed below.
2. Various chemicals may be used, but the initial approach should be scrubbing with small quantity of hot water containing suitable cleaning agent. Use no more liquid than necessary.
3. All waste chemicals, water, rags, etc. created as a result of decontamination are to be disposed of in accordance with the "Waste Disposal Chart".
4. Discuss large scale decontamination with the Radiation Safety Coordinator.

3.10.5 DECONTAMINATION TECHNIQUES
<table>
<thead>
<tr>
<th>METHOD</th>
<th>SURFACE</th>
<th>ACTION</th>
<th>TECHNIQUE</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>High efficiency</td>
<td>Dry surfaces</td>
<td>Removes contaminated</td>
<td>Only use approved vacuum cleaners with a High Efficiency Filters.</td>
<td>Good on dry porous surfaces. Avoid water reactions.</td>
<td>All dust must be filtered out. Machine is contaminated.</td>
</tr>
<tr>
<td>vacuum cleaning</td>
<td></td>
<td>dust by suction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot water and detergent</td>
<td>All surfaces</td>
<td>Dissolves and erosion</td>
<td></td>
<td>Extremely effective if done immediately after spill and on a nonporous surface.</td>
<td>Of little value for decontaminating large areas or long standing contamination or porous surfaces.</td>
</tr>
<tr>
<td>Complexion agents</td>
<td>Nonporous</td>
<td>Forms soluble</td>
<td>Make solution of 3% Complexing agent with water. Spray surface with solution. Keep moist for 30 min. Remove solution and rinse. Immerse smaller objects in solution.</td>
<td>Keeps contamination in solution. Nontoxic and very effective.</td>
<td>Requires long soaking time (30 min) and has little penetration power.</td>
</tr>
<tr>
<td>(i.e. Decon 75 Alconox)</td>
<td>surfaces.</td>
<td>complexes with</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>contamination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic solvents</td>
<td>Nonporous</td>
<td>Dissolve organic</td>
<td>Immerse or apply solvent to surface. Blot up liquid and wipe clean.</td>
<td>Quick dissolving power.</td>
<td>Requires good ventilation, flammable, and toxic.</td>
</tr>
<tr>
<td></td>
<td>surfaces.</td>
<td>material (oil, paint, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inorganic acids</td>
<td>Metal</td>
<td>Dissolves metals</td>
<td>Immerse smaller objects in a 1-2 N acid solution. Flush surface with water. Scrub with detergent water mixture and rinse.</td>
<td>Corrosive action on metals and porous deposits.</td>
<td>Possibility of excessive corrosion. Acids are corrosive to personnel.</td>
</tr>
<tr>
<td></td>
<td>surfaces.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 3.10.6 INCIDENT/ACCIDENT REPORTING

Notify Permit Holder and Radiation Safety Coordinator immediately following:
- Lost or stolen of nuclear substance or radiation device
- Radiation device is damaged or sealed source is separated from radiation device
- Sealed source fails to return to shielded position inside radiation device
- Major radioactive spill (> 100 exemption quantity of a nuclear substance), contamination of personnel or release of volatile material.

The University shall notify CNSC Duty Officer at 613-995-0479 or 1-844-879-0805 immediately of the location and circumstances of the situation and of any action that the University has taken or proposes to take with respect to the above as required by the applicable CNSC regulations.
SECTION 4.0  APPENDICES

4.1     FORMS
         4.1.1 APPLICATION FORM

Western University

APPLICATION for approval to obtain a
RADIATION INTERNAL PERMIT

Please complete the requested information and return to:

Hoa Ly
Radiation Safety Coordinator
Room 4190, Support Services Building
Please call ext. 84746, if you have any questions.

**Personal Information: Internal Permit Holder**

Name: ________________________________________

Department, Building, & Room Number: ______________________________________

Work Phone: (519) ______________________ Ext. _____________________________

Home Phone: __________________________  Fax: _____________________________

Email: ________________________________

**Dosimetry/Nuclear Energy Worker Information**

SIN: _________________________  Date of Birth (mm/dd/yy):_________________

Place of birth (Province if Canada or country): __________________________________

Male  Female  (Circle one)

Have you ever worn a radiation monitor before?    Y     N

If yes, please state the country/province: _________________________________

Will you be the active user and require the use of radiation badge?    Y     N

**Radioisotope Training/Experience**

1. Date of Employment by the University: ______________________________________
2. Radiation safety training at this University: Y  N  
Date: ___________________________

3. Attach a description (date, location) of previous radiation safety training courses, work experience, and a list of publications related to nuclear substances use.

**Nuclear Substance and/or Radiation Device Information**

<table>
<thead>
<tr>
<th>Nuclear Substance</th>
<th>Chemical Form</th>
<th>Possession Limit (mCi or MBq)</th>
<th>Maximum Order (mCi or MBq)</th>
<th>Physical Form</th>
<th>Purpose</th>
<th>Make and Model of Radiation Device (if applicable)</th>
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**Experimental Protocol**

Describe in detail your experimental procedure for each nuclear substance, emphasize the aspects that pertain to safety issues, describe any special hazards, and include the following:

1. Brief description of purpose or objectives
2. Brief description of materials (indicate the types of equipment needed)
3. Brief description of methodology
4. Quantity of radioactivity used per experiment and the frequency
5. Names of personnel to handle this isotope
6. Laboratory(ies) where this procedure will be performed
7. Provide a waste disposal flow chart indicating approx. activities (mCi or MBq) for each type of waste (solid, liquid, liquid scintillation vials, etc.): Describe the types of waste that will be generated from each experimental protocol. Identify the volumes and activity amounts.
8. Will you be using animals?  Y  N
9. Will you be receiving any nuclear substance that is not purchased directly from a commercial company? (i.e. borrowing/sharing from another permit holder, LHSC-UH)
Yes □ No □ If yes, explain
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Locations of Use - Nuclear substances

<table>
<thead>
<tr>
<th>Building</th>
<th>Room Number</th>
<th>Phone</th>
<th>Nuclear substance to be used</th>
<th>Classification (For office Use only)</th>
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Diagram of the room

For each of the above, named locations, on a separate sheet, provide a diagram of the area or room.
1. Include fume hood, waste storage area, radioactive-use sink, work stations, stock vial storage (fig, freezer, storage cupboard) student or staff work/study area, scintillation counter, personal hygiene sink, solvent storage area, biological containment cabinet, centrifuge, etc.
2. Identify where each radioactive work station is located.
3. Identify where contamination monitoring locations are performed (both radioactive work area and non-radioactive work area)
4. Describe the storage facilities, security and access control that will be used.
____________________________________________________________________________
____________________________________________________________________________

Personal Protective Equipment

Indicate the personal protective equipment or clothing to be used: provided:
1. Laboratory Coat - required
2. Disposable gloves - required
3. Safety glasses/goggles
4. Shielding (indicate thickness and type) ____________________
5. Remote handling Tools (specify) _________________________
RADIATION DETECTION INSTRUMENTS

(1) Portable Radiation Survey Instrument

Note: if you are sharing an instrument with someone else, or from your Department, the following information may already be documented. Complete the Serial Number and Owner only. Please complete multiples of this page if you use/own more than one portable survey instrument.

Meter

Manufacturer: __________________ Model Number: __________________
Serial Number: ______________ Storage Location: ______________________
Owner: ______________ Custodian: ___________________________
Western ID Tag #: __________________

Probe

Type: __________________ e.g. pancake Geiger-Mueller probe, NaI probe
Manufacturer: __________________
Probe Model: __________________ Serial Number: __________________
Check Source (if applicable): Isotope: ___________
Activity: ___________ Date of Activity ___________

Service Record

Purchase Date: ______________________________
Last Calibration Date: _________________________
Next Calibration Due Date: _____________________
Last Service Date: ___________________________

(2) Non-portable Counter (Liquid Scintillation, Sodium Iodide, etc.)

Note: if you are sharing an instrument with someone else, or from your Department, the following information may already be documented. Complete the Serial Number and Owner only. Please complete multiples of this page if you use/own more than one scintillation counter.
Type: Beta □  Gama □  Western ID Tag # _______________________

Manufacturer: ___________________  Model Number: ___________________

Serial Number: ___________________  Room Location: ___________________

Owner: ___________________________  Custodian: _______________________

Sealed Source(s) – Internal

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<tr>
<th>Nuclide</th>
<th>Quantity (mCi)</th>
<th>Calibration Date</th>
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Sealed Source(s) – External

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<th>Nuclide</th>
<th>Quantity (mCi)</th>
<th>Calibration Date</th>
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Service Record

Purchase Date: _______________________

Purchase Cost: _______________________

Last Calibration Date: _______________________

Next Calibration Date: _______________________

Is there a service contract for this instrument? Yes □ No □
### Personnel

Identify the names of all persons who will use nuclear substances or radiation devices under your supervision.

<table>
<thead>
<tr>
<th>Name</th>
<th>Email</th>
<th>Nuclear substances to be handled</th>
<th>Last date of Western Radiation Safety Training</th>
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*(Note: Attendance at Western radiation safety training is mandatory before any of the above named persons may be authorized as a worker on your Internal Permit. Radiation badges will be issued (if necessary) after radiation safety training is complete.)*

The applicant certifies that all information submitted is true and correct to the best of his/her knowledge. The applicant accepts the responsibilities as a Permit Holder and complies with the Nuclear Safety Control Act and Regulations, CNSC license conditions, Western policies, procedures and internal permit conditions.

Signed: Applicant Date: ________________

Signed: Department Chair Date: ________________

Signed: Radiation Safety Coordinator Date: ________________

Signed: Radiation Safety Committee Chair (AVP – Research) or Designate Date: ________________
WESTERN UNIVERSITY
NUCLEAR SUBSTANCE INVENTORY & WASTE FORM

BAR CODE # ______________________     AUTHORIZED BY: __________________

Permit Holder: ___________________   Permit #: _______________________
Nuclear Substance: __________________      Chemical Form: __________________
Purchase Order #:__________________   Wipe test of shipping vial on receipt? Yes (circle)
Total Activity ____________________    Total Volume: ______________________
Date of Activity: ___________________    Received Date: ___________________
Storage – Room/location: _______________    Received By: ______________________

<table>
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<tr>
<th>Date Used (m/d/y)</th>
<th>Name of User</th>
<th>Activity Used (eg: 100 uCi)</th>
<th>Activity Remaining</th>
<th>Disposal Method* and Measured Activity for Disposal (eg: LI = 50 uCi, S1 = 50 uCi)</th>
<th>Date of Disposal (m/d/y)</th>
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Date of Shipping Vial Disposal (m/d/y): Name: __________________________Signature: ______________

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<th>LIQUID (L)</th>
<th>SOLIDS (S)</th>
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<tbody>
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<td>LI Liquid to Environmental Safety Personnel</td>
<td>S1 Solid to Environmental Safety Personnel</td>
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<tr>
<td>L2 Liquid Scintillation Vials to Environmental Safety</td>
<td>S2 Return to Supplier (see note below)</td>
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<tr>
<td>L3 Transfer to another Research Unit (see note below)</td>
<td>S3 Transfer to another Research Unit (see note below)</td>
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<tr>
<td>L4 Storage until decayed to background level</td>
<td>S4 Storage until decayed to background level</td>
</tr>
<tr>
<td>L5 Return to Supplier (see note below)</td>
<td>S5 Store animals until decayed to background or below CNSC disposal limit (see note below)</td>
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**NOTE:** No radioactive waste shall be disposed to the sewer, regular garbage, transfer or return without consultation with the Western Radiation Safety Coordinator.
4.1.3 NUCLEAR SUBSTANCE ROOM DECOMMISSIONING FORM

The permit holder shall ensure that prior to decommissioning any area, room or enclosure where the permitted activity has been conducted: non-fixed contamination does not exceed 0.3 Bq/cm² for all class A radionuclides or 3 Bq/cm² for all class B & C radionuclides (see classification of selected radionuclides in the section 4.2 of the Western radiation safety manual.); averaged over an area not exceeding 100 cm². Any area, room, or enclosure containing fixed contamination must be reported to the Radiation Safety Coordinator.

Internal Permit Holder: _________________________________________________________

Lab Building & Number: ______________________________________________________

Performed By: ___________________________    Phone # ____________________________

Signature

1. Removal of required Postings/Signs:                              Completed
   1. Internal permit                                      Y   N
   2. CNSC safety poster(s)                                Y   N
   3. Western waste label(s)                               Y   N
   4. CNSC licence (if applicable)                          Y   N
   5. Entry door warning sign                               Y   N

2. Other labels:
   1. Refrigerator/freezer label                          Y   N
   2. Storage areas                                      Y   N
   3. Tape surrounding workstation                       Y   N
   4. Pipettors                                         Y   N
   5. Other lab equipment                                 Y   N

3. Inventory: records completed, stock vials, sources, tubes etc. disposed   Y   N

4. Radioactive Waste:
   1. Dispose of all remaining waste                       Y   N
   2. Check frig/freezer & dispose of all labeled contents Y   N
   3. Return pails to Environmental Safety                 Y   N

5. Dosimetry: Inform the TLD badge coordinator to remove name(s) from radiation exposure monitoring list (if applicable)   Y   N

6. Radiation Measuring Instruments (e.g. Scintillation Counter): Will these be disposed or transferred to someone else (identify all)? Provide details below:

____________________________________________________________________________
Contamination Monitoring Results

Provide a floor plan of the lab/area to be decommissioned. Indicate the locations of wipe test on the floor plan by a representative number and records results in the table below.

Radionuclide(s) being sampled or monitored for:
Iodine 125 Carbon 14 Chromium 51
Hydrogen 3 Sulfur 35 Calcium 45
Phosphorous 32 Phosphorous 33 Other (Identify) ____________

Counter Used (type, make and model): _______________________________

Calibration Date: _______________________ Background in CPM: _________

Lowest detector efficiency E: (e.g. 35% efficiency, E = 0.35) _____________

| Area sampled on the attached floor plan | Gross count in CPM | Net count in CPM | Contamination level in Bq/cm² 
(Net count in CPM)/(E x 600) |
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Please attach any additional area sampled on the floor plan if required
Potential fixed contamination is measured using an appropriate contamination meter at the above locations. Any measured location that is higher than the background level must be reported to the Radiation Safety Coordinator.
Potential radiation field is measured with calibrated dose rate meter. If the radiation field is above the background level, the source of radiation must be determined and removed or cleaned until the radiation field is equal to the background level.

Meter(s) used: _________________________________________________________________________

Reviewed by: ____________________________ Date: __________
Permit Holder

Reviewed by: ____________________________ Date: __________
Radiation Safety Coordinator
4.1.4 Western University
Unsealed Nuclear Substance Contamination Monitoring Record

Permit Holder: ________________________ Room number(s): ______________________

1. Indirect Monitoring (Wipe test using non-portable counter such as Liquid Scintillation Counter or NaI Counter)

Counter Type ____________________ Make _____________________ Model _________________

Contamination limit is 3 Bq/cm² or net count rate 900 cpm (assuming 10% collection efficiency, 100 cm² wiped area and 50% detector efficiency as a conservative approach for most unsealed nuclear substances used) or calculated net count rate (cpm) equal to 3 Bq/cm² if detector efficiency is less than 50%: ___________

Record results in the table below accordingly and keep the print out from the counter in the binder.

2. Direct Monitoring (Using Western calibrated contamination meter(s) for P-32 and/or I-125)

Make and Model of Meter(s): __________________________________________________

Net count rate in cpm or cps equal to 3 Bq/cm² for P-32 (from the calibration sticker) _______________
Net count rate in cpm or cps equal to 3 Bq/cm² for I-125 (from the calibration sticker) _______________

Direct Monitoring can be used for weekly documented contamination monitoring if radioactive work only involved P-32 and/or I-125 during that week.

Record results in the table below accordingly.

Note: If no radioactive work for any specific week then contamination monitoring is not required. Please indicate all non-radioactive work weeks such as ANo Radioactive Work®.

DO NOT LEAVE ANY WEEK BLANK

Numbered areas to be monitored indicated on the room diagram

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<tr>
<th>Year (        )</th>
<th>Name of Tester</th>
<th>Isotope used</th>
<th>Counted Unit</th>
<th>Background</th>
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CONTAMINATION LEVEL (Bq/cm²) = \( \frac{S - B}{E \times A \times T \times F} \)

Where:
- \( S \) = Sample count rate (cpm or cps)
- \( B \) = Background count rate (cpm or cps)
- \( E \) = Detector efficiency (e.g. if 50% efficiency, \( E = 0.50 \))
- \( A \) = Area wiped (100 cm²) or detector area in cm²
- \( T \) = 60 sec/min if count rate in cpm
- \( T = 1 \) if count rate in cps
- \( F = 0.1 \) (e.g. 10%) is collection factor for area wiped (indirect monitoring or wipe test)

Net count rate (cpm or cps) = Sample count rate (cpm or cps) – Background count rate (cpm or cps)

Detector efficiency = Net count rate (cpm) / Known activity (dpm)

1 microcurie (uCi) = \( 2.2 \times 10^6 \) disintegrations per minute (dpm)

Detector efficiency = Net count rate (cps) / Known activity (dps)

1 Becquerel (Bq) = 1 disintegration per second (dps)

1 microcurie (uCi) = 37 kilobecquerel (kBq) = 37000 becquerel (Bq)

Non-fixed contamination in all areas, rooms or enclosures where unsealed nuclear substances are used or stored does not exceed 3 Bq/cm².

**Problem:**
You have taken a swipe for unsealed H-3 and S-35 contamination in your designated radiation room. The liquid scintillation counter print out shows a sample count rate of 940 cpm for the swipe of the fume hood in 100 cm². The minimum detector efficiency is 50% and the background count rate is 40 cpm. What is the contamination level in Bq/cm²?

**Solution:**
Contamination level (Bq/cm²) = \( \frac{940 \text{ cpm} - 40 \text{ cpm}}{0.5 \times 100 \text{ cm}^2 \times 60 \text{ sec/min} \times 0.1} \)

Therefore, the contamination level is 3.0 Bq/cm².

Also, if you know the contamination limit in Bq/cm² and the counter print out shows in cpm then you can calculate a net count rate in cpm equal to the known contamination limit using the contamination level formula above. For example, the contamination limit is 3 Bq/cm², 10% collection efficiency, 100 cm² wiped area and 50% detector efficiency (as a conservative approach for most unsealed nuclear substances used.). Therefore, the calculated net count rate is 900 cpm.
Western University is committed to the health and safety of its employees. To this end, in the Radiation Safety program, the University informs all those working with nuclear materials including nuclear substances, radiation devices or class II prescribed equipment as Nuclear Energy Workers (NEWS). In accordance with the Nuclear Safety and Control Act and Regulations of Canada, the University is required to inform such NEW status if there is a reasonable probability of an individual receiving a radiation dose (effective dose) greater than the dose limit for the general public (1 mSv per year for the whole body). The radiation dose is tracking by the National Dose Registry maintained by the Radiation Protection Bureau of Health Canada of each workers lifetime exposure to radioactive material.

Western is committed to taking every reasonable precaution, as is practical, to maintain the radiation exposure of all Nuclear Energy Workers, staff, students and the public to ALARA, (As Low As Reasonably Achievable).

As a Nuclear Energy Worker you must be aware of the following critical radiation levels:

- Natural background levels: 2.0 –3.0 mSv/year
- Typical occupational level: 0.2-1.0 mSv/year
- Effective dose limit: (a) One-year dosimetry period: 50 mSv (b) Five-year dosimetry period: 100 mSv. The average is 20 mSv/year in five year period
- Action level of effective dose: 2.0 mSv/year (any value greater than this must be investigated and reported to the CNSC)

You must also be familiar with the following documents, which are provided to you:

1. The applicable dose limits as specified in the Radiation Protection Regulations by the Canadian Nuclear Safety Commission
2. Dose limits for pregnant Nuclear Energy Workers in section 13 of the Radiation Protection Regulations of the Canadian Nuclear Safety Commission
3. Radiation Risk in Perspective, a position statement of Health Physics Society
4. Risk Assessment, a position statement of Health Physics Society

A pregnant Nuclear Energy Worker must inform in writing as specified in section 11(1) of the Radiation Protection Regulations, her Internal Permit Holder and the Radiation Safety Officer in writing as soon as she is aware of her condition. The University must also follow section 11(2) of the Radiation Protection Regulations on being informed by a nuclear energy worker that she is pregnant.

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

Name ___________________________________________ Department _________________________

Signature _________________________________________ Date: _____________________________

Signature of Radiation Safety Officer ____________________Date: _____________________________
4.2 POSTINGS & LABELS

4.2.1 Radiation Warning Sign for Designated Nuclear Substance Room Door

Specific Storage Location in Designated Nuclear Substance Room (i.e. Fridge, Freezer)
4.2.2 CNSC Basic Level Room Poster

**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.

- 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 two 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 5D9
Telephone: 1-888-229-2872
Fax: (613) 996-5906

nuclearsafety.gc.ca

Canadi
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 dosimeter 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
DINAS, ON K1P 5S9
Telephone: 1-888-229-2372
Fax: 613-995-5066

nuclearsafety.gc.ca
Canada

Cat No. GC52-2949E-MZ
4.2.4 CNSC High Level Room Poster

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.

- 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 an appropriate area 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 5E9
Telephone: 1-888-329-2672
Fax: 613-995-5000

nuclearsafety.gc.ca

Canada

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4.2.5 CNSC GUIDELINES FOR HANDLING PACKAGES CONTAINING NUCLEAR SUBSTANCES POSTER

GUIDELINES FOR HANDLING PACKAGES CONTAINING NUCLEAR SUBSTANCES

Identifying Packages Containing Nuclear Substances

The packaging and labelling 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 label also shows the radiation dose rates.

On Excepted Packages, no external labelling 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 I - WHITE: Does not exceed 5 μSv·h at any location on the external surface of the package.
- Category II - YELLOW: Does not exceed 50 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(0.3 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 99 of the PTNS Regulations.

Opening Packages Containing Nuclear Substances

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1. If an appropriate survey meter is available, monitor the radiation fields around the package. Note any discrepancies.
2. Avoid unnecessary direct contact with unlabeled containers.
3. Verify the nuclear substance, the quantity, and other details with the information on the packing slip and with the purchase order.
4. Log the shipment details and any anomalies in the inventory record.
5. Report any anomalies (radiation levels in excess of package labelling, incorrect transport index, contamination, leaking, 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 solute, 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 dislodgement 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 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 of it in accordance with the conditions of the Nuclear Substances and Radiation Devices licence.

For more information, contact: Directorate of Nuclear Substance Regulations, Canadian Nuclear Safety Commission, P.O. Box 1046, Station B, Ottawa, ON, K1P 5H9. Telephone: 1-800-229-2672, Fax: (613) 995-5800.
4.2.6 CNSC SPILL PROCEDURES POSTER

SPILL PROCEDURES

Report any spill to the nearest radiation safety officer or supervisor.

Radiation safety officer

Telephone number

Supervisor emergency contact

Telephone number

General information

1. Do not wash or rinse spills. Use appropriate protective clothing.
2. Use sponges, absorbent materials, or vacuum spillage and report spill to supervisor.
3. Do not wash or rinse spills. Use appropriate protective clothing.
4. Use sponges, absorbent materials, or vacuum spillage and report spill to supervisor.
5. Do not wash or rinse spills. Use appropriate protective clothing.
6. Use sponges, absorbent materials, or vacuum spillage and report spill to supervisor.

Spill prevention

1. Do not wash or rinse spills. Use appropriate protective clothing.
2. Use sponges, absorbent materials, or vacuum spillage and report spill to supervisor.
3. Do not wash or rinse spills. Use appropriate protective clothing.
4. Use sponges, absorbent materials, or vacuum spillage and report spill to supervisor.
5. Do not wash or rinse spills. Use appropriate protective clothing.
6. Use sponges, absorbent materials, or vacuum spillage and report spill to supervisor.

Spill response

1. Do not wash or rinse spills. Use appropriate protective clothing.
2. Use sponges, absorbent materials, or vacuum spillage and report spill to supervisor.
3. Do not wash or rinse spills. Use appropriate protective clothing.
4. Use sponges, absorbent materials, or vacuum spillage and report spill to supervisor.
5. Do not wash or rinse spills. Use appropriate protective clothing.
6. Use sponges, absorbent materials, or vacuum spillage and report spill to supervisor.

For more information, contact:

Deputy Director, Health Sciences
Canadian Nuclear Safety Commission
P.O. Box 4000 Station B
Ottawa, ON, K1Y 4M2
Telephone: 1-800-967-0706
Fax: 1-800-441-6611

nuclearsafety.gc.ca

Canada
4.3 RADIATION PROTECTION INFORMATION

4.3.1 RADIATION UNITS

ROENTGEN (R): Describes the ionizing ability of Gamma and X-rays.

RAD OR GRAY (rad or Gy): The radiation absorbed dose is used to measure the energy deposited in a substance by any type of radiation. For x-ray and Gamma radiation 1 rad is equivalent to 1 roentgen.

REMS OR SIEVERT (rem or Sv): This unit takes into account the biological effects of different types of radiation. This is done by multiplying the dose by the Quality Factor (listed below).

QUALITY FACTOR (Radiation Weighting Factors)

<table>
<thead>
<tr>
<th>Item</th>
<th>Type of Radiation and Energy Range</th>
<th>Weighting Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Photons, all energies</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Electrons and muons, all energies$^1$</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Neutrons$^2$ of energy $&lt; 10$ keV</td>
<td>5</td>
</tr>
<tr>
<td>4.</td>
<td>Neutrons of energy $10$ keV to $100$ keV</td>
<td>10</td>
</tr>
<tr>
<td>5.</td>
<td>Neutrons of energy $&gt;100$ keV to $2$ MeV</td>
<td>20</td>
</tr>
<tr>
<td>6.</td>
<td>Neutrons of energy $&gt;2$ MeV to $20$ MeV</td>
<td>10</td>
</tr>
<tr>
<td>7.</td>
<td>Neutrons of energy $&gt;20$ MeV</td>
<td>5</td>
</tr>
<tr>
<td>8.</td>
<td>Protons, other than recoil protons, of energy $&gt;2$ MeV</td>
<td>5</td>
</tr>
<tr>
<td>9.</td>
<td>Alpha particles, fission fragments and heavy nuclei</td>
<td>20</td>
</tr>
</tbody>
</table>

$^1$ Excluding Auger electrons emitted from nuclei bound to DNA.

$^2$ Radiation weighting factors for these neutrons may also be obtained by referring to the continuous curve shown in Figure 1 on page 7 of the 1990 Recommendations of the International Commission on Radiological Protection, ICRP Publication 60, published in 1991.
### 4.3.2 Conversion of Units

#### The rad (rad) is replaced by the gray (Gy)

<table>
<thead>
<tr>
<th>Unit (rad)</th>
<th>Equivalent (Gy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kilorad (krad)</td>
<td>10 grays (Gy)</td>
</tr>
<tr>
<td>1 rad (rad)</td>
<td>10 milligrays (mGy)</td>
</tr>
<tr>
<td>1 millirad (mrad)</td>
<td>10 micrograys (uGy)</td>
</tr>
<tr>
<td>1 microrad (urad)</td>
<td>10 nanograys (nGy)</td>
</tr>
</tbody>
</table>

#### The gray (Gy) replaces the rad (rad)

<table>
<thead>
<tr>
<th>Unit (Gy)</th>
<th>Equivalent (rad)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 gray (Gy)</td>
<td>100 rad (rad)</td>
</tr>
<tr>
<td>1 milligray (mGy)</td>
<td>100 millirad (mrad)</td>
</tr>
<tr>
<td>1 microgray (uGy)</td>
<td>100 microrad (urad)</td>
</tr>
<tr>
<td>1 nanogray (nGy)</td>
<td>100 nanorad (nrad)</td>
</tr>
</tbody>
</table>

#### The rem (rem) is replaced by the sievert (Sv)

<table>
<thead>
<tr>
<th>Unit (rem)</th>
<th>Equivalent (Sv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kilorem (krem)</td>
<td>10 sieverts (Sv)</td>
</tr>
<tr>
<td>1 rem (rem)</td>
<td>10 millisieverts (mSv)</td>
</tr>
<tr>
<td>1 millirem (mrem)</td>
<td>10 microsieverts (uSv)</td>
</tr>
<tr>
<td>1 microrem (urem)</td>
<td>10 nanosieverts (nSv)</td>
</tr>
</tbody>
</table>

#### The Sievert (Sv) replaces the rem (rem)

<table>
<thead>
<tr>
<th>Unit (Sv)</th>
<th>Equivalent (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 sievert (Sv)</td>
<td>100 rem (rem)</td>
</tr>
<tr>
<td>1 millisievert (mSv)</td>
<td>100 millirem (mrem)</td>
</tr>
<tr>
<td>1 microsievert (uSv)</td>
<td>100 microrem (urem)</td>
</tr>
<tr>
<td>1 nanosievert (nSv)</td>
<td>100 nanorem (nrem)</td>
</tr>
</tbody>
</table>

#### The curie (Ci) is replaced by the becquerel (Bq)

<table>
<thead>
<tr>
<th>Unit (Ci)</th>
<th>Equivalent (Bq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kilocurie (kCi)</td>
<td>37 terabecquerels (TBq)</td>
</tr>
<tr>
<td>1 curie (Ci)</td>
<td>37 gigabecquerels (GBq)</td>
</tr>
<tr>
<td>1 millicurie (mCi)</td>
<td>37 megabecquerels (MBq)</td>
</tr>
<tr>
<td>1 microcurie (uCi)</td>
<td>37 kilobecquerels (KBq)</td>
</tr>
<tr>
<td>1 nanocurie (nCi)</td>
<td>37 becquerels (Bq)</td>
</tr>
</tbody>
</table>

#### The becquerel (Bq)* replaces the curie (Ci)

<table>
<thead>
<tr>
<th>Unit (Bq)</th>
<th>Equivalent (Ci)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 terabecquerel (TBq)</td>
<td>27 curies (Ci)</td>
</tr>
<tr>
<td>1 gigabecquerel (GBq)</td>
<td>27 millicuries (mCi)</td>
</tr>
<tr>
<td>1 megabecquerel (MBq)</td>
<td>27 microcuries (uCi)</td>
</tr>
<tr>
<td>1 kilobecquerel (KBq)</td>
<td>27 nanocuries (nCi)</td>
</tr>
<tr>
<td>1 becquerel (Bq)</td>
<td>27 picocuries (pCi)</td>
</tr>
</tbody>
</table>

---

*1Bq = 1 disintegration/second

1 microcurie = 2.2 x 10^6 disintegration per minute
1 becquerel = 1 disintegration per second
disintegration per minute = count per minute/detector efficiency

---

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4.3.3 DECAY RATES

Radiation source activity at any time (t) can be calculated from the initial activity or activity at reference date using the following formula:

\[ A = A_0 \left(0.5\right)^{t/T_{1/2}} \]

Where:
- \( A \) = Final activity or activity at time (t)
- \( A_0 \) = Initial activity or activity at reference date
- \( t \) = The elapsed time between \( A \) and \( A_0 \)
- \( T_{1/2} \) = Half-life of a radioactive isotope

4.3.4 DOSE RATE FROM A POINT SOURCE OF PHOTONS

The point source approximation is applicable whenever the dose is calculated at a distance that is at least three times the largest source dimension. If we exclude the attenuation factor, we can write for the exposure rate or dose rate from a point source of gamma photons in expression of the following form:

\[ X = \Gamma \times \frac{A}{r^2} \]

Where:
- \( X \) = Exposure rate (R/h) or dose rate (rem/h) at distance \( r \)
- \( \Gamma \) = Specific gamma ray constant (R·m²/Ci·h)
- \( A \) = Activity of the source (Ci)
- \( r \) = Distance from the point source (m)

Specific gamma ray constant of some radioisotopes

<table>
<thead>
<tr>
<th>Radioisotope</th>
<th>( \Gamma )  \ R · m²/Ci · h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony 122</td>
<td>0.24</td>
</tr>
<tr>
<td>Cesium 137</td>
<td>0.33</td>
</tr>
<tr>
<td>Chromium 51</td>
<td>0.016</td>
</tr>
<tr>
<td>Cobalt 60</td>
<td>1.32</td>
</tr>
<tr>
<td>Gold 198</td>
<td>0.23</td>
</tr>
<tr>
<td>Iodine 125</td>
<td>0.07</td>
</tr>
<tr>
<td>Iodine 131</td>
<td>0.22</td>
</tr>
<tr>
<td>Iridium 192</td>
<td>0.48</td>
</tr>
<tr>
<td>Mercury 203</td>
<td>0.13</td>
</tr>
<tr>
<td>Potassium 42</td>
<td>0.14</td>
</tr>
<tr>
<td>Radium 226</td>
<td>0.825</td>
</tr>
<tr>
<td>Sodium 22</td>
<td>1.20</td>
</tr>
<tr>
<td>Sodium 24</td>
<td>1.84</td>
</tr>
<tr>
<td>Zinc 65</td>
<td>0.27</td>
</tr>
</tbody>
</table>
If specific gamma ray constant $\Gamma$ is not provided, gamma exposure rate or dose rate can be estimated from the properties of the source using the following relationship (+/- 20% of actual value of the gamma ray constant)

$$\Gamma = 0.5 \sum E_i Y_i$$

Where:
$E_i$ = Energy of the $i^{th}$ gamma ray from the source (MeV)
$Y_i$ = Yield of the $i^{th}$ gamma ray from the source

### 4.3.5 BASIC EXTERNAL RADIATION PROTECTION

Radiation protection practice is a special aspect of the control of environmental health hazard by one or more of the following three techniques:
1. Minimizing exposure time
2. Maximizing distance from the radiation source
3. Shielding the radiation source

#### Time

Many biological effects of radiation are dependent on dose rate, it may be assumed, for environmental control, that the reciprocity relationship

Total dose = dose rate $\times$ exposure time

The more time workers spend in radiation areas, the more radiation dose they receive. Some effective methods of reducing exposure time are: job pre-planning, practicing the job on a mock-up outside the radiation area or in a low radiation area and ensuring that all required tools, equipment, materials and personnel are staged and ready to go before the radiation job starts.

#### Distance

The exposure rate from a gamma point source is inversely proportional to the square of the distance from the source. The Inverse Square Law can be expressed as follows

$$X_1 (d_1)^2 = X_2 (d_2)^2$$

Where:
$X_1$ = Exposure rate at distance $d_1$
$X_2$ = Exposure rate at distance $d_2$

#### Shielding

Negative beta particles: Shielding is required for high energy particles (0.5 MeV or higher) such as P-32, Y-90, Na-24, Bi-214, etc. The best materials to shield negative beta particles have low density and atomic
number Z. High density materials will increase bremsstrahlung production. The most common material used to shield negative beta particles is plastic (lucite).

### Penetration Ability of Negative Beta Radiation

<table>
<thead>
<tr>
<th>Energy (MeV)</th>
<th>Nuclear Substance</th>
<th>Maximum Range of Negative Beta Particle (cm) in Plastic (Lucite)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.392</td>
<td>Na-24</td>
<td>0.5</td>
</tr>
<tr>
<td>1.51</td>
<td>Bi-214</td>
<td>0.6</td>
</tr>
<tr>
<td>1.71</td>
<td>P-32</td>
<td>0.7</td>
</tr>
<tr>
<td>2.273</td>
<td>Y-90</td>
<td>1</td>
</tr>
</tbody>
</table>

Gamma: Gamma photon absorption is an exponential process, which means that gamma photons are never completely stopped, regardless of the thickness of the absorber. Our goal is to reduce the gamma radiation to the acceptable levels for the work we need to do. For quick shielding estimates, the half-value thickness concepts can be used. A half-value thickness (HVT) is the thickness of material that reduces the radiation intensity to one-half of its initial value.

\[ I = I_0 \times (0.5)^n \]

Where:
- \( I \) = Final intensity
- \( I_0 \) = Initial intensity
- \( n \) = the number of HVTs = \( \frac{\text{thickness of shielding material}}{\text{HVT}} \)

### HVT for gamma and X-rays of various energies in three common shielding materials (cm)

<table>
<thead>
<tr>
<th>Energy (MeV)</th>
<th>Lead (11.35 g/cm²)</th>
<th>Iron (7.86 g/cm²)</th>
<th>Concrete (2.35 g/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3</td>
<td>0.160</td>
<td>0.845</td>
<td>2.7</td>
</tr>
<tr>
<td>0.4</td>
<td>0.278</td>
<td>0.9535</td>
<td>3.075</td>
</tr>
<tr>
<td>0.5</td>
<td>0.396</td>
<td>1.062</td>
<td>3.39</td>
</tr>
<tr>
<td>0.6</td>
<td>0.4584</td>
<td>1.1438</td>
<td>3.64</td>
</tr>
<tr>
<td>0.7</td>
<td>0.5478</td>
<td>1.2256</td>
<td>3.894</td>
</tr>
<tr>
<td>0.8</td>
<td>0.6372</td>
<td>1.3074</td>
<td>4.146</td>
</tr>
<tr>
<td>0.9</td>
<td>0.7266</td>
<td>1.3892</td>
<td>4.398</td>
</tr>
<tr>
<td>1.0</td>
<td>0.816</td>
<td>1.471</td>
<td>4.65</td>
</tr>
<tr>
<td>1.1</td>
<td>0.8876</td>
<td>1.5434</td>
<td>4.864</td>
</tr>
<tr>
<td>1.2</td>
<td>0.9592</td>
<td>1.6158</td>
<td>5.078</td>
</tr>
<tr>
<td>1.3</td>
<td>1.0308</td>
<td>1.6882</td>
<td>5.292</td>
</tr>
<tr>
<td>1.4</td>
<td>1.1024</td>
<td>1.7606</td>
<td>5.506</td>
</tr>
<tr>
<td>1.5</td>
<td>1.174</td>
<td>1.833</td>
<td>5.72</td>
</tr>
<tr>
<td>1.6</td>
<td>1.2108</td>
<td>1.8812</td>
<td>5.98</td>
</tr>
<tr>
<td>-----</td>
<td>--------</td>
<td>--------</td>
<td>------</td>
</tr>
<tr>
<td>1.7</td>
<td>1.2476</td>
<td>1.9294</td>
<td>6.096</td>
</tr>
<tr>
<td>1.8</td>
<td>1.2844</td>
<td>1.9776</td>
<td>6.284</td>
</tr>
<tr>
<td>1.9</td>
<td>1.3212</td>
<td>2.0258</td>
<td>6.472</td>
</tr>
<tr>
<td>2.0</td>
<td>1.358</td>
<td>2.074</td>
<td>6.66</td>
</tr>
<tr>
<td>2.5</td>
<td>1.443</td>
<td>2.294</td>
<td>7.045</td>
</tr>
<tr>
<td>3.0</td>
<td>1.474</td>
<td>2.483</td>
<td>8.15</td>
</tr>
<tr>
<td>3.5</td>
<td>1.506</td>
<td>2.585</td>
<td>8.755</td>
</tr>
</tbody>
</table>
4.3.6 Selected Isotope Data Sheets

4.3.6.1 Phosphorus 32 (P-32)

Radiation Data Sheet

This data sheet presents information on radioisotopes only.
For information on chemical compounds incorporating this radioisotope, see the relevant Material Safety Data Sheet.

Part 1 - RADIOACTIVE MATERIAL IDENTIFICATION

<table>
<thead>
<tr>
<th>Chemical Symbol:</th>
<th>P</th>
<th>Common Names:</th>
<th>Phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic Weight:</td>
<td>32</td>
<td>Atomic Number:</td>
<td>15</td>
</tr>
</tbody>
</table>

Part 2 - RADIATION CHARACTERISTICS

Physical Half-Life: 14.3 days
CNSE Exemption Quantity (in Bq): $1 \times 10^9 \text{ (10 kBq)}$
A CNSC license is not required if the amount of radioactive nuclides possessed is less than one Exemption Quantity.

<table>
<thead>
<tr>
<th>Principal Emissions</th>
<th>Average Energy (MeV)*</th>
<th>Maximum Energy (MeV)**</th>
<th>Dose Rate at 1 m Distance (mSv/h/GBq)</th>
<th>Recommended Shielding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutrons</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Gamma &amp; X-rays</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Beta</td>
<td>0.6947</td>
<td>1.710</td>
<td>9.17</td>
<td>1 cm Plexiglas</td>
</tr>
<tr>
<td>Alpha</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Where beta radiation is present, bremsstrahlung radiation will be produced. Shielding may therefore be required.
** Average energy of most abundant emission.
*** Maximum of most abundant emission.

Progeny: n/a

Part 3 - DETECTION AND MEASUREMENT

Method of Detection: Geiger-Meuller detector, Gamma survey meters with sodium iodide crystal detectors.

Dosimetry:
External: TLD (whole body & skin) ___ Extremity ___ Neutron ___
Internal: Whole body ✓ Thorax ___ Urine analysis ✓ (specify) ___

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Part 4 - PREVENTATIVE MEASURES

Chronic acid and its salts have a corrosive action on the skin and mucous membranes. Sodium phosphate is a mild irritant. Phosphoric and Sodium Phosphate (P-32) solutions may emit radioactive fumes containing P-32 when heated to decomposition.

Recommended protective clothing: Disposable plastic, latex, or rubber gloves. Lab coat. Safety glasses.

Keep handling time to minimum. Use syringe shields (aluminium or lead foil) and tongs to avoid direct skin contact. When possible work behind a Plexiglas screen. Finger dosimeters should be worn if using quantities greater than a few tens of MBq (~a mCi). Vial should be encased in Lacite.

Always use the principles of time, distance and shielding to minimize dose. Consult CNSC license for requirements concerning engineering controls, protective equipment, and special storage requirements.

Part 5 - ANNUAL LIMIT ON INTAKE

<table>
<thead>
<tr>
<th></th>
<th>Ingestion</th>
<th>Inhalation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compound Type</td>
<td>All compounds</td>
<td>All compounds</td>
</tr>
<tr>
<td>Annual Limit on Intake (Bq)</td>
<td>8 × 10⁶</td>
<td>8 × 10⁵</td>
</tr>
</tbody>
</table>

EMERGENCY PROCEDURES

The following is a guide for first responders. The following actions, including remediation, should be carried out by qualified individuals. In cases where life threatening injury has resulted, first treat the injury, second deal with personal decontamination.

Personal Decontamination Techniques
- Wash well with soap and water and monitor skin
- Do Not discolor skin, only wash dry
- Decontamination of clothing and surfaces are covered under operating and emergency procedures

Spill and Leak Control
- Alert everyone in the area
- Confine the problem or emergency (Includes the use of absorbent material)
- Clear area
- Summon Aid

Emergency Protective Equipment, Minimum Requirements
- Gloves
- Footwear Covers
- Safety Glasses
- Outer layer or easily removed protective clothing
- Suitable respirator selected

Revision number: 0  Date of revision: 5 April 2004
4.3.6.2 Carbon 14 (C-14)

Part 1 - RADIOACTIVE MATERIAL IDENTIFICATION

<table>
<thead>
<tr>
<th>Chemical Symbol:</th>
<th>C</th>
<th>Common Names:</th>
<th>Carbon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic Weight:</td>
<td>14</td>
<td>Atomic Number:</td>
<td>6</td>
</tr>
</tbody>
</table>

Part 2 - RADIATION CHARACTERISTICS

Physical Half Life: 5730 years

CNSC Exemption Quantity (in Bq): $1 \times 10^7$ (100 Mq)

A CNSC licence is not required if the amount of radioactive nuclides possessed is less than one Exemption Quantity.

<table>
<thead>
<tr>
<th>Principal Emission</th>
<th>Average Energy (MeV)**</th>
<th>Maximum Energy (MeV)***</th>
<th>Dose Rate at 1 m Distance (mSv/Sv/chg)</th>
<th>Recommended Shielding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutrons</td>
<td>-</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Gamma &amp; X-rays</td>
<td>-</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Beta*</td>
<td>0.04945</td>
<td>0.156</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Alpha</td>
<td>-</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

* Where beta radiation is present, beta-absorbing radiation will be produced. Shielding may therefore be required.
** Average energy of total absorbed emission.
*** Maximum of most abundant emission.

Progeny: n/a

Part 3 - DETECTION AND MEASUREMENT

Method of Detection: This end window Geiger-Muller detector. Wipes counted by liquid scintillation.

Dosimetry:
- External: TLD (whole body & skin)
- Internal: Whole body

Exposure:
- Extremity
- Thorax
- Urine analysis
- Other (specify)
- Neutron
- Other (specify)

Breath (carbon dioxide):
Part 5 - PREVENTATIVE MEASURES

Handling: Carbon Monoxide: Chemical anoxia and asphyxiation. Carbon Dioxide: asphyxiation. Generation of carbon dioxide which could be inhaled.

Recommended protective clothing: Disposable lab-coat, gloves (select gloves appropriate for chemicals handled) and wrist guards. Some organic compounds can be absorbed through gloves therefore wear two pairs of gloves and change the outer layer frequently.

Optimize time, distance, shielding. Be careful not to generate carbon dioxide and handle potentially volatile or dusty compounds in a fume hood. Consult CNSC license for requirements concerning engineering controls, protective equipment, and specific storage requirements.

---

Part 5: ANNUAL LIMIT ON INTAKE

<table>
<thead>
<tr>
<th>Compound Type</th>
<th>Ingestion</th>
<th>Inhalation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>labelled organic compounds</td>
<td>Vapour</td>
</tr>
<tr>
<td>Annual Limit on Intake (BU)</td>
<td>3E+07</td>
<td>3E+07</td>
</tr>
</tbody>
</table>

---

EMERGENCY PROCEDURES

The following is a guide for first responders. The following actions, including translation, should be carried out by qualified individuals. In cases where life threatening injury has occurred, first treat the injury, second deal with personal decontamination.

**Personal Decontamination Techniques**
- Wash well with soap and water and monitor skin
- Do not abrade skin, only blot dry
- Decontamination of clothing and surfaces are covered under operating and emergency procedures

**Spill and Leak Control**
- Alert everyone in the area
- Confinement of the problem or emergency (includes the use of absorbent material)
- Clear area
- Summarize Aid

**Emergency Protective Equipment, Minimum Requirements**
- Gloves
- Footwear Covers
- Safety Glasses
- Outer layer or easily removed protective clothing
- Suitable respirator selected
4.3.6.3 Iodine 125 (I-125)

Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
Ottawa, Canada
K1P 5N9

Tel: (613) 995-5894  Fax: (613) 995-5086
24 Hour Emergency Hotline: (613) 995-0479

Radiation Safety Data Sheet
This data sheet presents information on radiotopes only.
For information on chemical compounds incorporating this radionuclide, see the relevant Material Safety Data Sheet.

Part 1 - RADIOACTIVE MATERIAL IDENTIFICATION

<table>
<thead>
<tr>
<th>Chemical Symbol:</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Names:</td>
<td>Iodine</td>
</tr>
<tr>
<td>Atomic Weight:</td>
<td>125</td>
</tr>
<tr>
<td>Atomic Number:</td>
<td>53</td>
</tr>
</tbody>
</table>

Part 2 - RADIATION CHARACTERISTICS

Physical Half-life: 60.14 days
CNSE Exemption Quantity (in Bq): \(1 \times 10^5\) (1 MBq)
A CNSE license is not required if the amount of radioactive nuclides possessed is less than one Exemption Quantity.

<table>
<thead>
<tr>
<th>Principal Emissions</th>
<th>Average Energy (MeV)**</th>
<th>Maximum Energy (MeV)***</th>
<th>Dose Rate at 1m Distance (mSv/h/2Gh)</th>
<th>Recommended Shielding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutrons</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Gamma &amp; X-rays</td>
<td>0.03549</td>
<td>-</td>
<td>0.074</td>
<td>-</td>
</tr>
<tr>
<td>Beta*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Alpha</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Where beta radiation is present, bremsstrahlung radiation will be produced. Shielding may therefore be required.
** Average energy of most abundant emission.
*** Maximum of most abundant emission.

Pregony

Part 3 - DETECTION AND MEASUREMENT

Method of Detection: Scintillation detector

Dosimetry:
External: TLD (whole body & skin) ☑ Extremity ☑ Other ☑ Neutron ☑
Internal: Whole body ☑ Thorax ☑ Urine analysis ☑ Other (specify) ☑ Thyroid ☑
Part 4 - PREVENTATIVE MEASURES

Exposure to significant amounts of radiiodine increases risk of developing thyroid cancer. Iodine is toxic by ingestion and inhalation and a strong irritant of eyes and skin. Iodine can be absorbed through the skin. When iodinated (1-125) albumin injection is heated to decomposition, radioactive fumes containing 1-125 may be emitted.

Recommended protective clothing: Disposable plastic, latex, or rubber gloves. Wear a lab coat, which must be monitored before leaving the laboratory. Also wear safety glasses. Some iodine compounds can penetrate surgical rubber gloves. Wear two pairs, or polyethylene gloves over rubber.

Minimise handling time. Use syringe shields and tongs. When possible handle iodine compounds in a fume hood.

Consult CNSC license for requirements concerning engineering controls, protective equipment, and special storage requirements.

Part 5 - ANNUAL LIMIT ON INTAKE

<table>
<thead>
<tr>
<th>Compound Type</th>
<th>Ingestion</th>
<th>Inhalation</th>
</tr>
</thead>
<tbody>
<tr>
<td>All compounds</td>
<td>$1 \times 10^6$</td>
<td>$1 \times 10^6$</td>
</tr>
</tbody>
</table>

EMERGENCY PROCEDURES

The following is a guide for first responders. The following actions, including remediation, should be carried out by qualified individuals. In cases where life threatening injury has resulted, first treat the injury, second deal with personal decontamination.

**Personal Decontamination Techniques**

X Wash well with soap and water and monitor skin
X Do Not abrade skin, only blot dry
X Decontamination of clothing and surfaces are covered under operating and emergency procedures

**Spill and Leak Control**

X Alert everyone in the area
X Confine the problem or emergency (includes the use of absorbent material)
X Clear area
X Summon Aid

**Emergency Protective Equipment, Minimum Requirements**

X Gloves
X Footwear Covers
X Safety Glasses
X Outer layer or easily removed protective clothing
X Suitable respirator selected

Revision number: 1 Date of revision: 1 September 2004
# 4.3.6.4 Iodine 131 (I-131)

## Radiation Safety Data Sheet

This data sheet presents information on radionuclides only. For information on chemical compounds incorporating this radionuclide, see the relevant Material Safety Data Sheet.

### Part 1 - RADIOACTIVE MATERIAL IDENTIFICATION

<table>
<thead>
<tr>
<th>Chemical Symbol:</th>
<th>I</th>
<th>Common Names:</th>
<th>Iodine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic Weight:</td>
<td>131</td>
<td>Atomic Number:</td>
<td>53</td>
</tr>
</tbody>
</table>

### Part 2 - RADIATION CHARACTERISTICS

**Physical Half-Life:** 8.04 days

**CNNSC Exemption Quantity (in Bq):** \( 1 \times 10^4 \text{ (10 kBq)} \)

A CNNSC license is not required if the amount of radioactive nuclides possessed is less than one Exemption Quantity.

**Principal Emissions**

<table>
<thead>
<tr>
<th>Neutrons</th>
<th>Average Energy (MeV)**</th>
<th>Maximum Energy (MeV)***</th>
<th>Dose Rate at 1m Distance (mSv/h@1GBq)</th>
<th>Recommended Shielding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Gamma & X-rays**

- Average Energy: 0.3645 MeV
- Maximum Energy: 0.606 MeV
- Dose Rate: 0.076 mSv/h
- Recommended Shielding: 24 mm Pb

**Beta**

- Average Energy: 0.1915 MeV
- Maximum Energy: 1.2 MeV
- Dose Rate: -
- Recommended Shielding: -

**Alpha**

- Average Energy: -
- Maximum Energy: -
- Dose Rate: -
- Recommended Shielding: -

*Where beta radiation is present, bremsstrahlung radiation will be produced. Shielding may therefore be required.

**Average energy of most abundant emission.

***Maximum of most abundant emission.

**Progeny**

- \(< 1\% \text{ to } ^{132}\text{Xe} (11.8 \text{ d}) >

### Part 3 - DETECTION AND MEASUREMENT

**Method of Detection:** Scintillation detector

**Dosimetry:**

- **External:**
  - TLD (whole body & skin)
  - Extremity
  - Neutron

- **Internal:**
  - Whole body
  - Thorax
  - Urine analysis
  - Thyroid

(specify)
**Part 4 - PREVENTATIVE MEASURES**

Exposure to significant amounts of radiiodine increases risk of developing thyroid cancer. Iodine is toxic by ingestion and inhalation and a strong irritant of eyes and skin. Iodine can be absorbed through the skin. Heating Hippuran (I-131) or sodium iodide -I-131 to decomposition may result in radioactive fumes containing I-131 to be emitted.

Recommended protective clothing: Disposable plastic, latex, or rubber gloves. Wear a lab coat, which must be monitored before leaving the laboratory. Also wear safety glasses. Fluoroscopy aprons provide no protection against the radiation from I-131. Always wear disposal plastic when working with I-131 and use instruments to handle I-131.

Minimise handling time. Use syringe shields and tongs. Store volatile iodine -I-131 in a refrigerator to reduce the production of radioactive vapour. Consult CNSC license for requirements concerning engineering controls, protective equipment, and special storage requirements.

**Part 5 - ANNUAL LIMIT ON INTAKE**

<table>
<thead>
<tr>
<th></th>
<th>Ingestion</th>
<th>Inhalation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compound Type</td>
<td>All compounds</td>
<td>All compounds</td>
</tr>
<tr>
<td>Annual Limit on Intake (Bq)</td>
<td>$9 \times 10^3$</td>
<td>$2 \times 10^6$</td>
</tr>
</tbody>
</table>

**EMERGENCY PROCEDURES**

The following is a guide for first responders. The following actions, including remediation, should be carried out by qualified individuals. In cases where life threatening injury has resulted, first treat the injury, second deal with personal decontamination.

**Personal Decontamination Techniques**
- Wash well with soap and water and monitor skin
- Do Not abrade skin, only blot dry
- Decontamination of clothing and surfaces are covered under operating and emergency procedures

**Spill and Leak Control**
- Alert everyone in the area
- Confine the problem or emergency (includes the use of absorbent material)
- Clear area
- Summon Aid

**Emergency Protective Equipment, Minimum Requirements**
- Gloves
- Footwear Covers
- Safety Glasses
- Outer layer or easily removed protective clothing
- Suitable respirator selected

Revision number: 0  
Date of revision: 24 Oct. 2003
4.3.6.5 Sulphur 35 (S-35)

Radiation Safety Data Sheet
This data sheet presents information on radionuclides only. For information on chemical compounds incorporating this radionuclide, see the relevant Material Safety Data Sheet.

### Part 1 - RADIOACTIVE MATERIAL IDENTIFICATION

<table>
<thead>
<tr>
<th>Chemical Symbol:</th>
<th>5</th>
<th>Common Names:</th>
<th>Sulphur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic Weight:</td>
<td>35</td>
<td>Atomic Number:</td>
<td>16</td>
</tr>
</tbody>
</table>

### Part 2 - RADIATION CHARACTERISTICS

- **Physical Half-Life:** 87.44 days
- **CNSE Exemption Quantity (in Bq):** $1 \times 10^8 (100 \text{ MBq})$

A CNSE license is not required if the amount of radioactive nuclides possessed is less than one Exemption Quantity.

<table>
<thead>
<tr>
<th>Principal Emissions</th>
<th>Average Energy (MeV)**</th>
<th>Maximum Energy (MeV)***</th>
<th>Dose Rate at 1m Distance (mSv/h @1GBq)</th>
<th>Recommended Shielding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutrons</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Gamma &amp; X-rays</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Beta*</td>
<td>0.04883</td>
<td>0.167</td>
<td>n/a</td>
<td>1 cm Plexiglas</td>
</tr>
<tr>
<td>Alpha</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Where beta radiation is present, bremsstrahlung radiation will be produced. Shielding may therefore be required.

**Average energy of most abundant emission.

***Maximum of most abundant emission.

### Part 3 - DETECTION AND MEASUREMENT

- **Method of Detection:** Thin end window Geiger-Mueller detector, Liquid scintillation counter
- **Dosimetry:**
  - **External:** TLD (whole body & skin), Extremity, Neutron
  - **Internal:** Whole body, Thorax, Urine analysis **(specify)**

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---
### Part 4: Preventative Measures

Sulphur dioxide: irritant to eye, nose, throat, lungs; bronchoconstriction; mutagen, suspect reproductive effects.
Hydrogen sulphide: moderate irritant to eye (conjunctivitis), lung; acute systemic toxicity; CNS effects. Sulphur is combustible.
Recommended protective clothing: Wear disposable lab coat, gloves and wrist guards for secondary protection. Select appropriate gloves for chemicals handled.
Handle potentially volatile compounds in ventilated enclosures. Take care not to generate sulphur dioxide or hydrogen sulphide which could be inhaled.
Consult CNSC license for requirements concerning engineering controls, protective equipment, and special storage requirements.

### Part 5: Annual Limit on Intake

<table>
<thead>
<tr>
<th>Compound Type</th>
<th>Ingestion</th>
<th>Inhalation</th>
</tr>
</thead>
<tbody>
<tr>
<td>All compounds</td>
<td>$1 \times 10^7$</td>
<td>$2 \times 10^8$</td>
</tr>
</tbody>
</table>

### EMERGENCY PROCEDURES

The following is a guide for first responders. The following actions, including remediation, should be carried out by qualified individuals. In cases where life threatening injury has resulted, first treat the injury, second deal with personal decontamination.

**Personal Decontamination Techniques**
- Wash well with soap and water and monitor skin
- Do Not abrade skin, only blot dry
- Decontamination of clothing and surfaces are covered under operating and emergency procedures

**Spill and Leak Control**
- Alert everyone in the area
- Confin the problem or emergency (includes the use of absorbent material)
- Clear area
- Summon Aid

**Emergency Protective Equipment, Minimum Requirements**
- Gloves
- Footwear Covers
- Safety Glasses
- Outer layer or easily removed protective clothing
- Suitable respirator selected

Revision number: 0  Date of revision: 5 April 2004
4.3.6.6 Tritium (H-3)

<table>
<thead>
<tr>
<th>Part 1 - RADIOACTIVE MATERIAL IDENTIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Symbol: H</td>
</tr>
<tr>
<td>Common Names: Tritium</td>
</tr>
<tr>
<td>Atomic Weight: 3</td>
</tr>
<tr>
<td>Atomic Number: 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part 2 - RADIATION CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Half-Life: 12.35 years</td>
</tr>
<tr>
<td>CNNS Exemption Quantity (in Bq): 1 x 10^6 (1 GBq)</td>
</tr>
<tr>
<td>A CNNS license is not required if the amount of radioactive material possessed is less than one Exemption Quantity.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Principal Emissions</th>
<th>Average Energy (MeV)</th>
<th>Maximum Energy (MeV)</th>
<th>Dose Rate at 1m Distance (uSv/h/100 Bq)</th>
<th>Recommended Shielding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutrons</td>
<td>-</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Gamma &amp; X-rays</td>
<td>-</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Beta*</td>
<td>0.0057</td>
<td>0.0186</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Alpha</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

* Where beta radiation is present, bremsstrahlung radiation will be produced. Shielding may therefore be required.
** Average energy of most abundant emission.
*** Maximum of most abundant emission.

Pregnancy: n/a

<table>
<thead>
<tr>
<th>Part 3 - DETECTION AND MEASUREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method of Detection: Wipes counted by liquid scintillation</td>
</tr>
</tbody>
</table>

Dosimetry:
<table>
<thead>
<tr>
<th>External: TLD (whole body &amp; skin)</th>
<th>Extremity</th>
<th>Neutron</th>
<th>Other (specify)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal: Whole body</td>
<td>Thorax</td>
<td>Urine analysis</td>
<td></td>
</tr>
</tbody>
</table>

79
**Part 4: Preventative Measures**

Tritium is not a radiation hazard unless it enters the body. Once in the body, tritium water is uniformly distributed in the body water and can then irradiate live tissue. Inhaled tritium gas will irradiate the lungs. Tritiated water is much more (10,000×) radiotoxic than gaseous tritium. Tritiated thyroxine will be concentrated in the nuclei of DNA synthesizing cells and may result in chromosomal damage. Tritiated water can be absorbed through the surface of skin, leading to an internal exposure. Gaseous tritium is a fire and explosion hazard when exposed to heat or flame and can react vigorously with oxidizing materials.

Recommended protective clothing: Lab coat. PVC gloves (0.5 mm thick) are preferred because of this material’s low permeability to tritiated water. Many tritium compounds readily penetrate gloves and skin. Handle these compounds remotely, wear two pairs of gloves and change the outer layer at least every twenty minutes. Plastic aprons provide added protection especially against tritiated water. Plastic suits may be necessary for work at TBq levels or in an atmosphere contaminated with tritiated water.

Handle tritiated water, gas, and volatile liquids in ventilated enclosures. Store tritiated water at room temperature as it is known to contaminate the frost in freezers. Use glass containers to store tritium compounds because tritiated water and tritiated organic solvents will pass through plastic. Consult CNSC licence for requirements concerning engineering controls, protective equipment, and special storage requirements.

**Part 5: Annual Limit on Intake**

<table>
<thead>
<tr>
<th>Compound Type</th>
<th>Ingestion (Bq)</th>
<th>Inhalation (Bq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tritiated water</td>
<td>1E+09</td>
<td>1E+09</td>
</tr>
<tr>
<td>Tritiated water</td>
<td>1E+09</td>
<td>1E+13</td>
</tr>
<tr>
<td>Elemental tritium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Emergency Procedures**

The following is a guide for first responders. The following actions, including remediation, should be carried out by qualified individuals. In cases where life-threatening injury has resulted, first treat the injury, second deal with personal decontamination.

**Personal Decontamination Techniques**
- Wash well with soap and water and monitor skin
- Do Not abrasively skin, only blot dry
- Decontamination of clothing and surfaces are covered under operating and emergency procedures

**Spill and Leak Control**
- Alert everyone in the area
- Contain the problem or emergency (includes the use of absorbent material)
- Clean area
- Summon Aid

**Emergency Protective Equipment, Minimum Requirements**
- Gloves
- Footwear Covers
- Safety Glasses
- Outer layer or easily removed protective clothing
- Suitable respirator selected

Revision number: _______ Date of revision: 23 Oct. 2003
The licensee shall classify each room, area or enclosure where more than one exemption quantity of an unsealed nuclear substance is used at a single time as:

a) Basic-level if the quantity does not exceed 5 ALI
b) Intermediate-level if the quantity does not exceed 50 ALI
c) High-level if the quantity does not exceed 500 ALI, or
d) Containment-level if the quantity exceeds 500 ALI, or
e) Special purpose if approved in writing by the Commission or a person authorized by the Commission

Except for basic-level classification, the licensee shall not use unsealed nuclear substances in these rooms, areas or enclosures without written approval of the Commission or a person authorized by the Commission.

<table>
<thead>
<tr>
<th>Nuclear Substance</th>
<th>EQ (MBq)</th>
<th>ALI (Inhale)</th>
<th>Basic Level (MBq)</th>
<th>Intermediate Level (MBq)</th>
<th>High Level (MBq)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium 109</td>
<td>1</td>
<td>2.1E+00</td>
<td>1.0E+01</td>
<td>10.50</td>
<td>50.00</td>
</tr>
<tr>
<td>Calcium 45</td>
<td>10</td>
<td>8.7E+00</td>
<td>2.6E+01</td>
<td>43.50</td>
<td>130.00</td>
</tr>
<tr>
<td>Carbon 14</td>
<td>10</td>
<td>1.0E+03</td>
<td>3.4E+01</td>
<td>500.00</td>
<td>1700.00</td>
</tr>
<tr>
<td>Chromium 51</td>
<td>10</td>
<td>5.6E+02</td>
<td>5.3E+02</td>
<td>2800.00</td>
<td>26500.00</td>
</tr>
<tr>
<td>Cobalt 57</td>
<td>1</td>
<td>3.3E+01</td>
<td>9.5E+01</td>
<td>165.00</td>
<td>4750.00</td>
</tr>
<tr>
<td>Fluorine 18</td>
<td>1</td>
<td>2.2E+02</td>
<td>4.1E+02</td>
<td>1100.00</td>
<td>20500.00</td>
</tr>
<tr>
<td>Hydrogen 3 (HT)</td>
<td>1000</td>
<td>1.0E+07</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hydrogen 3 (HTO)</td>
<td>1000</td>
<td>1.0E+03</td>
<td>1.0E+03</td>
<td>5000.00</td>
<td>50000.00</td>
</tr>
<tr>
<td>Indium 111</td>
<td>1</td>
<td>6.5E+01</td>
<td>6.9E+01</td>
<td>325.00</td>
<td>345.00</td>
</tr>
<tr>
<td>Iodine 123</td>
<td>10</td>
<td>9.5E+01</td>
<td>9.5E+01</td>
<td>475.00</td>
<td>4750.00</td>
</tr>
<tr>
<td>Iodine 125</td>
<td>1</td>
<td>1.4E+00</td>
<td>1.3E+00</td>
<td>7.00</td>
<td>65.00</td>
</tr>
<tr>
<td>Iodine 131</td>
<td>1</td>
<td>1.0E+00</td>
<td>9.1E-01</td>
<td>5.00</td>
<td>45.50</td>
</tr>
<tr>
<td>Iron 55</td>
<td>1</td>
<td>2.2E+01</td>
<td>6.1E+01</td>
<td>110.00</td>
<td>3050.00</td>
</tr>
<tr>
<td>Phosphorus 32</td>
<td>0.1</td>
<td>6.9E+00</td>
<td>8.3E+00</td>
<td>34.50</td>
<td>415.00</td>
</tr>
<tr>
<td>Phosphorus 33</td>
<td>100</td>
<td>1.5E+01</td>
<td>8.3E+01</td>
<td>75.00</td>
<td>4150.00</td>
</tr>
<tr>
<td>Plutonium 239</td>
<td>0.01</td>
<td>6.3E-04</td>
<td>8.0E-02</td>
<td>0.00315</td>
<td>4.00000</td>
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<td>Sulfur 35 (inorganic)</td>
<td>100</td>
<td>1.8E+01</td>
<td>1.1E+02</td>
<td>90.00</td>
<td>550.00</td>
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<tr>
<td>Sulfur 35 (organic)</td>
<td>100</td>
<td>1.7E+02</td>
<td>2.6E+01</td>
<td>850.00</td>
<td>1300.00</td>
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<tr>
<td>Technetium 99m</td>
<td>10</td>
<td>6.9E+02</td>
<td>9.1E+02</td>
<td>3450.00</td>
<td>45500.00</td>
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<td>Scandium 46</td>
<td>1</td>
<td>4.2E+00</td>
<td>3.6E-01</td>
<td>21.00</td>
<td>650.00</td>
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<tr>
<td>Uranium (Depleted)</td>
<td>0</td>
<td>3.4E-03</td>
<td>1.9E+00</td>
<td>0.017</td>
<td>9.500</td>
</tr>
<tr>
<td>Uranium (Enriched)</td>
<td>0.01</td>
<td>3.2E-03</td>
<td>4.3E-01</td>
<td>0.017</td>
<td>21.500</td>
</tr>
<tr>
<td>Uranium (Natural)</td>
<td>0</td>
<td>3.2E-03</td>
<td>2.1E+00</td>
<td>0.016</td>
<td>105.000</td>
</tr>
</tbody>
</table>

Note that the appropriate ALI value is the one that best represents the risks associated with the nuclear substance. If it cannot be determined whether the greater risk is related to inhalation or ingestion of the substance, then the most restrictive value should be used.
## 4.5 Classification of Selected Radionuclides

<table>
<thead>
<tr>
<th>CLASS</th>
<th>RADIONUCLIDE</th>
<th>CLASS A</th>
<th>CLASS B</th>
<th>CLASS C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All alpha emitters and their daughter isotopes</td>
<td>Ag-110m</td>
<td>Br-82</td>
<td>Ce-143</td>
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<tr>
<td></td>
<td>Bi-210</td>
<td>Co-60</td>
<td>Co-56</td>
<td>Ce-45</td>
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<td>Cs-134</td>
<td>Co-60</td>
<td>Fe-59</td>
<td>Ca-45</td>
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<td>Na-22</td>
<td>Pu-238</td>
<td>Zr-89</td>
<td>Cd-109</td>
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<td>Cs-137</td>
<td>Zn-65</td>
<td>Sr-90</td>
<td>Zn-63</td>
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<td>U-238</td>
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<td>Class B</td>
<td>Re-188</td>
<td>Ba-133</td>
<td>La-140</td>
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<td>Ra-223</td>
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<td>Y-86</td>
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<td>Class C</td>
<td>O-15</td>
<td>Ca-45</td>
<td>Tl-201</td>
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<td>Pr-144</td>
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<td>Pu-241</td>
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<td>Xe-133</td>
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<td></td>
<td>Tc-99</td>
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</tr>
</tbody>
</table>

When using more than one radionuclide in a room, the nuclide with the lowest contamination limit must be used to determine the limit (A, B or C) that applies to that room.
4.6 LIST OF FEDERAL ACT AND SELECTED CNSC REGULATIONS

The following Federal Act, selected CNSC regulations and documents have been identified relevant to the CNSC licences issued to Western and available on-line at:

http://www.nuclearsafety.gc.ca/eng/regulatory_information/

- Nuclear Safety and Control Act
- General Nuclear Safety and Control Regulations
- Nuclear Substances and Radiation Devices Regulations
- Radiation Protection Regulations
- Packaging and Transport of Nuclear Substances
- Class II Nuclear Facilities and Prescribed Equipment Regulations
- GD-52 Design Guide for Nuclear Substance Laboratories and Nuclear Medicine Rooms
- G-121 Radiation Safety in Educational, Medical and Research Institutions
- G-129 Keeping Radiation Exposures and Doses “As Low As Reasonably Achievable (ALARA)”
- RD-58 Thyroid Screening for Radioiodine
4.7 LIQUID SCINTILLATION FLUIDS/COCKTAILS/VIALS APPROVED FOR DISPOSAL

Ecoscint A
Ecoscint
Ecoscint H
Ecoscint O
Betamax ES
Cytoscint ES
Ecolite
Ecolume
Bio-Safe II
Bio-Safe NA
Econosafe
Mono Flow 5
Optifluor
Microscint 20
Microscint PS
Ultima Gold
OrganicSolv 3
Envirosafe
Betaplate Scint
Ready Safe
ScintSafe Econo 1
ScintSafe Econo 2
Scinti-Safe Plus 50%
BSC Scintillation Cocktail
Scintiverse BD Cocktail
4.8 CNSC AUTHORIZED LIST OF SUPPLIERS/SHIPPERS FOR IMPORTING TRITIUM (H-3)

MP Biochemical
29525 Fountain Parkway
Solon, OH 44139
USA

Moravek Biochemicals Inc.
577 Mercury Lane
Brea, CA 92821
USA

American Radiolabeled Chemicals Inc.
101 Arc Drive
St. Louis, MO 63146
USA

Valeant Pharmaceuticals International (formerly ICN)
Corporate Headquarters
One Enterprise
Aliso Viejo, CA 92656
USA

Perkin Elmer
549 Albany Street
Boston, MA 02118
USA

GE HealthCare
800 Centennial Ave.
Piscataway, NJ 08855-1327
USA

Sigma-Aldrich
PO Box 14508
St. Louis, MO 63178
USA

Please note that Tritium (H-3) ordered from Mandel Scientific and Amersham in the past is now ordered through Perkin Elmer and GE HealthCare, respectively.