McMaster University

Risk Management Manual Program

Complete Program Title: **Radiation Safety Program for University Laboratories**	Risk Management Manual (RMM) Number: **700**
Submitted by: _____ **Senior Health Physicist** Approved By: _____ **Chair, Health Physics Advisory Committee**	Authorized by: _____ **Vice-President, Research** _____ **President and Vice-Chancellor**
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1 Purpose

1.1 Under the Radiation Protection Regulations of the Canadian Nuclear Safety Commission (CNSC), every licensee is required to implement a Radiation Safety Program that meets specified requirements. This entry in the McMaster University Risk Management Manual specifies the Radiation Safety Program implemented by McMaster University (the University) for activities in University laboratories and work areas governed by nuclear substance and radiation device licences issued by the CNSC.

1.2 The Radiation Safety Program is submitted as a part of the application for CNSC licences and, as such, becomes legally binding on the University and those working under the Licences. Compliance with this program is a legal requirement under the Canadian Nuclear Safety and Control Act and its Regulations.

1.3 The Radiation Protection Program incorporates best practices in addition to legal requirements. Therefore, compliance with the program will also serve to protect the University and individuals from civil liabilities which may arise from exposure to members of the public.

1.4 The overall objectives of the Radiation Safety Program are:

- Prevent deterministic effects (radiation injuries).
- Minimize the probability of stochastic effects for workers by requiring that doses be maintained as low as reasonably achievable (ALARA).

- Protect the public and environment by ensuring that releases of radioactive material are maintained ALARA.
- Achieve compliance with the Canadian Nuclear Safety and Control Act and Regulations.

2 Scope

2.1 This entry applies to all activities involving the acquisition, possession, use, storage, transfer, shipping, production, import, export, servicing, disposal and abandonment of nuclear substances and radiation devices in University laboratories and work areas except as outlined in 2.3 below.

2.2 This program applies to all persons working with or in proximity to nuclear substances and radiation devices under University licences, including but not limited to: faculty, staff, undergraduate students, graduate students, post-doctoral fellows, visiting professors, volunteers and contractors.

2.3 Those areas and activities that fall under Nuclear Facility licences issued by the CNSC are subject to separately documented Radiation Protection Programs and, as such, are exempt from these requirements.

3 Related Documents

3.1 The Canadian Nuclear Safety and Control Act

3.2 The General Nuclear Safety and Control Regulations

3.3 The Radiation Protection Regulations

3.4 The Nuclear Substances and Radiation Devices Regulations

3.5 The Nuclear Security Regulations

3.6 The Packaging and Transport of Nuclear Substances Regulations

3.7 Radiation Safety Procedures maintained by the Health Physics department

3.8 RMM 107 – Health Physics Advisory Committee Terms of Reference

4 Definitions

4.1	ACL	Administrative Control Level. A University established limit related to the radiation safety program. ACL's are set below corresponding Regulatory limits.
4.2	ALARA	As Low As Reasonably Achievable, Social and economic factor taken into consideration.
4.3	ALI	The Annual Limit on Intake. That quantity of a nuclear substance that, if ingested or inhaled, would result in a committed effective dose of 20 mSv.
4.4	Authorized User	A person registered with the Health Physics Department who has completed required training and who is authorized to handle nuclear substances in HPAC approved projects.
4.5	CNSC	The Canadian Nuclear Safety Commission as established by Section 8 of the Canadian Nuclear Safety and Control Act. The regulatory body governing the use of nuclear substances, radiation devices, and nuclear facilities in Canada and it territorial waters
4.6	Effective Dose:	As defined in the Radiation Protection Regulations, Section 1(1). In summary, the sum of the products of the equivalent dose of radiation

		received and committed to each organ or tissue multiplied by the corresponding tissue weighting factor,
4.7	Equivalent Dose:	As defined in the Radiation Protection Regulations, Section 1(1). In summary, the sum of the products of the absorbed dose of radiation of each type multiplied by the corresponding radiation weighting factor.
4.8	Ensure	Take every reasonable precaution to achieve the stated objective.
4.9	EQ	The Exemption Quantity of a nuclear substance as defined in the Nuclear Substances and Radiation Devices Regulations. Generally, the quantity of nuclear substance above which activities may require CNSC licensing. Exemption Quantities for some common nuclides are listed in Appendix A.
4.10	HPAC	The Health Physics Advisory Committee.
4.11	Nuclear Substance	As defined in the Nuclear Substances and Control Act. Generally, a radionuclide. The full definition from the Act is: (a) deuterium, thorium, uranium or an element with an atomic number greater than 92; (b) a derivative or compound of deuterium, thorium, uranium or an element with an atomic number greater than 92; (c) a radioactive nuclide; (d) a substance that is prescribed as being capable of releasing nuclear energy or as being required for the production of nuclear energy; (e) a radioactive by-product of the development, production or use of nuclear energy; and (f) a radioactive substance or radioactive thing that was used for the development or production, or in connection with the use, of nuclear energy.
4.12	Project Supervisor	The person responsible for a project. Project Supervisors may be any of the following: (a) a Faculty Member at McMaster University (b) a Manager or Senior Manager in a University Department (c) a senior representative of an external agency or corporation performing work at McMaster University under a contractual agreement.
4.13	Radiation Device	As defined in the Nuclear Substances and Radiation Devices Regulations. The full definition from the regulations is: (a) a device that contains more than the exemption quantity of a nuclear substance and that enables the nuclear substance to be used for its radiation properties; and; (b) a device that contains a radium luminous compound
4.14	Radiological Work	Work with nuclear substances or radiation devices and/or in a posted radiation or contamination area.
4.15	RSP	The Radiation Safety Program defined in this document and in radiation safety procedures issued by the Health Physics Department.

5 Responsibilities

5.1 The Health Physics Advisory Committee (HPAC):

The complete terms of reference of the HPAC are documented in RMM 107.

The HPAC receives its authority from the President and Vice Chancellor of McMaster University. The HPAC is charged with the following responsibilities:

- Informing the President and Senior Management of the hazards related to the use of nuclear substances and radiation devices and to regulate its use as requested by the President.
- Establishing and continually reviewing an adequate radiation safety program at McMaster University.
- Maintaining the University's compliance with radiation protection regulations promulgated by federal, provincial and local authorities.
- Granting authorizations and restricting use of nuclear substances and radiation devices within the limits prescribed in the applicable CNSC licences for the work.
- Providing radiation protection services on a contractual basis at McMaster University locations to non-McMaster University organizations.

Note: The HPAC has no authority with respect to patient safety in medical diagnostic or therapeutic procedures.

5.2 The Health Physics Department

Under the direction of the Senior Health Physicist, the Health Physics Department is responsible for

- Facilitating the implementation of this Radiation Safety Program.
- Supervising the University's common radionuclide laboratories, storage facilities and waste handling areas.
- Providing services that may be required to meet the objectives of this program including (but not restricted to):

(a) registration and authorization of workers

(b) radiation safety training programs

(c) consultation and advice on radiation safety

(d) administration of the external and internal dosimetry programs

(e) auditing and inspecting laboratories

(f) radiation surveys and monitoring

(g) radioactive waste collection and disposal

(h) calibration and short term loan of radiation protection instruments

(i) leak testing of sealed radioactive sources

(j) maintaining records of nuclear substances obtained by authorized projects

(k) supervision of radiation emergencies and special decontamination operations

(l) maintaining radiation protection records

(m) preparing and maintaining policies and procedures related to the RSP

(n) prescribing medical examinations under the direction of the HPAC's Medical Consultant.

- Issuing stop-work orders when required as defined in Section 6.

5.3 Project Supervisors:

Each project supervisor is responsible for the following:

- Providing adequate facilities, equipment, instruments, supervision and written instructions to control radiation hazards and to comply with the RSP.
- Requiring that work with nuclear substances and radiation devices is conducted in a safe manner and in accordance with this RSP, the application for project approval and the permit granted by the HPAC. In particular, ensuring:

(a) compliance with stated possession and in-use activity limits;

(b) work is conducted only in the locations authorized on the permit;

(c) work is conducted only by authorized persons who have completed required training with Health Physics;

(d) all required protective equipment and devices are used as specified in the project application and in the approved permit; and

(e) radioactive waste is disposed of in the manner specified in the application and in accordance with this RSP and the permit.

- Implementing all required radiation safety procedures within the laboratory(ies) under their control
- Directing all persons working on the project to incorporate RSP requirements and ALARA considerations in all radiological work, and monitoring staff for compliance.
- Immediately terminating unsafe work and ensuring that unsafe acts and conditions are reported to Health Physics
- Immediately informing Health Physics of any incident involving nuclear substances or radiation devices including spills, personnel contamination, loss, theft or damage.

5.4 Individuals

Each Individual authorized to work with nuclear substances or radiation devices is responsible for:

- Complying with the requirements of the HPAC and the Radiation Safety Program and with the Conditions of Approval established for the project under which the work is conducted.
- Taking all reasonable and necessary precautions to ensure that work is conducted in a safe manner.
- Following all procedures, posted instructions and established practices designed to achieve safety in radiological work
- Seeking assistance from supervision or Health Physics when unsure of how to proceed safely with a task
- Using prescribed personnel protective equipment, devices and dosimeters
- Immediately alerting supervision and Health Physics to any unsafe condition or act
- Conducting radiation and contamination measurements related to their work as directed by health physics or supervision
- Controlling contamination through good work practices and housekeeping
- For designated Nuclear Energy Workers, notifying Health Physics in writing immediately upon confirmation of pregnancy.

5.5 Departmental Chairs, Directors or Equivalent Senior Managers are responsible for:

- Providing for the costs of decommissioning for laboratories and areas under control of the Department and for the disposal of exceptional wastes such as large sealed sources
- Departmental Chairs shall act as the Project Supervisor for projects involving the use of nuclear materials or radiation devices in undergraduate and graduate teaching within their academic unit or Department.

5.6 The Vice-President, Research

The Vice-President, Research is responsible for:

- Determining overall staffing and budget levels for the Health Physics Department.
- Monitoring, in conjunction with the HPAC, the performance of the Health Physics Department to ensure the adequate implementation of the radiation safety program in the University
- Providing funding for the operation of this Radiation Safety Program at levels approved through the normal budgetary process of the University.

5.7 Facility Services:

Facility Services is responsible for:

- Safe receipt and delivery of radioactive material within the University
- Maintaining facilities and laboratories in campus buildings

5.8 Hamilton Health Sciences (HHS):

Under the agreement between the University and HHS regarding use and occupancy of the Health Sciences Centre (HSC), HHS is responsible for:

- Safe receipt and delivery of radioactive material within the HSC
- Maintaining facilities and laboratories in the HSC

5.9 McMaster University Security Services:

McMaster University Security Services is responsible for

- Providing consultation and advice regarding security of nuclear substances and radiation devices
- Conducting regular security patrols of campus buildings
- Conducting, in conjunction with Health Physics, security audits of approved working areas and laboratories
- Investigating, in conjunction with Health Physics any theft or attempted theft of nuclear substances or radiation devices.
- Providing a continual dispatch service and alerting the on-call Health Physics staff member to any reported or suspected radiation emergency or incident.

6 Procedures

6.1 Approval of Work with Radioactive Materials

6.1.1 No person shall acquire, produce, import, export, posses, transfer, ship, transport, use, store, service, dispose or abandon nuclear substances or radiation devices at McMaster University except as authorized by a permit issued under the authority of the Health Physics Advisory Committee. Approval is required for each individual project.

6.1.2 Persons desiring approval for a project shall apply in writing by completing the Project Application form supplied by Health Physics and any additional information requested by the HPAC.

6.1.3 Project Supervisors may be any of the following:

(a) A Faculty Member at McMaster University

(b) A Manager or Senior Manager in a University Department

(c) A senior representative of an external agency or corporation performing work at McMaster University under a contractual agreement.

6.1.4 Projects involving unsealed nuclear substances shall be classified according to the quantity of material in use at any one time as Basic, Intermediate, High or Containment as follows:

(a) Basic-Level if the quantity does not exceed 5 ALI

(b) Intermediate-Level if the quantity does not exceed 50 ALI

(c) High-Level if the quantity does not exceed 500 ALI

(d) Containment-Level if the quantity exceeds 500 ALI

(e) Special-Purpose if approved by the CNSC

The "Quantity In Use" excludes stock solutions from which aliquots are drawn for the work at hand, samples which are in secure storage, and waste previously placed in containers for decay or disposal. It includes the activity of all open source material being handled in any stage of the process at any one time. Where more than one project is in progress in the same area, room or enclosure at any one time, it includes the quantity in use in all such projects.

6.1.5 For projects at the Basic Level and projects involving radiation devices or sealed sources capable of producing radiation fields of less than 1 mSv/h at 30 cm, approval may be granted by the Senior Health Physicist on behalf of the HPAC.

6.1.6 Projects at higher levels must be approved by the HPAC as a whole. For projects at the Intermediate level, approval may occur by email poll. Projects at higher levels will normally be considered at the next scheduled meeting of the Committee. Project applicants shall be invited to attend the meeting during consideration of their project to answer questions that may arise.

6.1.7 In addition to the internal approvals described above, for projects permitted under certain licences written approval from the CNSC is required before commencing a project requiring the use of more than 10, 000 EQs of a nuclear substance at one time. Application for approval shall be made by Health Physics.

6.1.8 If approved, the Project Supervisor shall be issued a Permit. If the Project Supervisor holds a valid Permit already, then a revision may be issued listing the new project.

6.1.9 Projects may be grouped and listed on one permit or issued individual permits at the discretion of the HPAC. Generally, similar projects will be grouped together onto one permit.

6.1.10 Permits shall be issued with an expiry date determined at the discretion of the HPAC. The maximum term for a Basic Level Project shall be five years. The maximum term for a higher level project shall be three years. Prior to expiry, Project Supervisors must re-apply in order to continue work. If there has been no change in the work, the original application may be re-submitted with a cover letter stating that the work is as described in the application.

6.1.11 Regardless of the expiry date, permits shall be deactivated if a project becomes inactive. Projects shall be considered inactive if there has been no use of nuclear substances or radiation devices for twelve months and there are no specific plans to resume use in the next 6 months. Permits that have been deactivated may be re-activated by the Senior Health Physicist upon written request of the Project Supervisor.

6.1.12 When a permit expires or is deactivated, the areas listed on the permit shall be decommissioned unless other approved work continues. Any remaining nuclear substances or radiation devices shall be removed for disposal or, if required in the future, transferred to Health Physics or another Project Supervisor for storage.

6.1.13 Health Physics shall maintain a list of active permits and shall provide the list annually to the HPAC.

6.2 **User Authorization and Nuclear Energy Worker Designation**

6.2.1 No person shall perform work with nuclear substances or radiation devices unless that person is approved by Health Physics as an Authorized User.

6.2.2 Supervisors shall post a current list of Authorized Users for Intermediate and higher level projects. Supervisors should post a current list of Authorized Users for Basic Level projects.

6.2.3 All Authorized Users handling more than one EQ of activity in a year shall be designated as Nuclear Energy Workers (NEWs) as defined by the Nuclear Safety and Control Act.

6.2.4 At the discretion of Health Physics, Authorized Users handling less than one exemption quantity per year may be exempted from the requirement to register as Nuclear Energy Workers. This exemption is generally intended to be applied in the case of small quantities of nuclear substances handled in undergraduate teaching laboratories.

6.2.5 Any person granted unescorted access to areas with High Level or Containment Level laboratories shall be designated as a NEW regardless of the specific activities handled.

6.2.6 Individuals designated as NEWs shall submit to medical examinations prescribed by Health Physics as advised by the Medical Consultant to the HPAC.

6.3 **Radiation Safety Training**

6.3.1 All Authorized Users and others with unsupervised access to nuclear substances and radiation devices shall receive Radiation Safety Training that prepares them to perform their duties safely in routine and upset conditions. Health Physics has the lead responsibility to develop and conduct this training.

6.3.2 Radiation Safety Training shall be designed to augment task and job specific training provided by Project Supervisors. Radiation safety aspects of work shall be incorporated in all task specific training provided by Project Supervisors.

6.3.3 The Radiation Safety Training programs shall be documented.

6.3.4 All Radiation Safety Training shall be approved by the Senior Health Physicist.

6.3.5 Visitors are exempt from Radiation Safety Training requirements provided they are escorted at all times while in posted areas and provided that they do not perform radiological work.

6.3.6 Authorized Users shall complete Radiation Safety Training which addresses the following:

(a) Meaning of designation as an NEW

(b) Risks and Hazards of Ionizing Radiation

(c) The Radiation Safety Program and Radiation Safety Procedures

(d) Management of External Exposures

(e) Management of Internal Exposures

(f) Radiation and Contamination Measurements

(g) Response to radiological emergencies and upsets

(h) Emergency Dose Limits

6.3.7 In addition, Health Physics shall observe and assess the first iodination and the first use of energetic beta emitters by any Authorized User.

6.3.8 Authorized Users shall complete continuing training programs required by Health Physics in order to maintain their authorization. Continuing training activities may be identified by Health Physics from time to time based on, for example, changes to the radiation safety program or procedures, a need to

improve performance in an area for groups or individuals, operating experience, regulatory requirements.

6.3.9 Persons other than Authorized Users who have unsupervised access to nuclear substances or radiation devices shall complete Radiation Safety Training which addresses the following:

(a) Risks and Hazards of Ionizing Radiation

(b) General Radiation and Contamination Hazards within laboratories

(c) Safe Work Practices within posted areas

(d) Response to alarms and emergencies

6.3.10 Health Physics shall provide a hazard orientation for all persons granted unsupervised access to High Level and Containment Level areas. The orientation shall include location and magnitude of radiological hazards and safe work practices that are to be observed.

6.3.11 Contractors and maintenance and support staff from Facility Services and other University departments, performing work in a posted area shall have their work reviewed by the Project Supervisor for the purpose of determining radiation safety and radiation safety training requirements. Where there is a reasonable probability of encountering nuclear substances, such as when servicing drains and ventilation systems, Health Physics shall be consulted prior to commencing the work.

6.4 Dose Limits

6.4.1 All doses shall be maintained As Low as Reasonably Achievable, social and economic factors being taken into consideration (ALARA).

6.4.2 Regardless of the dose level established through any ALARA optimization, all doses shall be maintained less than the Regulatory Dose Limits defined by the Radiation Protection Regulations during normal operations. Regulatory dose limits are reproduced in Table 1, through Table 5, Appendix B.

6.4.3 During the control of an emergency and the consequent immediate and urgent remedial work, the Emergency Dose Limits defined by the Radiation Protection Regulations shall not be exceeded. These Dose Limits do not apply to declared pregnant workers. Emergency dose limits are reproduced in Table 6.

6.4.4 All work shall be conducted such that no person exceeds the applicable Administrative Control Levels (ACLs) for dose defined in Table 1 through Table 5 without the prior written authorization of the HPAC, except during control of an emergency and the consequent immediate and urgent remedial work. Every instance where an ACL is exceeded without prior authorization shall be investigated by Health Physics. A verbal report shall be made immediately upon discovery to the HPAC Chair and the CNSC. A preliminary written report shall be completed and presented to the HPAC and the CNSC within 10 days. The final report shall be presented to the HPAC and CNSC when complete.

6.5 Pregnancy

6.5.1 Every Nuclear Energy Worker who becomes aware that she is pregnant shall immediately notify the Senior Health Physicist in writing.

6.5.2 Upon notification, the Health Physics department shall review the duties of the worker and prescribe adjustments as required to conform to the Dose Limits in Table 4 and the general restrictions below. The Project Supervisor is responsible for arranging any accommodation required that will not occasion costs or business inconvenience constituting undue hardship to the University.

6.5.3 Radioiodinations shall not be performed by declared pregnant workers.

6.5.4 Duties shall be such that there is no reasonable probability for an accidental exposure exceeding the Regulatory Dose Limits defined in the Radiation Protection Regulations and no reasonable probability of a measurable intake of nuclear substances.

6.6 Personnel Monitoring and Dosimetry

6.6.1 TLD dosimeters provided by a licensed dosimetry service shall be prescribed for the following individuals:

(a) all workers who are anticipated to receive external exposures in excess of 2 mSv per annum.

(b) all declared pregnant Nuclear Energy Workers where there is a reasonable probability of external exposures exceeding 0.2 mSv for the balance of pregnancy.

(c) Security and Facility Services personnel whose routine duties require them to enter radiation areas and radioisotope labs.

(d) Authorized Users with access to areas where High-Level and Containment-Level projects are conducted.

(e) Any person affiliated with the university who does not otherwise qualify who requests a dosimeter in writing.

6.6.2 Extremity dosimeters provided by a licensed dosimetry service shall be prescribed for all Authorized Users who may handle energetic beta-emitters (^{32}P, ^{89}Sr, ^{90}Sr, ^{90}Y, ^{153}Sm, ^{186}Re and others determined by Health Physics) in quantities exceeding 10 MBq.

6.6.3 Where it is determined by the HPAC that there is a reasonable probability of an intake exceeding one tenth of the ALI per annum, a bioassay or screening program shall be established for the work by the Senior Health Physicist. Bioassay or screening programs may be required by the HPAC even if it is determined that there is no reasonable probability of an intake exceeding one-tenth of the ALI.

6.6.4 Every person using radioiodine meeting the following criteria shall undergo thyroid screening within the period specified

Thyroid screening must be performed between 24 hours and 5 days after:

(a) use of a total quantity of Iodine-124, Iodine 125 or Iodine-131 in a 24 hour period exceeding;

i. 2 MBq in an open room;

ii. 200 MBq in a fume hood;

iii. 20 000 MBq in a glove box;

iv. any other quantity in other containment approved in writing by the CNSC; or

(b) involvement in a spill of greater than 2MBq of Iodine 124, Iodine-125 or Iodine-131; or

(c) detection of external contamination with Iodine 124, Iodine-125 or Iodine-131.

Thyroid screening must be performed between 8 hours and 48 hours after:

(a) use of a total quantity of Iodine-123 in a 24 hour period exceeding;

i. 200 MBq in an open room;

ii. 20 GBq in a fume hood;

iii. 2 TBq in a glove box;

iv. any other quantity in other containment approved in writing by the CNSC; or

(b) involvement in a spill of greater than 200MBq of Iodine 123; or

(c) detection of external contamination with iodine 123.

6.6.5 Thyroid Screening for internal radioiodine shall be performed using

(a) a direct measurement of the thyroid with an instrument that can detect 1 kBq of Iodine 124, Iodine-125 or Iodine-131; or 10 kBq of Iodine 123

(b) a bioassay procedure approved by the CNSC or a person authorized by the CNSC.

Health Physics shall determine the method to be employed.

6.6.6 If thyroid screening detects more than 10 kBq of Iodine 124, Iodine 125 or Iodine 131; or 100 kBq of Iodine 123 in the thyroid, the Senior Health Physicist shall immediately make a preliminary report to the CNSC and have bioassay performed within 24 hours by a person licensed by the CNSC to provide internal dosimetry.

6.6.7 All persons shall use all prescribed dosimetry and comply with bioassay and screening requirements.

6.7 **Facilities Requirements and Posting**

6.7.1 Use or storage of more than one EQ of a nuclear substance shall not commence in any area, room or enclosure until it is approved by the Senior Health Physicist and unless it is listed on the permit for the work.

6.7.2 Areas being considered for approval shall be assessed by Health Physics against the requirements of GD-52, Design Guide for Nuclear Substance Laboratories and Nuclear Medicine Rooms, or an equivalent document approved by the CNSC.

6.7.3 Where the area, room or enclosure is not at a location listed in the licence, and where the project may continue beyond 90 days from commencement, the Senior Health Physicist shall ensure that the CNSC is notified within seven days of commencement of the project. The Senior Health Physicist shall notify the CNSC within 7 days of the conclusion of all projects at any location.

6.7.4 Areas being considered for Intermediate or higher level approval require the approval of the HPAC and the CNSC prior to commencing work.

6.7.5 Health Physics shall maintain a listing of all areas, room and enclosures where more than one exemption quantity of a nuclear substance is used or stored.

6.7.6 Every area, room or enclosure approved for the use or storage of more than one hundred EQ of a nuclear substance or a radiation device, or where there is a reasonable probability that a person may be exposed to an effective dose rate of more than 25 μSv/h, shall be posted at every point of access with: a durable sign(s) approved by Health Physics containing:

- the radiation warning sign;
- the words "Rayonnement-Danger-Radiation" or an equivalent warning;
- a no food or drink warning;
- the name of the Project Supervisor; and
- instructions to notify McMaster University Security in the event of an emergency using the appropriate emergency call number (88).

6.7.7 Within each area, room or enclosure, the areas (benches, fumehoods, sinks etcetera) to be used for handling nuclear substances and radiation devices shall be clearly marked and delineated from other areas, generally with the use of yellow tape bearing the radiation warning symbol. If the entire area, room or enclosure is dedicated to this type of work, then such markings are not required.

6.7.8 Fumehoods shall be inspected at least annually and the face velocity measured to verify compliance with University standards for hazardous material handling. Fumehoods that do not meet that standard shall be tagged out shall not be returned to service until they meet the standard or the use of the hood is approved in writing by Health Physics.

6.7.9 The following shall be posted conspicuously in each approved area, room or enclosure:

- all current HPAC permits for use of that area
- a radioisotope safety poster approved by the CNSC which corresponds to the classification of the area, room or enclosure.

6.8 Conduct of Work

6.8.1 All radiological work shall be carefully planned and executed and shall incorporate steps to control exposures and contamination spread and ensure they are maintained ALARA. The work shall be conducted according to procedures that address the radiation safety aspects of the work.

6.8.2 Work that may result in exceeding any Administrative Control Level requires the prior written approval of the HPAC.

6.8.3 During and immediately following radiological work, all persons shall check themselves and their work area to ensure that contamination levels and radiation fields are being appropriately controlled according to the criteria listed in Appendix C.

6.8.4 Each lab shall maintain ready access to suitable, calibrated radiation and contamination survey meters required to assess conditions as specified in the project application or as subsequently specified by Health Physics.

6.8.5 Work shall comply with detailed Radiation Safety Procedures where they exist or, subject to approval by the HPAC, with alternate documented procedures that provide an equivalent level of safety and assurance of regulatory compliance.

6.8.6 Work shall be conducted as specified in the Permit Application. Any significant change that could have an impact on safety or regulatory compliance requires approval as outlined in section 6.1.

6.8.7 Every container in which nuclear substances in excess of 1 EQ are used or stored shall have a durable, clearly visible label bearing the radiation warning symbol and the words "Rayonnement – Danger - Radiation" or equivalent warning together with information as to the nature, form, quantity, and date of measurement. Labeling is not required for laboratory containers such as beakers, flasks and test tubes used transiently in laboratory procedures while the user is present.

6.8.8 Nuclear Substances shall be stored in such a manner that:

(a) The storage container is labeled as described above

(b) The storage container provides adequate shielding such that accessible radiation fields outside of the area, room , or enclosure where the nuclear substances are stored does not exceed 2.5 μSv/h

(c) The material in storage is only accessible by authorized persons

(d) The storage container provides adequate protection against fire, explosion, flooding or accidental breakage of the primary storage container.

6.9 Decommissioning

6.9.1 Upon completion of a project or the expiry or revocation of a Permit, all areas, rooms and enclosures that are no longer to be used for work with nuclear substances or radiation devices shall be decommissioned under the supervision of Health Physics.

6.9.2 Decommissioning shall include:

(a) removal of residual nuclear substances or radiation devices for storage or disposal as appropriate

(b) decontamination to the criteria listed in Appendix D

(c) obtaining CNSC authorization to abandon, transfer or dispose of any residual fixed contamination

(d) removal of all signs and postings

(e) decontamination and/or removal of contaminated services such as drains and ventilation systems.

6.9.3 Where it is likely that radiological work will continue in the area, step (e) may be deferred subject to establishment of ongoing controls satisfactory to the HPAC. The funding for the work remains the responsibility of the Project Supervisor and Department.

6.9.4 The cost for decommissioning shall be borne by the Project Supervisor last assigned the area, room or enclosure. The costs shall, in any case, be guaranteed by the Department Chair or equivalent Senior Manager to whom the Project Supervisor reports if they cannot be recovered from the Project Supervisor.

6.9.5 Once decommissioned, an area, room or enclosure shall be removed from the list of approved areas maintained by Health Physics.

6.9.6 A record of the decommissioning shall be maintained by Health Physics

6.10 **Leak Testing of Sealed Sources and Radiation Devices**

6.10.1 Each sealed source containing 50 MBq of a nuclear substance shall be leak tested by Health Physics using instruments and procedures capable of detecting a leakage of 200 Bq or less of the nuclear substances.

6.10.2 The frequency of leak testing shall be every six months.

6.10.3 Where an event that may have damaged the source has occurred, testing shall be done immediately after the event.

6.10.4 Any nuclear substance used as shielding shall be leak tested as above.

6.10.5 Where leakage of 200 Bq or more is detected,

(a) Use of the source or shielding shall be terminated immediately

(b) The use of any associated radiation device shall be discontinued immediately

(c) Health Physics shall supervise monitoring and decontamination efforts to minimize the spread of contamination

(d) The Senior Health Physicist shall notify the HPAC and CNSC immediately after steps (a) to (c).

6.11 **Disposal of Radioactive Waste**

6.11.1 All Authorized Users shall take every reasonable measure to minimize the volume of radioactive waste generated.

6.11.2 Short lived radioactive wastes (^{32}P, ^{131}I, ^{125}I and other radionuclides identified by Health Physics) shall be segregated from other radioactive wastes to allow delay and decay to divert the waste from the radioactive waste stream.

6.11.3 No person shall discharge nuclear substances to the sewer except as explicitly authorized on a permit.

6.11.4 A listing of the dates, radionuclide and activity of nuclear substances disposed of under each project shall be maintained by the project Supervisor. The listing shall include and specify nuclear substances disposed of as solid waste, liquid waste to Health Physics, liquid waste to sewer and any other disposal pathway utilized.

6.11.5 All radioactive wastes shall be disposed of through Health Physics except as authorized on a Permit.

6.12 **Security Requirements**

6.12.1 Nuclear substances and radiation devices shall be maintained secure at all times such that access is restricted to Authorized Users. This may generally be achieved by:

(a) Keeping the lab locked when an Authorized User is not in attendance; or

(b) Keeping the nuclear substances in a locked fridge, freezer, cupboard or other theft-resistant container.

6.12.2 Additional security provisions are required for work at or above "High Level" and for work with certain sealed sources. Security provisions for such work require the approval of the Senior Health Physicist.

6.13 Radiation Safety Instrumentation

6.13.1 Radiation safety instrumentation required for the safe conduct of work shall be maintained by the Project Supervisor as a condition of approval.

6.13.2 Health Physics shall provide advice and support in the selection, use and care of radiation safety instruments.

6.13.3 Radiation Survey Meters shall be calibrated annually. Normally, this work will be performed by Health Physics. When it is necessary to do so, Health Physics will identify a suitable calibration service and facilitate the annual calibration of Radiation Survey Meters. The cost will be borne by the Project Supervisor.

6.14 Emergency Procedures

6.14.1 General

All emergencies shall be responded to promptly under the guidance of Health Physics. Immediately upon becoming aware of the occurrence of an emergency, the Senior Health Physicist or designate shall report verbally to the CNSC. The chair of the HPAC shall be notified verbally within 24 hours, and should also be notified by e-mail. A full written report shall be provided to the HPAC and the CNSC within 21 days of an event/incident.

6.14.2 On Call Resources

The Senior Health Physicist or another Health Physics staff member competent to respond to any of the emergencies listed shall be maintained on call at all times. A contact procedure shall be maintained with the Security Services Dispatcher.

6.14.3 Fire

Health Physics shall respond to any fire involving a radioisotope laboratory to provide contamination control and radiological safety supervision as required. Periodic tours of High Level and Containment Level laboratories shall be offered by Health Physics for the local Fire Department and McMaster University Security Services.

6.14.4 Theft or Loss

Any suspected theft or loss of nuclear substances or a radiation device shall be reported immediately to McMaster University Security Services or Health Physics. Health Physics, Security Personnel and the Project Supervisor shall respond immediately to conduct a search for the material and conduct an investigation.

The Senior Health Physicist shall notify the CNSC immediately.

6.14.5 Spill

Every laboratory shall maintain readiness for spill response as outlined in the Radiation Safety Procedure "Radiological Spill Response".

6.14.6 Overexposure without physical injury

Any suspected or reported exposure to radiation in excess of the applicable limits in Table 1 through Table 5 shall be reported immediately to McMaster University Security Services or Health Physics. The Senior Health Physicist shall be immediately notified and shall lead or assign an investigation team.

6.14.7 Accidents involving ingestion or inhalation and/or skin contamination

Any suspected or actual occurrence of an intake or skin contamination shall be reported immediately to Health Physics. Health Physics personnel will respond to provide dose assessment and

decontamination. The matter shall constitute an emergency if the dose limits in Appendix B have been exceeded.

6.14.8 Accidents involving injuries contaminated with nuclear substances.

Such incidents shall be reported immediately to McMaster University Security Services who shall arrange for first aid, Health Physics and emergency response as required. Injured parties requiring medical treatment shall be transported to a local hospital for treatment. McMaster University Security Services shall ensure that the hospital is notified of the presence of radioactive contamination.

6.14.9 Unauthorized Release of Nuclear Substances to the Environment

Such incidents shall be reported immediately to McMaster University Security Services or Health Physics. Health Physics staff shall be notified immediately to initiate assessment and remediation activities. The incident shall be reported by Health Physics to the Ontario Ministry of the Environment and the City of Hamilton Environmental Department in addition to the CNSC.

6.14.10 Radiation Devices

Emergency procedures for radiation devices shall be maintained by the Project Supervisor with one copy provided to Health Physics and one copy posted near the device.

6.15 Inspections, Audits and Enforcement

6.15.1 The ability to use nuclear substances and radiation devices at McMaster University shall be considered a privilege as opposed to a right. The privilege, within the restrictions of licences granted by the CNSC, is granted at the sole discretion of the HPAC.

6.15.2 The Senior Health Physicist and designated Health Physics Staff may impose any restriction on a Permit or Authorized User up to and including suspending authorization and confiscating materials if, in their opinion, violations of the Radiation Safety Program have occurred which may lead to safety hazards or non-compliance with the CNSC Act and Regulations.

6.15.3 All persons shall comply with orders given as described in 6.15.2 pending review by the HPAC at its next scheduled meeting.

6.15.4 The HPAC may take any action it deems appropriate, including permanent cancellation of projects and authorization of users.

6.15.5 Health Physics shall conduct inspections of laboratories to assess general safety, compliance and radiological conditions in laboratories. Basic-Level and Intermediate Level laboratories shall be inspected at least monthly. High and Containment Level laboratories should be inspected daily and shall be inspected at least weekly. Any exceptions to this frequency shall be reported to the HPAC. A summary of inspection findings shall be provided to the HPAC at least annually.

6.15.6 Health Physics shall perform an annual detailed audit of safety and compliance in all approved areas, rooms and enclosures and shall report findings to the HPAC.

6.16 Radiation Safety Procedures Manual

6.16.1 Health Physics shall prepare supporting, detailed "Radiation Safety Procedures", consistent with the requirements of this program as directed by the HPAC. Radiation Safety procedures shall be approved by the Senior Health Physicist and authorized by the HPAC.

6.16.2 Compliance with applicable Radiation Safety Procedures is a requirement of the Radiation Safety Program.

6.17 Reporting

6.17.1 The Senior Health Physicist shall prepare and submit an Annual Compliance Report to the CNSC as specified in the applicable licence(s).

6.17.2 The Senior Health Physicist shall prepare a summary of radiological safety and compliance in the University and shall present the report to the HPAC, Senior Management, the Central Joint Occupational Safety Committee and the McMaster University Board of Governors.

7 Records

7.1 Records required by the Radiation Safety Program and supporting Radiation Safety Procedures shall be retained until their disposal is authorized in writing by the Senior Health Physicist.

7.2 The following records shall be retained:

(a) Nuclear Energy Worker Declarations

(b) Radiation Safety Training Records

(c) Source Leak Test Records

(d) Contamination Monitoring Results

(e) Purchase and Inventory Records

(f) Radiation Survey Meter Calibration Records

(g) Occupational Radiation Exposure Reports

(h) Lab Decommissioning Records

(i) Copies of any investigation reports for incidents and emergencies.

7.3 One year after the expiry of a licence, Health Physics should notify the CNSC of its intention to authorize the disposal of records related to the radiation safety program. The notification will include the nature of the records to be disposed of and the intended date of authorization, which shall be at least 90 days after notification.

7.4 After the date in the notification to the CNSC has passed, Health Physics will notify Project Supervisors of the types and dates of records that may be disposed of.

7.5 Any Project Supervisor who becomes aware of an inaccuracy or incompleteness in record keeping or maintenance shall immediately notify Health Physics. Health Physics shall investigate and, if required, file a report of the deficiency in record with the CNSC within 21 days.

8 Exceptions

8.1 All exceptions to this program must be applied for in writing and require the written approval of the Health Physics Advisory Committee.

8.2 The Senior Health Physicist may temporarily approve exceptions, pending the next scheduled meeting of the HPAC. In such case, the members of the HPAC shall be notified of the temporary exception in writing within three days of it being granted.

8.3 Exceptions that are contrary to the CNSC Act and Regulations shall not be granted without the written approval of the CNSC.

9 Appendices:

(a) Exemption Quantities, ALIs and Basic Level Limits for Common Nuclear Substances

(b) Dose Limits

(c) Laboratory Contamination and Radiation Field Limits

(d) Decommissioning Criteria

Appendix A Exemption Quantities, ALIs and Basic Level limits for Common Nuclear Substances

	EQ		ALI		Basic Limit	
	(MBq)	(mCi)	(MBq)	(mCi)	(MBq)	(mCi)
H-3*	1000	30	500	12.5	2500	62
C-11	1	0.03	800	20	4000	100
C-14	10	0.3	30	0.8	150	4
F-18	1	0.03	400	10	2000	50
Na-24	0.1	0.003	50	1.2	250	6
P-32	0.1	0.003	8	0.2	40	1
P-33	100	3	80	2	400	10
S-35	100	3	100	2.5	500	12
Cl-36	1	0.03	20	0.5	100	2
K-42	1	0.03	50	1.2	250	6.2
Ca-45	10	0.3	30	0.8	150	3.8
Ca-47	1	0.03	10	0.2	50	1.2
Cr-51	10	0.3	500	12.5	2500	62
Mn-54	1	0.03	30	0.8	150	4
Co-57	1	0.03	100	2.5	500	12
Fe-59	1	0.03	10	0.2	50	1.2
Co-60	0.1	0.003	6	0.2	30	0.8
Zn-65	1	0.03	5	0.1	25	0.6
Ga-67	1	0.03	100	2.5	500	12
Ga-68	0.01	0.0003	200	5	1000	25
Br-82	1	0.03	40	1	200	5
Rb-86	0.1	0.003	7	0.2	35	0.9
Sr-90	0.01	0.0003	0.7	0.02	3.5	0.09
Y-90	0.1	0.003	7	0.2	35	0.9
Tc-99	10	0.3	30	0.8	150	3.8
Tc-99m	10	0.3	900	22.5	4500	112
Cd-109	1	0.03	10	0.2	50	1.2
Ag-110m	1	0.03	7	0.2	35	0.9
In-111	1	0.03	70	1.8	350	8.8
I-123	10	0.3	100	2.5	500	12.5
I-124	0.01	0.0003	2	0.05	10	0.2
I-125	1	0.03	1	0.02	5	0.1
I-129	0.1	0.003	0.2	0.005	1	0.02
I-131	1	0.03	1	0.02	5	0.1
Cs-137	0.01	0.0003	3	0.08	15	0.4
Pm-147	10	0.3	80	2	400	10
Lu-177	10	0.3	40	1	200	5
Tl-204	0.01	0.0003	20	0.5	100	2.5
Am-241	0.01	0.0003	0.1	0.002	0.5	0.01
Cm-244	0.01	0.0003	0.2	0.005	1	0.02

*ALI and Basic level permit limits are for organically bound tritium only

Appendix B Dose Limits

Table 1 Dose limits for Nuclear Energy Workers in Basic and Intermediate Level laboratories

Dose	Period of Time	Regulatory Dose Limit (mSv)	Administrative Control Level (mSv)
Effective dose	one-year dosimetry period	50	2
	five-year dosimetry period	100	10
	quarterly Dosimetry Period	NA	1
	day	NA	0.5
Equivalent dose to the skin	one-year dosimetry period	500	100
	quarterly dosimetry period	NA	50
	day	NA	5
Equivalent dose to the hands and feet	one-year dosimetry period	500	100
	quarterly dosimetry period	NA	50
	day	NA	10
Lens of an eye[1]	one-year dosimetry period	150	NA
Internal exposure due to radioiodines	one-year dosimetry period	NA[2]	0.1 ALI
	thyroid burden at any time	10 kBq – dose assessment	1 kBq
Internal exposure due to other radionuclides	one-year dosimetry period	NA[2]	0.1 ALI

[1] Doses are not normally measured separately for the lens of the eye. The limits for equivalent Dose to the skin will ensure sufficient management of these exposures.
[2] Annual doses due to internal exposure are included in the calculation of effective dose.

Table 2 Dose limits for Nuclear Energy Workers in High and Containment Level laboratories

Dose	Period of Time	Regulatory Dose Limit (mSv)	Administrative Control Level (mSv)
Effective dose	one-year dosimetry period	50	5
	five-year dosimetry period	100	50
	quarterly Dosimetry Period	NA	5
	day	NA	1
Equivalent dose to the skin	one-year dosimetry period	500	150
	quarterly dosimetry period	NA	100
	day	NA	5
Equivalent dose to the hands and feet	one-year dosimetry period	500	250
	quarterly dosimetry period	NA	100
	day	NA	10
Lens of an eye[1]	one-year dosimetry period	150	NA
Internal exposure due to radioiodines	one-year dosimetry period	NA[2]	0.1 ALI
	thyroid burden at any time	10 kBq – dose assessment	1 kBq
Internal exposure due to other radionuclides	one-year dosimetry period	NA[2]	0.1 ALI

[1] Doses are not normally measured separately for the lens of the eye. The limits for equivalent dose to the skin will ensure sufficient management of these exposures.
[2] Annual doses due to internal exposure are included in the calculation of effective dose.

Table 3 Dose limits for Nuclear Energy Workers operating under a CNSC processing licence

Dose	Period of Time	Regulatory Dose Limit (mSv)	Administrative Control Level (mSv)
Effective dose	one-year dosimetry period	50	15
	five-year dosimetry period	100	50
	quarterly Dosimetry Period	NA	5
	day	NA	1
Equivalent dose to the skin	one-year dosimetry period	500	150
	quarterly dosimetry period	NA	100
	day	NA	5
Equivalent dose to the hands and feet	one-year dosimetry period	500	250
	quarterly dosimetry period	NA	100
	day	NA	10
Lens of an eye[1]	one-year dosimetry period	150	NA
Internal exposure due to radioiodines	one-year dosimetry period	NA[2]	0.1 ALI
	thyroid burden at any time	10 kBq – dose assessment	1 kBq
Internal exposure due to other radionuclides	one-year dosimetry period	NA[2]	0.1 ALI

[1] Doses are not normally measured separately for the lens of the eye. The limits for equivalent dose to the skin will ensure sufficient management of these exposures.
[2] Annual doses due to internal exposure are included in the calculation of effective dose.

Table 4 Effective dose limits for pregnant NEWs

Dose	Period of Time	Regulatory Dose Limit (mSv)	Administrative Control Level (mSv)
Effective dose	one-year dosimetry period	50	See Table 1 through Table 3
	five-year dosimetry period	100	See Table 1 through Table 3
	quarterly dosimetry period	NA	See Table 1 through Table 3
	balance of pregnancy	4	2
	day	NA	0.2

Table 5 Dose limits for non-NEWs

Dose	Period of Time	Regulatory Dose Limit (mSv)	Administrative Control Level (mSv)
Effective dose	one-year dosimetry period	1	0.8
	quarterly Dosimetry Period	NA	0.5
	day	NA	0.2
Equivalent dose to the skin	one-year dosimetry period	50	15
	quarterly dosimetry period	NA	10
	day	NA	5
Equivalent dose to the hands and feet	one-year dosimetry period	50	25
	quarterly dosimetry period	NA	10
	day	NA	1
Lens of an eye[1]	one-year dosimetry period	15	NA
Internal exposure due to I-125 and I-131	one-year dosimetry period	NA[2]	0.01 ALI
	thyroid burden at any time	10 kBq – dose assessment	0.1 kBq
Internal exposure due to other radionuclides	one-year dosimetry period	NA[2]	0.01 ALI

[1] Doses are not normally measured separately for the lens of the eye. The limits for equivalent dose to the skin will ensure sufficient management of these exposures.
[2] Annual doses due to internal exposure are included in the calculation of effective dose.

Table 6 Emergency dose limits and guidelines

Objective	Emergency dose limit	Comment
Control of an emergency and the consequent immediate and urgent remedial work	500 mSv (50 rem)	Applies to any McMaster University employee and volunteers from outside agencies.
Rescue and Lifesaving	1 Sv (100 rem)[1]	Any volunteer who has been briefed on potential consequences of exposure.

[1]A person who acts voluntarily to save human life may choose to exceed this dose limit

Appendix C Laboratory contamination and radiation field limits

Table 7 Contamination limits[1]

Area	Non-fixed contamination limit (Bq/cm² averaged over ≤ 100 cm²) Class A	Class B	Class C
Approved radioisotope laboratory or work area	3	30	300
Any other area	0.3	3	30

CLASS	**RADIONUCLIDE**				
Class A	Alpha emitters and their progeny				
	Ag-110m	Bi-210	Co-56	Co-60	Cs-134
	Cs-137	I-124	Lu-177m	Mn-52	Na-22
	Po-210	Pu-238	Pu-239	Pu-240	Sb-124
	Sc-46	Sr-82	U-234	U-235	U-238
	V-48	Zn-65			
Class B	Au-198	Ba-133	Br-82	Ce-148	Co-58
	Cu-67	Fe-59	Hg-194	Hg-203	I-131
	Ir-192	La-140	Mo-99	Nb-95	Pa-233
	Ra-223	Re-186	Re-188	Ru-103	Sb-122
	Sm-153	Sr-90	Xe-127	Y-86	Y-90
	Yb-169	Zr-89	Zr-95		
Class C	C-11	C-14	Ca-45	Cd-109	Ce-141
	Cl-36	Co-57	Cr-51	Cu-60	Cu-61
	Cu-64	F-18	Fe-55	Ga-67	Ga-68
	Ge-68	H-3	I-123	I-125	In-111
	In-113m	In-114	K-42	Kr-85	Lu-177
	Mn-52m	Mn-56	N-13	Na-24	Nb-98
	Ni-63	O-15	P-32	P-33	Pd-103
	Pr-144	Pu-241	Rh-106	S-35	Sc-44
	Sn-113	Sr-89	Tc-94m	Tc-99	Tc-99m
	Te-127	Tl-201	V-49	W-181	W-188
	Xe-133	Zn-63			

[1]These are licence limits. Lower values may be required by Health Physics. When more than one classification of radionuclide is used in an area, the lowest limit shall be applied.

Table 8 Radiation field limits

Area	Radiation Field Limit
Generally accessible areas within approved radioisotope laboratories or work areas	25 μSv/h (2.5 mrem/h)
Areas within approved radioisotope laboratories posted as Radiation Areas with access restrictions approved by Health Physics	1000 μSv/h (100 mrem/h)
Any other area	2.5 μSv/h (0.25 mrem/h)

Appendix D Decommissioning criteria

Table 9 Decommissioning criteria[1]

Non-fixed contamination limit
(Bq/cm² averaged over ≤ 100 cm²)

Class A	Class B	Class C
0.3	3	30

CLASS	RADIONUCLIDE				
Class A	Alpha emitters and their progeny				
	Ag-110m	Bi-210	Co-56	Co-60	Cs-134
	Cs-137	I-124	Lu-177m	Mn-52	Na-22
	Po-210	Pu-238	Pu-239	Pu-240	Sb-124
	Sc-46	Sr-82	U-234	U-235	U-238
	V-48	Zn-65			
Class B	Au-198	Ba-133	Br-82	Ce-148	Co-58
	Cu-67	Fe-59	Hg-194	Hg-203	I-131
	Ir-192	La-140	Mo-99	Nb-95	Pa-233
	Ra-223	Re-186	Re-188	Ru-103	Sb-122
	Sm-153	Sr-90	Xe-127	Y-86	Y-90
	Yb-169	Zr-89	Zr-95		
Class C	C-11	C-14	Ca-45	Cd-109	Ce-141
	Cl-36	Co-57	Cr-51	Cu-60	Cu-61
	Cu-64	F-18	Fe-55	Ga-67	Ga-68
	Ge-68	H-3	I-123	I-125	In-111
	In-113m	In-114	K-42	Kr-85	Lu-177
	Mn-52m	Mn-56	N-13	Na-24	Nb-98
	Ni-63	O-15	P-32	P-33	Pd-103
	Pr-144	Pu-241	Rh-106	S-35	Sc-44
	Sn-113	Sr-89	Tc-94m	Tc-99	Tc-99m
	Te-127	Tl-201	V-49	W-181	W-188
	Xe-133	Zn-63			

[1]These are licence limits. Lower values may be required by Health Physics. When more than one classification of radionuclide is used in an area, the lowest limit shall be applied.