RADIATION SAFETY MANUAL

Occupational Health & Safety Division
Safety, Security and Emergency Management

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BCIT®

REVISION HISTORY

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1 INTRODUCTION

1.1 *Policy*

It is a primary goal of BCIT to promote and maintain a safe and secure working environment for staff, students and visitors.

The Radiation Safety Manual contains information pertaining to the licensing, acquisition, safe handling, storage and disposal of open and sealed sources of radioactive material.

1.2 *Objectives*

The radiation safety program at BCIT is committed to the promotion of the concepts of ALARA (As Low As Reasonably Achievable) with respect to minimizing radiation exposure. The ALARA concept is foremost in consideration through the well planned management of work practices, the appropriate training and qualification of its personnel, the careful consideration of locations and practices using radioactive substances and the development of strategic emergency procedures. Further, it is important for staff to demonstrate an overall attitude that reflects a healthy respect for radiation to set examples for our students.

1.3 *Scope*

The procedure is directed at departments and users who already possess, or wish to acquire and use radioactive materials

2 DEFINITIONS

"**Action level**" means a specific dose of radiation or other parameter that, if reached, may indicate a loss of control on the part of the licensee's radiation protection program, and triggers a requirement for a specific action to be taken.

"**ALARA**" means "As Low As Reasonably Achievable", social and economic factors being taken into account.

"**Applicant Authority**" means a position within an applicant's organizational structure with power to direct the application of financial and human resources. The Applicant Authority for BCIT is the director of Safety, Security and Emergency Management.

"**Bioassay** "or "**Bioscreening**" means any procedure used to determine the nature, activity, location or retention of radionuclides in a body by direct (in vivo) measurement or by indirect (in vitro) analysis of material excreted or otherwise removed from a body.

"**Contamination**" means the presence of a radioactive substance on a surface.

"**CNSC**" means the Canadian Nuclear Safety Commission.

"**Export**" means the transfer of a nuclear substance, prescribed equipment or prescribed information from Canada to a foreign destination.

"**Import**" means the transfer of a nuclear substance, prescribed equipment or prescribed information into Canada from a foreign location.

"**Leak test**" means a method of verifying the integrity of the encapsulation of the sealed source.

"**Licence**" means the document issued by the CNSC that lists the type and activities of Nuclear Substances that the Institute is permitted to possess and import, and specifies the conditions that BCIT must meet in order to comply with the CNSC Regulations.

"**Licensee**" means a person who is licensed to carry on an activity described below:

(a) possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information;
(b) mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance;
(c) produce or service prescribed equipment;
(d) operate a dosimetry service for the purposes of this Act;
(e) prepare a site for, construct, operate, modify, decommission or abandon a nuclear facility; or
(f) construct, operate, decommission or abandon a nuclear-powered vehicle or bring a nuclear-powered vehicle into Canada.

"**Nuclear Energy Worker (NEW)"** means a person who is required, in the course of the person's business or occupation in connection with a nuclear substance or nuclear facility, to perform duties in such circumstances that there is a reasonable probability that the person may receive a dose of radiation that is greater than the prescribed limit for the general public.

"**Open source**" means a source other than a sealed source. Also called an unsealed source.

"**Optically Stimulated Luminescence (OSL)"** means a device that measures ionizing radiation exposure by measuring the amount of photons emitted from a crystal in the detector when the crystal is stimulated with light. The amount of photons emitted is dependent upon the radiation exposure.

"**Radiation Safety Committee (RSC)"** means a committee formed to monitor, advise on or oversee, radiation safety matters. The primary role of the RSC is to advise RSOs and management on the quality and effectiveness of radiation safety policies and programs and the safety of employee work practices. Members of RSCs are usually selected or appointed because of their expertise or job-related interests in radiation safety.

"**Radiation Safety Officer (RSO)**"means the person responsible for the management and control of the licensed activity and of the nuclear substances. The RSO is the person CNSC will contact about radiation safety and compliance matters.

"**Sealed source**" means a radioactive nuclear substance in a sealed capsule or in a cover to which the substance is bonded, where the capsule or cover is strong enough to

prevent contact with or the dispersion of the substance under the conditions for which the capsule or cover is designed.

"**Signing Authority**" means a person designated by the applicant authority to act on behalf of the applicant in communications with the CNSC. The Signing Authority is the only person who can request changes to a licence. At BCIT the Radiation Safety Officer is designated as the Signing Authority.

"**Survey program**" means the process of measuring and managing radiation fields and radioactive contamination.

"**Thermoluminescent Device (TLD)"** means a device that measures ionizing radiation exposure by measuring the amount of visible light emitted from a crystal in the detector when the crystal is heated. The amount of light emitted is dependent upon the radiation exposure.

"**Transfer**" means to change the possession of a nuclear substance or prescribed equipment from one licensee to another.

"**Unsealed source**" means a source other than a sealed source. Also called an open source.

"**Wipe test**" means an indirect form of contamination monitoring that involves wiping a suspect surface and measuring the nuclear substances collected on the wipe sample

3 REFERENCE MATERIALS AND APPLICABLE LEGISTLATION

Information Available from the CNSC at www.nuclearsafety.gc.ca

1. Canadian Nuclear Safety Commission Laws and Regulations.

2. Design Guide for Nuclear Substance Laboratories and Nuclear Medicine Rooms

   This document sets out the requirements of the CNSC for the design and construction of adequate radioisotope laboratories.

3. Posters:

   a) Use of Unsealed Nuclear Substances – Basic Level, and
   b) Use of Unsealed Nuclear Substances – Intermediate Level

4. Packaging and Transport of Nuclear Substances Regulations, 2015 (SOR/2015–105)

   These Regulations apply to the packaging and transport of nuclear substances, including the design, production, use, inspection, maintenance and repair of packaging and packages and the preparation, consigning, handling, loading, carriage, storage during transport, receipt at final destination and unloading of packages.

5. Waste Management, Volume I: Management of Radioactive Waste (P-290).

   This document sets out requirements and guidance for managing radioactive waste.

6. REGDOC-2.7.2, Dosimetry, Volume I: Ascertaining Occupational Dose

   This regulatory document sets out guidance for ascertaining occupational dose. It also provides guidance for making changes to dose-related information filed with Health Canada's National Dose Registry.

7. REGDOC-2.7.1, Radiation Protection

This regulatory document provides requirements and guidance on the topics of radiation protection programs, the principles of worker dose control and the principles of radiological hazard control to ensure the protection of workers and members of the public.

4 ROLES AND RESPONSIBILITIES

4.1 *BCIT, The Licensee*

BCIT must not only ensure that its users perform their work in compliance with the regulations, and provide users with all that they need to work safely, but must also encourage and promote safe practice in the use of radiation and radioactive materials.

- BCIT has the legal responsibility to ensure the CNSC regulations and the licence requirements are met.
- BCIT must provide adequate facilities, equipment, services and training to its users.

4.2 *The Radioisotope User*

The user is responsible for day to day radioisotope operations in accordance with the policy and procedures of the institution, and with most aspects of general safety practice.

- The user is responsible for compliance with the conditions of the licence,
- record keeping,
- routine contamination control,
- the posting of signs and labels,
- the maintenance of radiation survey instrumentation,
- the general housekeeping and decontamination of facilities,
- the handling of radioactive waste, and
- the control of radioactive materials so visitors and cleaning staff do not receive unnecessary exposures.

4.3 *Nuclear Energy Worker*

- Workers identified as NEWs must acknowledge they are in agreement with this designation.
- NEWs must acknowledge they are aware of the associated risks and obligations of being classified as a NEW.
- NEWs must sign the Acknowledgement of NEW Status Form which shall be kept on file by the RSO.

The Acknowledgement of NEW Status Form can be found in Appendix D.

4.4 *Radiation Safety Committee*

The BCIT Radiation Safety Committee monitors, advises on or oversees radiation safety matters. The primary role of the RSC is to advise RSO and management on the quality and effectiveness of radiation safety policies and programs and the safety of employee work practices. Members of RSCs are usually selected or appointed because of their expertise or job-related interests in radiation safety.

4.5 *Medical Radiography Instructional Staff*

All instructional staff shall be certified according to a recognized standard, such as that of the Canadian Association of Medical Radiation Technologists, and must possess qualification required by any relevant Federal or Provincial regulations or statues. Instructional staff shall:

- Comply with the Institute's radiation safety program and procedures, WorkSafe BC's Occupational Health and Safety Regulations, and provisions applicable to collective agreements.
- Seek guidance from the Radiation Safety Officer concerning safety related knowledge and skills required to ensure safe performance on the job.
- Attend radiation safety training programs and meetings as assigned.
- Immediately report to the RSO any work related accident, injury, near miss incident or accidental radiation exposure.
- Immediately report to the RSO any hazardous or potentially hazardous work practice or work condition.
- Cooperate with the BCIT Safety and Security Department and the Radiation Safety Committee of the Institute.
- Arrange for instruction and supervision of students in the radiation safety aspects of classes or laboratories for which the instructor has responsibility.

4.6 *Medical Radiography Students*

All students must work only under the direct supervision or a qualified operator. Students shall:

- Comply with the Institute's radiation safety program and procedures associated with all Institute related activities.
- Seek guidance from their instructors concerning radiation safety related knowledge and skills required to ensure safe performance in their Institute related activities.
- Immediately report to their instructor any accident, near miss incident, accidental radiation exposure, hazardous practice or condition with respect to their Institute related activities.
- Comply with the radiation safety policies and programs of partnered or associated health care facilities when they are engaged in Institute related activities at those associated health care facilities.

4.7 *Staff Receiving Shipments Containing Radioactive Material*

- Staff in Shipping/Receiving should, without delay, contact the intended recipient to have the package picked up, or deliver it to the designated area in the recipient's laboratory and inform someone of the delivery.

- Staff receiving, handling and transporting radioactive shipments within the institute must be certified to do so. An in-house training package is available from the RSO for this purpose.
- Shipments of radioactive material should be locked in secure storage if immediate pick-up or delivery is not possible.
- A notice, similar to the one in Appendix B, should be posted in Shipping/Receiving.

4.8 *Radiation Safety Officer*

The overall objective of the Radiation Safety Officer is to provide day to day administration and control of radiation safety programs at BCIT, ensuring the Institute's compliance with regulatory agency requirements relating to radiation safety. To ensure ionizing radiation safety compliance on behalf of managers and the Radiation Safety Committee by following the regulations of the Canadian Nuclear Safety Commission, WorkSafe BC Occupational Health and Safety Regulations, Health Canada Safety Codes, and other legislation appropriate to the unique hazards associated radiation and the Institution.

- In conjunction with managers and the RSC, the Radiation Safety Officer will supervise, advise and consult in regards to issues related to the Institution's use of radioactive materials in accordance with legislation and any relevant requirements of the CNSC.
- Prepares annual reports in accordance with conditions contained in any relevant licence issued to the Institution by the CNSC.
- Reviews, either independently or in concert with the Institution's RSC, requests for authorization to purchase or use radioactive materials in order to ensure that the proposed uses and locations of use are acceptable and comply with the Institution's Radiation Safety Manual, relevant legislation and licence conditions.
- Authorizes only those purchases, uses of radioactive materials, work procedures, conditions and locations of use that assure compliance with the Institution's Radiation Safety Manual, relevant legislation, and licence conditions and assesses the qualifications and competence of persons who apply to use or handle radioactive materials.
- Assesses the proposed use of radioactive materials in laboratories, and designates laboratories for the use of radioactive materials.
- Maintains a record of the status of all designated laboratories that use radioactive materials.
- Develops and implements administrative controls or procedures to ensure radiation safety and compliance with regulatory requirements.
- Ensures that radiation safety programs appropriate to the organization's undertakings are developed, implemented and maintained in consultation with RSC.

- Ensures that persons are adequately trained in radiation safety matters and compliance with the Institution's radiation safety procedures.
- Authorizes qualified persons to possess, use or handle radioactive materials in accordance with the Institution's policies and relevant legislation, procedures and licences.
- Authorizes and controls the disposal of radioactive materials.
- Designates Nuclear Energy Workers.
- Act as the Signing Authority for the CNSC.
- Assesses, independently or in conjunction with managers or the RSC, the effectiveness of radiation safety programs yearly.
- Ensures that persons who may be exposed to radiation in the course of the duties (such as cleaners, secretaries, shippers and receivers) receive appropriate training in radiation safety matters.
- Develops and implements programs to inspect and critically review the conduct of licensed activities, the adequacy of locations and facilities where radioactive materials are used and stored, and the adequacy of personnel training and safety procedures.
- Implements remedial action to correct any deficiencies identified in the inspection programs referred to above.
- Initiates revisions to procedures, changes to equipment and facilities, and amendments to CNSC licences to ensure that the Institution's operations, equipment and facilities remain in compliance with regulatory requirements.
- Communicates with managers, the RSC, and users of radioactive materials on matters relevant to radiation safety.
- Designs and implements personnel monitoring and bioassay programs to measure "external" and "internal" exposure to ionizing radiation and review, at least quarterly their records of exposure. Where the reviews of radiation exposure records indicate that exposures are unnecessarily high, recommends to managers, measures to reduce these exposures in accordance with the ALARA principle of dose limitation.
- Investigates reports of overexposures to ionizing radiation, of accidents involving radioactive materials, and losses of radioactive materials in order to confirm or determine pertinent facts.
- Recommends appropriate action to mitigate the consequences of, or to prevent the recurrence of, overexposures to ionizing radiation, accidents involving radioactive materials or losses of radioactive materials including a formal report to the CNSC.
- Administers or controls the issue, use and maintenance of radiation monitoring devices and equipment within the Institution, and the recording of results.

- Ensures that incidents and the results of related investigations are reported to the CNSC and other relevant authorities in accordance with legislation and the licence issued to the Institution.
- Assesses 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 radioactive materials.
- Ensures that the results of programs to reduce or remove radioactive contamination meet regulatory requirements.
- Ensures that sealed radiation sources are leak-tested in accordance with the Institution's procedures and regulatory requirements.
- Ensures through training and inspections that all persons who use or handle radioactive materials follow approved procedures in order to prevent occupational exposures to ionizing radiation that exceed regulatory limits or violate the ALARA principle of dose limitation.
- Prepares or reviews proposed or existing radiation safety procedures, either independently or in cooperation with the RSC.
- Coordinates or participates in, emergency responses to accidents involving radioactive materials.
- Ensures that records and reports that are required of the Institution by legislation and licences are prepared, maintained or submitted as required.
- Ensures that any radioactive materials that are to be transported (returns, transfers, or disposals) are packaged for transport in accordance with The Transport of Dangerous Goods Regulations.
- Notifies the CNSC within 15 days of a change of RSO or applicant authority.

4.8.1 Radiation Safety Officer Qualifications

A bachelor's degree in Health physics, chemistry or biology and/or recognized certificate in the safe use of radioactive materials (e.g. Registered Technologist in Nuclear Medicine). Two years general radiation safety experience plus up to four years of experience related to radiation safety in an institution with a radiation safety program of similar size. Additional experience in instrument calibration is desirable. Excellent interpersonal and communication skills (both verbal and written) and analytical reasoning and problem solving skills.

5 CONTROLS

5.1 *How to Obtain Approval for Nuclear Substance Use*

In order to comply with both CNSC Regulations and BCIT policy, persons wishing to purchase/use radioactive sources at BCIT should carry out the following steps:

1) Obtain a copy of the appropriate current CNSC licence from the RSO.

2) Discuss the proposed use in detail with the RSO who will assess the application with respect to facilities and equipment, and procedures listed. The user must be able to show how all of the conditions of the licence will be met. Additional information required includes statements of:

- intended use
- location of use
- source type, activity and physical form. For instrumentation containing radioactive materials also specify the make and model of the proposed instrumentation
- present training of staff that will use such sources and proposed training methods for future staff
- training to be carried out for students and staff not previously trained in nuclear substance use
- specific methods to be used for disposal of radioactive waste
- description of routine survey program indicating the areas to be surveyed, methods of survey, levels of contamination considered acceptable, provisions for maintaining survey records and frequency of survey
- radiation survey instruments and locations, giving details of the make, model number, range and detector for each type of instruments and provide details of calibration procedures.

Upon receipt of the above information the RSO will convene a meeting of the Radiation Safety Committee to consider the proposal. The Committee will either approve the application or return it to the applicant with recommendations for correction of perceived deficiencies. If the proposal is consistent with the current licence and satisfies BCIT policy, the Radiation Safety Committee may be able to give immediate authorization to proceed. However, if a modification to the licence is required, the RSO will have to apply to the CNSC for an amendment. Response times for such changes could require significant time delays.

All radioisotope purchase requests, together with a current inventory of each radioisotope in possession shall be submitted to the Radiation Safety Officer, or designate, for approval. In particular, the Radiation Safety Officer must confirm that the "possession limits" of the licence are not being exceeded, and that equipment and facilities are adequate for the safe handling of the activities of radioisotope requisitioned. For new uses of radioactive materials please refer to Training and Education section of this manual.

5.2 *Radioactive Materials — General Safety Rules*

5.2.1 Open Sources

Open sources are controlled by keeping them contained when in secure storage, by using them in appropriately vented enclosures (a well-ventilated laboratory fume hood or glove box), by routinely monitoring work areas for radioactive contamination, decontaminating the area if necessary, and by keeping careful records of the acquisition, use and disposal of these materials. Depending upon the radioisotope, other precautions such as special shielding and protective clothing may be necessary to ensure the safety of those who use radioactive materials.

5.2.2 Sealed Sources

Sealed sources are controlled by keeping them in locked storage, by shielding them to reduce radiation fields, by regularly checking them for leakage, by handling them remotely, and by keeping accurate inventory records.

5.3 *Control of Nuclear Substances*

Access to nuclear substances is limited to those person having both authorization and appropriate knowledge and expertise in the handling of those substances. It is also limited to those sites specifically approved for that purpose. This is ensured through the secured environments of our laboratories and storage sites. Each site shall have posted an appropriate sign designating the access to ‘Authorized Persons Only’.

Each and every nuclear substance acquired by the institution requires a detailed record of every application and use from the time of acquisition to disposal. Nuclear substance usage is tracked by the users and copies of all records are kept by the RSO.

5.3.1 Open Sources

The inventory sheet provides both the radioisotope user and the Radiation Safety Officer with a continuous record of the amount of radioactive material on hand. The record must be kept current with purchases and disposals as they occur. A separate sheet should be used for each radioisotope. A sample of an inventory record sheet can be found in Appendix I.

5.3.2 Sealed Sources

All radioactive materials in sealed source form, or incorporated into devices, must be listed on the radioisotope inventory. Devices must be listed along with manufacturers’ name, model and serial number. Inventories should also show the use/storage location of the device. A sample of an inventory record sheet can be found in Appendix J.

5.4 *Contamination Control*

The responsibility for routine contamination monitoring rests with the user who should survey or wipe test at the end of the work period and keep an ongoing record of the results of their monitoring. The users must have available, or have ready access to

instruments suitable for the detection of the radioisotopes with which they work, and must be trained in their proper use. The results of their routine monitoring must be verified by surveys periodically performed by the Radiation Safety Officer.

The CNSC criterion for the maximum levels of surface contamination permitted in laboratories where open source radioactive materials are used is:

1) On all normally accessible working surfaces in a radioisotope laboratory, levels of loose radioactive contamination shall not exceed;

Activity Limit (Bq/cm^2)	Class of Radionuclide *
3	A
30	B
300	C

* See Table in Appendix E for Class Designations

2) In all other accessible areas, levels of non-fixed a radioactive contamination shall not exceed;

Activity Limit (Bq/cm^2)	Class of Radionuclide
0.3	A
3.0	B
30.0	C

In all cases, the contamination level may be averaged over an area not exceeding 100 square centimeters.

For fixed contamination, any level of fixed contamination must be reported to the CNSC in Bq/cm^2 and the release of any room or enclosure with fixed contamination must be approved in writing by the CNSC.

Surface contamination may be calculated as follows:

$$\text{Becquerels/cm}^2 = \text{CPM}/60 \times 100/\text{Ec} \times 100/\text{Ew} \times 1/\text{A}$$

Where CPM is the net count rate above background in counts per minute
Ec is the counting efficiency (%)
Ew is the wipe efficiency =10% with distilled water
A is the area wiped (cm^2)

A portable contamination meter may be preferable to wipes for use in contamination control because areas of radioactive contamination may be found and decontaminated immediately. The meter reading is only however a qualitative indicator of contamination. Wipe tests must still be done to determine the quantitative level. When performing contamination monitoring with a portable meter, if results are higher than background levels (CPM), the area needs to be decontaminated and checked again using wipes. Portable meters are generally not suitable when the background radiation is high in the area being checked, and these instruments are not suitable for tritium and only marginally useful for other low energy beta emitters such as carbon-14 and nickel-63. Wipe testing should be used in these instances.

5.4.1 Wipe Testing Methodology for Laboratories

1) On a plan of the laboratory, mark locations that are to be tested. Number these locations. Ten locations should be adequate for most laboratories. When you set up a wipe-testing program, aim to test locations where radioisotopes are used and include likely contaminated locations such as door handles, telephone receivers, pipette handles and taps.

2) Using a cotton ball lightly moistened with alcohol or water held by forceps wipe a representative area (100 cm^2) in each of the designated locations. Use one cotton ball per location and make sure the wipe is identified.

3) Let the wipes air dry.

4) Measure the radioactivity on each wipe using appropriate detection equipment.

5) Do a background count using an uncontaminated wipe.

6) If there are levels of contamination above the levels in the table above, you can identify the contaminated location and decontaminate with detergent and water or a commercial decontamination solution. Repeat wipe testing the location and decontaminating until contamination is non-detectable. Decontamination procedures can be found in Accidents and Emergencies Involving the Release and Radioactivity and Contamination of Personnel in Section 5 of this manual.

7) Keep records of results.

8) Wipe test on a regular basis. At least weekly when open radioactive sources are being used.

5.5 Decommissioning a Radioactive Material Use Site

All nuclear substances must be removed from the site.

Decommissioning of a site requires that all removable contamination be carefully checked. Prior to use of an area for other non-radioactive purposes contamination levels of surface must be below;

0.3 Bq/cm^2 - for long lived and Alpha emitting substances (Class A)
3.0 Bq/cm^2 - for long lived Beta or Gamma emitting substances (Class B)
30 Bq/cm^2 - for short lived Beta and Gamma emitting substances (Class C)

Decommissioning of a site requires any level of fixed contamination be reported to the CNSC in Bq/cm^2 and the release of any room or enclosure with fixed contamination must be approved in writing by the CNSC.

All radioactivity-related warning signs and labels are to be removed.

All decommissioning records are to be kept by the RSO for review by the CNSC.

The site may be subject to an inspection by the CNSC prior to release for other purposes.

5.6 *Leak Testing of Sealed Sources*

Leak testing is not required for all sealed sources. Consult the radioisotope licence to determine whether sources on the licence must be leak tested, or contact the RSO. Generally, except for gaseous sources , sources of tritium and static eliminators retained for less than 15 months, leak tests shall be performed on all sealed sources or nuclear substance used as shielding over 50 MBq. At BCIT we leak test the majority of sources that might be handled by students annually no matter what their activity.

Leak testing is a requirement following any incident which might have resulted in damage to the radioactive source or source holder.

The leak test frequency depends upon the type of device, the nature of the source, and how the instrument is used. CNSC Nuclear Substances and Radiation Devices Regulations Section 18 states the following frequency requirements;

a) Where the sealed source or shielding is used after being stored for 12 or more consecutive months, immediately before using it.
b) Where the sealed source or shielding is being stored, every 12 months.
c) Where an event that may have damaged the sealed source or shielding has occurred, immediately after that event
d) in all other cases;
    i. where the sealed source or shielding is located in a radiation device, every 12 months
    ii. where the sealed source or shielding is not located in a radiation device, every six months

Note that sealed sources containing large amounts of radioactive material should be leak tested by the Radiation Safety Officer or by someone with appropriate training.

5.6.1 Indirect Leak Test

a) Lightly moisten a swab with water or with 50% alcohol. Wipe the surfaces of the device or of the source container on which radioactive contamination would be most likely to accumulate should the source be leaking. Specific instructions are available for each of the devices containing sealed sources.

b) Send labeled swabs in test tube to the RSO for analysis. The activity of the wipe shall be determined by appropriate counting methodology.

c) If the total activity of the swipe exceeds 200 Becquerels, immediately inform the Radiation Safety Officer and remove the source or radiation device from use. Measures must be taken to ensure that the spread of any leakage contamination is limited. The device or source should be properly packaged and sent for repair or disposal to a licensed service provider. The Radiation Safety Officer will immediately notify the CNSC.

d) Record all results.

See Appendix C for a sample leak test certificate

5.7 *Import and Export of Radioactive Material*

The radioisotope licence is also a permit to import radioactive material. When ordering radioisotopes and devices containing radioactive material from other countries, a copy of the radioisotope licence must be sent to your supplier for enclosure with the shipping documents of the order or to the customs broker.

To export any amount of radioactive material, an export permit is required. Users wishing to import or export radioactive material should contact the RSO who will complete the above requirements.

5.8 *Radioisotope Laboratories*

5.8.1 Assessment

The adequacy of a facility for radioisotope work may be determined by making use of the checklist in the "Design compliance Form" which is part of the CNSC document Design Guide for Nuclear Substance Laboratories and Nuclear Medicine Rooms. A copy of this guide may be obtained from the RSO. A design assessment form must be submitted to the CNSC for laboratories to be designated intermediate, high or containment.

5.8.2 Laboratory Hygiene

Due to the possible presence of contamination, the following are not permitted in radioisotope laboratories:

1) the consumption or storage of food and beverages
2) the application of make-up
3) smoking
4) pipetting by mouth
5) storage of food in fridges containing radioactive material

Housekeeping: Good laboratory practice will ensure that benches and fume hoods do not become cluttered with apparatus and supplies.

5.8.3 Laboratory Posters

Two "Laboratory Rules" posters are available, and refer to Basic and Intermediate laboratories. Each laboratory must post according to the appropriate classification. Copies of each poster are available from the RSO.

5.8.4 Security

Radioisotope laboratories must be locked when not in use, or radioisotope stocks must be in secure storage within each laboratory. Users must maintain adequate security procedures.

All losses or thefts of radioactive materials must be reported to the local authorities, Radiation Safety Officer, Occupational Health and Safety Manager, and Director of Safety, Security and Emergency Management, immediately after discovery of such loss.

All losses or thefts of radioactive materials require an immediate report to the CNSC, a thorough investigation to attempt to recover the material, remedial action to ensure that such a loss cannot recur, and a written account to the CNSC at the conclusion of the investigation (within 21 days of the discovery). The Radiation Safety Officer, or designate, is responsible for communications with the CNSC.

5.9 *Radiation Warning Signs and Labels*

Signs are required when any area, room or enclosure which contains over 100 times the exemption quantity of a radioisotope, or if a person could receive a dose of ionizing radiation at a rate exceeding 25 µSv/hr (2.5 mR/hr).

Exemption Quantities are listed in Appendix F - Exemption Quantity Tables

A copy of the CNSC licence must be posted in a conspicuous place at the site of any licensed activity.

Areas within large laboratories where open source radioisotopes are used should be clearly indicated with appropriate markings or by some other suitable method.

No person shall possess a container or device that contains a radioactive nuclear substance unless the container or device is labelled with

a) the radiation warning symbol set out in Schedule 3 of Radiation Protection Regulations and the words “RAYONNEMENT — DANGER — RADIATION”; and

b) the name, quantity, date of measurement and form of the nuclear substance in the container or device.

This does not apply in respect of a container or device:

a. that is used to hold radioactive nuclear substances for current or immediate use and is under the continuous direct observation of the licensee;
b. in which the quantity of radioactive nuclear substances is less than or equal to the exemption quantity; or
c. that is used exclusively for transporting radioactive nuclear substances and labelled in accordance with the Packaging and Transport of Nuclear Substances Regulations.

Every licensee who is required under section 21 of the Radiation Protection Regulations to post a sign shall:

a) post and keep posted, in a visible location at the place where the radioactive nuclear substance is used or stored, a durable and legible sign that indicates the name or job title and the telephone number of a person who can initiate any required emergency procedure and who can be contacted 24 hours a day; and
b) post and keep posted, in a visible location at every personnel access opening to any equipment fitted with a radiation device, a durable and legible sign that bears

i. the radiation warning symbol set out in Schedule 3 to the Radiation Protection Regulations and the words “RAYONNEMENT — DANGER — RADIATION”, and
ii. the requirement to follow the personnel entry procedures required by the licence.

Each laboratory must post the appropriate lab designation poster complete with the name and title and emergency phone numbers of the Radiation Safety Officer and other appropriate contacts. A list of Emergency Contacts can be found in Appendix H.

5.10 *How to Inspect Radioactive Shipments*

Shipments should be inspected immediately upon receipt. The following procedure is recommended:

Wear a lab coat and disposable gloves while handling the package. Place the package in a fume hood.

Monitor the radiation field about the package and compare with the Transport Index stated on the package. Packages containing radioactive materials are categorized by radiation level and display the IAEA warning labels as follows:

The transport index for a package is the number expressing 0.1 times the maximum exposure rate (µSv/hr) at one meter from any surface of the package.

A transport index of 0.1 would indicate a maximal rate of 1.0 µSv/hr.

Open the outer package and check for possible damage to the contents as apparent by broken seals or by discoloration of packing materials.

Remove the inner package or primary container, monitor the radiation field.

Document any pertinent findings.

Verify the radioisotope, the activity, and other details with the information on the packing slip and with your copy of the purchase order. Log the pertinent data in your inventory record. An example of an inventory record can be found in Appendix I.

Report any anomalies (contamination, leakage, damage or wrong shipment) immediately to the Radiation Safety Officer who will in turn notify the carrier and the CNSC appropriately.

Category	Response
Shipping Container damage on receipt	**Investigation to determine cause & extent of damage. If contamination is found, report to carriers and CNSC.**
Shipping Container Security Seal tampering found on receipt	**Investigation to determine extent of security breech. If tampering or theft is discovered, report to carriers and CNSC.**

5.11 *Packaging and Transport of Radioactive Material*

Packaging and transport of nuclear substances is strictly regulated under the Packaging and Transport of Nuclear Substances Regulations of the CNSC and Transport Canada's Transportation of Dangerous Goods Regulations.

The following aspects of transport can only be performed by those persons possessing a current Class 7 Transport of Dangerous Good (TDG) Certificate.

5.11.1 Packaging

If radioactive material is properly packaged, it can be safety transported without hazard to persons and property under most conceivable accident situations. Packaging details are described in the Transport Packaging of Radioactive Materials Regulations.

5.11.2 Transport

No radioactive material may be sent by mail: specified commercial courier services are generally used for small packages.

Institute or private vehicles may NOT be used to transport radioactive material.

Arrange with the Radiation Safety Officer for the transport of any nuclear substance from the Institute.

The degree of preparation for transport will vary with each source but in most cases transport documentation is required.

Typically;

1) Leak test certificate
2) Shipping labels and Declaration
3) Source certificate

BCIT's TDG training includes:

- Recognize the regulating bodies that control the transportation of dangerous goods.
- Identify what regulations/publications each organization is responsible for.
- Determine if a worker is qualified to transport Class 7 Radioactive Materials.
- Identify the required elements of a Training Certificate.
- Recognize the symbols for all classes of dangerous goods.
- Recognize what shipments are considered Class 7 Radioactive Materials.
- Classify Class 7 Radioactive Materials into the appropriate category.
- Determine what type of package is required for a specific shipment.
- Describe the tests that must be passed in order for a package to be acceptable.
- Explain the requirements of an overpack.
- Recognize and identify safety marks found on dangerous goods shipments.
- Recognize the difference between Radioactive I, II and III packages.
- Calculate and verify the Transport Index (TI) of a radioactive shipment.
- Recognize a UN number.
- Explain the markings on the label of Class 7 dangerous good.
- Complete a Shipper's Declaration for Dangerous Goods.
- Identify the required placarding for a shipment of dangerous goods.
- Describe the process of receiving a Class 7 Radioactive shipment.
- Identify a package that has been tampered with or damaged.
- Describe the process of disposing of or re-using shipping packages.
- Identify a Dangerous Occurrence as defined by the CNSC.
- Identify an Accidental Release as defined by Transport Canada.
- Describe how to respond to an emergency situation, including the loss/theft of a radioactive shipment.
- Outline the required information for an official report on a Dangerous Occurrence.

5.12 *Declaration of Pregnancy*

CNSC Regulations state that once a pregnant workers notifies her employer of her pregnancy, a pregnant NEW may not receive more than 4.0 mSv of abdominal absorbed dose equivalence from the time pregnancy has been declared to the end of the pregnancy. It is also recommended the licensee (BCIT) is immediately informed of the pregnancy. This is accomplished by informing the RSO of the pregnancy in writing. A consultation with the RSO may be required where the pregnant worker/student is informed of the risks associated to fetal radiation exposure and a plan is devised to further promote the ALARA Principle.

Typical solutions may include;

- Extended use of lead aprons where abdominal protection is doubled
- Duty reassignment to areas offering less radiation exposure
- Avoidance of volatile radioiodine
- Avoidance of higher radiation exposure procedures
- More frequent dosimetry monitoring (every 2 to 4 weeks)

5.13 *Maintenance and Modification of Devices Containing Radioactive Material*

Maintenance and modification of devices containing radioactive material must be left to the manufacturer or to their representative. Even relatively small sources within devices should not be tampered with because of the possibility of unacceptably high radiation exposure to the fingers and eyes, or source damage which could result in the spread of radioactive contamination.

All modifications to devices containing radioactive material must receive the approval of the Canadian Nuclear Safety Commission if they involve the radioactive source or source holder, or if they in any way affect the integrity and safe operation of the nuclear component.

Plans for such maintenance and modifications must be submitted to the Radiation Safety Officer for forwarding to CNSC for approval.

5.14 *Medical Radiography*

5.14.1 Radiation Lockout Switches

All stationary and portable x-ray machines will be equipped with a lockout switch to render the exposure button inoperable when radiography is not being practiced.

All units must have the lockout switch engaged when radiation is not in use.

The radiation lockout key must be removed from the generator unit in the “off” position after hours, when Medical Radiography instructors are not present in the lab.

5.14.2 Safe Practices

No radiation exposures may be done unless there is a Medical Radiography instructor present in the lab.

All staff and students must remain behind protective barriers during radiation exposure.

All doors must be closed during radiation exposure.

Warning signs must be posted on all entrance doors to radiographic rooms.

No staff or students may enter a radiographic room when the door is shut.

The x-ray beam should not be directed towards protective barriers, shielding, staff or students.

5.15 *Gauges and Dials Containing Radium*

Aircraft instruments containing 226Ra luminous compounds are common if they were manufactured between 1930 and 1950. While sealed within the instruments this material poses only a low to moderate level of radiation risk. With age, the radium containing coating breaks down releasing some of the radioactive material in the form of dust. This can be a considerable internal radiation risk if it is inhaled or ingested. It is therefore

important that instruments are not disassembled in an inappropriate environment or by untrained personnel. The luminescent qualities of these compounds have long been lost so it is difficult to tell which ones are radioactive without a proper survey meter.

In order to comply with CNSC regulations;

1. Ensure that all gauges containing radium are identified, labeled and logged. (Labels must indicate 226Ra - Radiation Danger)

2. All incoming gauges should be monitored with a survey meter to verify or exclude the presence of radioactive material. Newly received radioactive gauges must be logged and labeled.

3. Verify that all work premises are free of contamination. This is done by wipe testing all work surfaces that have a likelihood of being contaminated. This must be done immediately if any gauges are damaged.

4. Any disposal or transfer of these gauges must be done through Radiation Safety Officer. The means of disposal is very limited.

5. Disassembly of these instruments is not permitted at BCIT as a specialty licence is required for this purpose.

6. Storage of these devices should be only in secured areas not immediately occupied by personnel. The gauges must be adequately shielded so that the radiation exposure rate is less than 2.5 µSv at occupied locations adjacent to the storage site. Unwanted gauges should be identified for the radiation safety offer to prepare for interim storage and disposal.

   For further information see Appendix G.

5.16 *Radiation Detection and Measurement*

Prior to the commencement of any work with radioactive material, the user must have available a properly functioning calibrated instrument which is suitable for the detection of the radioisotopes to be used. The following tables will serve to guide those proposing to use radioisotopes in their instrument purchases.

It is important that the battery level be checked and that the detector is not moved too quickly over the surface being examined. Instrument calibrations must be performed annually in accordance with CNSC expectations. Both survey and contamination meters should be checked for response constancy on a regular basis.

The response to radiation by an instrument depends upon (1) the type of radiation (beta, gamma, etc.), (2) its energy and (3) the design of the instrument. See Appendix M for a guide to selecting an appropriate detector.

5.17 *Radioactive Waste Management*

The approved means for disposal of radioactive waste material are specified in the conditions on the radioisotope licence, and users are reminded that it is their responsibility to demonstrate that all releases are within the prescribed limits. Radioisotope users should be aware that they may be asked by the CNSC to show that radioactive waste disposal is within the allowable limits.

RSO authorization is required to transfer and dispose nuclear substances and radiation devices.

All waste must be monitored at the source and then the appropriate method of waste disposal must be selected depending upon the nature of the waste form and the activity of the radioisotope contained therein.

Radioactive waste should be segregated according to the half-life of the isotope.

Waste containers must be tagged with a trefoil and indicating isotope, date and activity.

When the radioactive concentration of the waste exceeds the disposal criteria specified on the licence, the material must either be “diluted” until the disposal criterion is achieved, allowed to decay sufficiently, or sent to a licensed radioactive waste management facility after making prior arrangement.

Where possible and advantageous, radioactive waste may be converted from one form to another to facilitate disposal. For example, liquids may be placed in an absorbent medium and disposed as solid waste.

Storage of radioactive waste for decay prior to disposal is recommended, but only where adequate storage facilities exist. Laboratories are generally not satisfactory waste storage areas. BCIT maintains a special storage bunker for this purpose. Contact the RSO to arrange use of this bunker.

Before releasing radioactive waste to municipal garbage, the residual activity must be measured and recorded, and all signs and tags are to be removed or defaced.

5.18 *Accidents and Emergencies Involving the Release and Radioactivity and Contamination of Personnel*

5.18.1 Minor Spills (Typically less than 100 exemption quantities of a nuclear substance)

a) Inform Co-workers.
b) Cordon off area until spill is decontaminated.
c) Mark the location of the spill with a pencil.
d) Drop absorbent paper on the spill if wet, or if spill is dry, wet with water/oil before using absorbent paper.
e) Do not track contaminants away from the spillage area.
f) Place contaminated clean-up materials in a closed container (e.g. plastic bag). Seal and label container.
g) Following decontamination, wipe test the area to determine residual activity.

h) Survey clothing and body for contamination.
i) Report details of spill and action taken to the RSO.

5.18.2 Major Spills if Personnel are Suspected of Being Contaminated (Major spills are typically more than 100 exemption quantities, or contamination of personnel, or release of volatile material)

CNSC Expectations for Licensee Response During Skin Contamination Events will be followed.

a) Measure and record net count rate and time.
b) Locate contaminated area with a survey meter.
c) If skin is intact
    i. Wet area, wash with a mild soap.
    ii. Rub gently into a lather for about 3 minutes and rinse thoroughly with lukewarm water.
    iii. DO NOT ABRADE THE SKIN!!! If radiation level is still above background inform the Radiation Safety Officer.
d) Measure and record net count rate and time.
e) Repeat steps a - d until readings do not drop.
f) If cuts, abrasions, or open wounds are observed:
    i. Dry clean the affected area with suction swabs.
    ii. If skin is contaminated in the area of cuts, abrasions, or open wounds, use wet swabs in a direction away from the area, taking care not to spread activity over body or into wound.
    iii. Inform the appropriate authorities.
g) If body ingestion has occurred obtain advice immediately from the Radiation Safety Officer.
h) Report details of spill and action taken to the RSO.
i) RSO to report details of spill to Manager of Safety and Director of Safety, Security and Emergency Management.
j) Incidents of skin contamination are to be reported immediately to the CNSC if a NEW was calculated to have received an extremity (skin) dose above 50 mSv or if a non-NEW was calculated to have received an extremity (skin) dose above 5 mSv.

5.18.3 Major Spills Involving Radiation Hazard (Major spills are typically more than 100 exemption quantities, or contamination of personnel, or release of volatile material)

a) Notify all persons to vacate the area at once.
b) Do not attempt to clean up the spill, but take such action as may be expedient to prevent its spread.
c) Notify the Radiation Safety Officer and Security.
d) If the spill is on clothes, discard clothes in plastic bag immediately.
e) Switch off all fans if the materials are volatile.

f) Vacate the room and prohibit entrance to the area, until approved by the Radiation Safety Officer. Post appropriate signs.
g) Make all information available to the Radiation Safety Officer, e.g. amount of activity and chemical form.
h) RSO to immediately report details of spill to Manager of Safety and Director of Safety, Security and Emergency Management and CNSC.
i) Under no circumstances should an untrained person attempt to control or clean up the contamination. The Radiation Safety Officer shall initiate and supervise the necessary action.

5.18.4 Accidents Involving Radioactive Dusts, Mists, Fumes, Organic Vapors and Gases

a) Notify all persons to vacate the room immediately.
b) Hold your breath and switch off fans and close windows.
c) Notify the Radiation Safety Officer and Security.
d) Close and lock all doors giving access to the room. Post appropriate signs.
e) Do not enter the room or permit anyone to leave the premises until approved by the Radiation Safety Officer.

5.18.5 Injuries to Personnel Involving Radiation Hazard

a) Minor Wounds: Wash immediately under running water.
b) Report all incidents, e.g. wounds, overexposure, ingestion, inhalation, etc. to the Radiation Safety Officer.
c) Injured personnel should be taken to BCIT Medical Services or call First Aid 604-432-8820.

5.18.6 Fires Involving Radioactivity

a) Attempt to put out the fire if hazard is not immediately present.
b) Call 911.
c) Notify the Radiation Safety Officer.
d) The RSO will perform a dose rate survey upon approach. The RSO will then visually inspect the device or source and estimate the extent of damage. If the damage is extensive the soured or device should be properly packaged and sent for disposal to a licensed service provider. If the damage is minimal, proceed to step f.
e) If a sealed source or device was involved in a fire place barriers at least one meter around the device
f) Radiation surveys and a leak tests to monitor any contamination should be performed before and after cleanup is initiated.

Users must confirm their awareness of reporting requirements to the Radiation Safety Officer by email after reviewing this manual and confirm that a root cause analysis will be

performed after an incident. An incident must be reported to the CNSC immediately with a written report submitted in 21 days.

6 TRAINING AND EDUCATION

The Radiation Safety Officer is responsible for ensuring that only persons adequately trained to work with radioactive materials are authorized to do so. This authorization is limited to the scope of their training and experience. Appropriate radiation safety training depends upon the extent of radioisotope use in your department, and the education and experience of the radioisotope users. For extensive applications, a radiation safety training course, internal or external, presented at regular intervals should adequately ensure the familiarization of new staff and students with safe practices, and with the policies and procedures of the institution. For minor applications, such courses may be presented less frequently, and new personnel should be interviewed and given initial supervision from experienced staff. For most situations, information sessions which deal with such subjects such as the safe handling of radioiodine and phosphorus-32, waste handling and wipe testing are beneficial.

Personnel who handle (load, unload, offer for transport or transport on public roadways) radioactive shipments for the purpose of redistribution to labs within the institute must be trained or work under the direct supervision of a person trained in the safe handling of radioactive material. All trained personnel must hold a valid Transport of Dangerous Goods (TDG) Certificate appropriate to duties performed. This can be arranged through the RSO. See Transport of Dangerous Goods for further details. A comprehensive on-line course is available to all personnel requiring more extensive training and certification in Radioactive Material – TDG. TDG refresher training is given every 2 years.

All users must also be given “hands-on” experience in the use of monitoring instruments, wipe testing, confinement and clean-up of small spills, contamination control and the use of protective clothing.

It is the responsibility of the institution and individual departments to ensure that all staff that work with radioactive material are properly instructed in safe handling procedures and are aware of the hazards involved. In certain applications, workers may require specialized training and certification to use devices containing radioactive materials. The level of training required shall be set by the RSO as approved by the Radiation Safety Committee.

6.1 *Instructors*

- Orientation to Radiation Safety
- Radioactivity and Interaction with Matter
- Radiobiology
- Radiation Units
- Radiation Detection and Measurement
- Control of Radiation Exposure
- Radiation Safety Regulation

- Regulatory Requirements

Refresher training is required every 3 years

Nuclear Medicine personnel working with open sources will be required to obtain a minimum of 4 hours of continuing education credits during each 24 month period. This will be logged in the personnel records.

6.2 *Students (Nuclear Medicine)*

- Critically evaluate literature relating to risk within the nuclear industry.
- Discuss the mechanisms of damage caused by radiation within a cell.
- Discuss cellular, tissue and organism responses to varying doses of radiation.
- Relate the effects of radiation on tissues and the human body as a whole as demonstrated by cellular and genetic defects manifested in acute and late radiation syndromes.
- Outline the concept of risk as it applies to radiation and nuclear medicine practice.
- Educate staff and patients about the risks associated with radiation and common protective practices practiced during in class role playing.
- Recognize, evaluate and remedy preventable radiation hazards within the nuclear medicine environment.
- Interpret and promote compliance with CNSC regulations, standards and guidelines relevant to the practice of nuclear medicine.
- Outline practical applications and benefits of the ALARA concept within a radiation safety program.
- Effectively utilize radiation protection theory, including the ALARA principle and organ sensitivities to minimize exposure to patients, staff, care givers and general public from radiation.
- Determine bioassay requirements when using volatile forms of radioactive substances.
- Describe and relate the effects and risks of radiation on the embryo and foetus during various phases of maturation.
- Demonstrate a working knowledge of radiation safety practices, regulations, licence requirements and radiation safety programs.
- Apply principles of time, distance and shielding and evaluate effectiveness of such principles in order to minimize radiation exposure.
- Demonstrate practical knowledge of personal and area monitoring, decontamination, radionuclide storage and other legal aspects pertaining to the handling of radioactive materials.
- Discuss radiation dose of nuclear medicine examinations relative to other imaging procedures.
- Apply ALARA principles to minimize patient exposure dose with regards to PET/CT and SPECT/CT scanning.
- Demonstrate practical knowledge of radiation protection practices with respect to CT scanner operation and regulatory body recommendations for reducing occupational doses.

- Demonstrate practical knowledge of the use, quality control and troubleshooting of survey meters.
- Fulfill the requirements of Transport Canada and The Canadian Nuclear Safety Commission to obtain a Transport of Dangerous Goods Certificate for Class 7 Radioactive Material.

Nuclear Medicine Student Training is done in the second term of studies.

6.3 *Housekeeping/Security/Receiving*

- Awareness Training
- Radioactive Signs and Labels
- Reporting Structure
- Roles of the RSO

Refresher training is required every 3 years

Changes to existing regulatory requirements and recommendations will be disseminated by the RSO either directly to the appropriate departmental personnel and/or through the Radiation Safety Committee.

7 DOSIMETRY

7.1 *How to Monitor Personnel for Exposure to Ionizing Radiation*

External radiation exposures are monitored by means of thermoluminescent (TLD) or optically stimulated luminescence (OSL) dosimeters. Persons who have a reasonable probability of exceeding the Maximum Permissible Dose (MPD) of 1 mSv/year (WorkSafe BC OHS Regulation 7.22) are required to be monitored by a CNSC approved Dosimetry Service.

Individual users and departments at BCIT should contact the Radiation Safety Officer (RSO) to assess requirements and to enroll in this monitoring service. Dosimeters are normally issued for three months, but one month, and two week wearing periods are provided for special applications. Individual thermoluminescent ring dosimeters may be obtained to monitor extremity doses. Dosimetry results will be emailed to NEWs annually.

Dosimeters should normally be worn at waist level. If a lead apron is used, the dosimeter should be worn under the apron and extremity dosimeters should also be worn if significant exposures are expected. Rings are to be worn on the dominant hand. Rings must be worn in cases where greater than 50 MBq of 32P are to be handled.

7.2 *Action Levels*

Category		Level Exceeds	Response
Quarterly Results	NEW Staff - Whole Body (WB)	0.5mSv	Investigation to determine cause - future prevention
	NEW Staff - Extremity	35mSv	Investigation to determine cause - future prevention
	NEW Students Nuclear Med. WB	0.75mSv	Investigation to determine cause - future prevention
	NEW Students Nuclear Med. Extremity	45mSv	Investigation to determine cause - future prevention
	All other staff &students WB	0.25mSv	Investigation to determine cause - future prevention
Annual Results	NEW	2 mSv	Investigation to determine cause - future prevention
	Non NEW	0.75 mSv	Investigation to determine cause - future prevention

Internal radiation exposures are measured by means of bioscreening. All operations involving the use of open source radioactive materials present some potential for harm through the possibility of the inhalation, ingestion or skin absorption of these substances. Therefore, when sufficiently large quantities of radioisotopes are manipulated, bioscreening tests to measure the degree of intake must be conducted. Bioscreening requirements for 123I, 125I, 131I and 32P have been specified and information concerning those and other isotopes can be obtained by contacting the RSO.

Operations with quantities of tritiated water or tritium labeled compounds may require bioassays. Information regarding appropriate bioassay procedures is available from the RSO.

7.3 *Exceeding a Dose Limit*

If BCIT becomes aware that a dose of radiation received by or committed to a person or an organ or tissue may have exceeded an applicable dose limit in the Radiation Protection Regulations, the RSO must

(a) immediately notify the person and the Commission of the dose;

(b) require the person to leave any work that is likely to add to the dose if the person may have or has received a dose that exceeds a dose limit for a nuclear energy worker;

(c) conduct an investigation to determine the magnitude of the dose and to establish the causes of the exposure;

(d) identify and take any action required to prevent the occurrence of a similar incident; and

(e) within 21 days after becoming aware that the dose limit has been exceeded, report to the Commission the results of the investigation or the progress that has been made in conducting it.

7.4 *Medical Radiography*

OSLs must be worn during all laboratory sessions. They must be returned to their hanger at the end of the session.

OSLs will remain in the laboratory at all times. The only exception is when the individual is practicing radiography in the clinical setting of a medical facility.

OSLs must be worn at the waist of the individual. During fluoroscopic procedures the OSL must be worn under a lead apron.

OSLs reports will be sent to the RSO who will review it to ensure no adverse exposures have occurred. All dosimetry results will be available by request from the RSO.

In the event that an adverse exposure has occurred the situation will be reviewed by the Radiation Safety Officer.

8 RECORD KEEPING

It is important that records be accurately maintained and kept for reference.

Record	Kept in	Copies to	Saved for
Open Sources	Department	RSO	1 Year after the expiry of the current licence
Sealed Sources	Department	RSO	1 Year after the expiry of the current licence
Wipe test results	Department		1 Year after the expiry of the current licence
Leak tests results	Department	RSO	3 Years
TLD records	Department	RSO	Indefinitely
Names of Workers and students (NEW'S)	Department	RSO	3 Years after Termination
Worker Training Programs	Department	RSO	3 Years after Termination
Labs and designations	RSO	Safety Committee	1 Year after the expiry of the current licence
Storage Locations	RSO	Safety Committee	1 Year after the expiry of the current licence
Inventory of radiation Detection Equipment	RSO	Safety Committee	1 Year after the expiry of the current licence
Emergency Contacts	RSO	Safety Committee	1 Year after the expiry of the current licence
Decommissioning Results	RSO	Department	1 Year after the expiry of the current licence
Waste Disposal and Transfers	RSO		1 Year after the expiry of the current licence
Transport	RSO		2 Years
Emergencies and Incident reports	RSO	Safety Committee	1 Year after the expiry of the current licence
Decommissioning Reports	RSO	Department	1 Year after the expiry of the current licence
Inspections, Measurement, Tests or Servicing	Department	RSO	3 Years after the expiry of the current licence

Written notification must be made to the CNSC 90 days prior to the disposal of any record.

9 PROGRAM REVIEW

9.1 *Quality Assurance in the 137Cs Calibration Apparatus and Process*

General:

The terms of the overall Quality Assurance Program for radiation safety related issues at the BCIT follow those recommendations of the IAEA Safety Series 6.

Specific to the calibration licence;

1. Annual leak tests are performed to ensure source integrity.
2. Survey Meter Manuals are updated as required.
3. Built-in checks are performed with each calibration;
    a. Battery check
    b. Zero
    c. Alarm feature
    d. Audible feature
    e. Activity - Range response linearity
    f. Examination of connections/cables
    g. Calibration limits are noted
4. Meters responses are compared to previous years' results examining response trends.
5. Questionable meter responses are compared to calibrated meters.
6. Calibrations are performed under similar conditions.
7. Personnel monitoring is performed and assessed.
8. Source and attenuators are inspected with each use.
9. Source emissions, while in storage, are checked in adjacent rooms annually.

9.2 *Quality Assurance in Laboratories*

General:

The terms of the overall Quality Assurance Program for radiation safety related issues at the BCIT follow those recommendations of the IAEA Safety Series 6.

Specific to the above licence;

1. Annual leak tests are performed in accordance with CNSC regulations to ensure sealed source integrity.
2. Each area is inspected for correct signage
3. Verify appropriate condition and use of protective equipment and safety procedures including: Lead aprons, Shielding
4. Verify the performance and appropriate response to contamination checks

5. Calibrations are performed under almost identical conditions
6. Ensure that the survey meter is in good working order and has been calibrated
7. Ensure that radiation levels from storage areas are less than 2.5 µSv/hr
8. Ensure that any new personnel have been appropriately classified and trained in radiation safety
9. Check exposure rates from storage in adjacent rooms annually
10. Ensure adequate security is in place for all areas using or storing radioactive materials

Inspections are performed annually and results are relayed in the Radiation Safety Committee meeting.

9.3 *Quality Assurance in the 137Cs Fixed Gauge*

General:

Specific to the above licence;

1. Annual leak tests are performed to ensure sealed source integrity
2. Area is inspected for correct signage
3. Verify appropriate condition and use of protective equipment and safety procedures
4. Ensure that the survey meter is in good working order and has been calibrated
5. Ensure that any new personnel have been appropriately classified and trained in radiation safety
6. Ensure adequate security is in place for all areas using or storing radioactive materials

Inspections are performed annually and results are relayed in the Radiation Safety Committee meeting.

APPENDIX A

An Explanation of SI Units

BCIT™

APPENDIX A: AN EXPLANATION OF SI UNITS

The Curie (Ci) which is equal to 37,000 million (3.7×10^{10}) disintegrations per second, has in Canada been replaced by the Becquerel (Bq), which is defined as the radioactivity producing 1 disintegration per second.

Therefore, 1 curie is equal to 3.7×10^{10} Becquerels or 1 Ci = 3.7×10^{10} Bq

The rem, which is a unit of radiation dose, is being replaced by the unit of dose equivalent, the Sievert (Sv), which is defined as 1 joule per kilogram for X, gamma, and beta radiation.

Therefore, 1 Sievert is equal to 100 rem or 1 Sv = 100 rem

As was the case with the curie, prefixes are used to describe quantities which are larger or smaller than the basic unit. Some of the more common prefixes are:

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

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

50 millisieverts (mSv) = 5 rem

APPENDIX B

Receiving Radioactive Packages

APPENDIX B: RECEIVING RADIOACTIVE PACKAGES

NOTICE

Please notify the Radiation Safety Officer if packages of radioactive Material arrive in damaged condition. Do not open package or forward to consignee until cleared by the Radiation Safety Officer.

Radiation Safety Officer:

Joe Cortese

Office Telephone: 604-451-6993

Cellular Telephone: 778-928-2396

Please follow the following poster when receiving radioactive packages

Guidelines for Handling Packages Containing Nuclear Substances

GUIDELINES FOR HANDLING PACKAGES CONTAINING NUCLEAR SUBSTANCES

Identifying Packages Containing Nuclear Substances

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

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

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

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

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

The transport index is the maximum radiation level in microsieverts per hour at one metre from the external surface of the package, divided by 10.

Example: 1 µSv/h (0.1 mrem/h) at 1 m equals a TI = 0.1.

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

Opening Packages Containing Nuclear Substances

Radiation Safety Officer	**Phone Number**

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

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

5. Wear protective clothing while handling the package.
6. If the material is volatile (unbound iodine, tritium, radioactive gases, etc.) or in a powder form, open the package in a fume hood.
7. Open the outer package and check for possible damage to the contents, broken seals, or discoloration of packing materials. If the contents appear to be damaged, isolate the package to prevent further contamination and notify the Radiation Safety Officer.
8. If damage is evident, wipe test the inner package or primary container which holds the unsealed nuclear substance. If contamination is detected, monitor all packaging and, if appropriate, all locations in contact with the package, for contamination. Contain the contamination, decontaminate, and dispose in accordance with the conditions of the Nuclear Substances and Radiation Devices licence.

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

Canada

APPENDIX C

Sample Leak Test Certificate

APPENDIX C: SAMPLE LEAK TEST CERTIFICATE

Sampling and Measuring
Leak Test Certificate

Licensee
British Columbia Institute of Technology
3700 Willingdon Ave. Burnaby, B.C.

Contact
Joe Cortese
604-451-6993

Sampler and Measurer

Name _____

Phone _____ Date _____

Source information

Device _____ Source _____

Sampling Method _____

Date _____ Signed _____

Measuring Method

Calibration date of measuring equipment _____

Background _____

Device/Source # _____ Model _____

Serial # _____ Net CPM _____

Efficiency _____ cps/Bq _____

kBq _____ Pass/Fail

Action _____

APPENDIX D

Nuclear Energy Worker Acknowledgement

APPENDIX D: NUCLEAR ENERGY WORKER ACKNOWLEDGEMENT

BCIT Notification of Nuclear Energy Worker Status

In accordance with the Nuclear Safety and Control Act and Regulations of Canada, this is to inform you that you are considered a NUCLEAR ENERGY WORKER (NEW). A NEW as defined in the Nuclear Safety and Control Act means a person required, in the course of the person's business or occupation in connection with a nuclear substance or nuclear facility to perform duties in such circumstances that there is a reasonable probability that the person may receive an exposure dose that is greater that the prescribed limit for a member of the general public.

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

a) the risks associated with radiation to which I may be exposed during the course of my work, including the risk associated with exposure to an embryo or foetus;

Health effects caused by exposure to ionizing radiation can be grouped into two general categories, acute and long-term effects.

Acute effects result when large doses of radiation are absorbed over a short period resulting in; radiation burns, radiation sickness, possible death and genetic effects in embryos and foetuses.

Long Term Effects are not readily apparent and are associated with the absorption of lower quantities of radiation over longer periods. Examples of long term effects include anemia, leukemia, tumours, impaired fertility and genetic defects in embryos and foetuses.

b) the applicable dose limits as specified in the Radiation Protection Regulations;

Effective Dose Limits

Item	Person	Period	Effective Dose (mSv)
1	Nuclear energy worker, including a female nuclear energy worker who is breastfeeding and a female nuclear energy worker who is pregnant but who has not yet informed the licensee in writing that she is pregnant	**(a)** One-year dosimetry period	50
		(b) Five-year dosimetry period	100
2	Pregnant nuclear energy worker who has informed the licensee in writing that she is pregnant	Balance of the pregnancy starting from the date on which the licensee has been informed of the pregnancy	4
3	Person who is not a nuclear energy worker	One calendar year	1

Equivalent Dose Limits

Item	Organ or Tissue	Person	Period	Equivalent Dose (mSv)
1	Lens of an eye	**(a)** Nuclear energy worker	One-year dosimetry period	50
		(b) Any other person	One calendar year	15
2	Skin	(a) Nuclear energy worker	One-year dosimetry period	500
		(b) Any other person	One calendar year	50
3	Hands and feet	(a) Nuclear energy worker	One-year dosimetry period	500
		(b) Any other person	One calendar year	50

c) my expected radiation dose levels;
d) my rights and recommendations should I become pregnant.

It is recommended that every NEW should immediately inform the licensee in writing when becoming pregnant or is breastfeeding. The maximum permissible dose limits defined above for pregnant workers become effective after notification. The licensee will make those accommodations to limit exposure that will not occasion costs or business convenience constituting undue hardship on the licensee.

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

_____
Name

_____ _____
Signature of Worker Signature of RSO & Date

APPENDIX E

Radionuclide Classification

APPENDIX E: RADIONUCLIDE CLASSIFICATION

CLASS	RADIONUCLIDE				
CLASS A	all alpha emitters and their daughter isotopes				
	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-143	Co-58
	Cu-67	Fe-59	Hg-194	Hg-203	I-131
	Ir-192	La-140	Mo-99	Nb-95	Pa-233
	Ra-223	Re-186	Re-188	Ru-103	Sb-122
	Sm-153	Sr-90	Xe-127	Y-86	Y-90
	Yb-169	Zr-89	Zr-95		
CLASS C	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			

APPENDIX F

Exemption Quantities of Radioactive Materials used at BCIT

APPENDIX F: EXEMPTION QUANTITIES OF RADIOACTIVE MATERIALS USED AT BCIT

Nuclide	Mass Number	Quantity in Bq
Barium	133	10^6
Carbon	14	10^7
Cesium	137	10^4
Chromium	51	10^7
Cobalt	57	10^6
Cobalt	60	10^5
Gallium	67	10^6
Gold	195	10^7
Hydrogen	3	10^9
Indium	111	10^6
Iodine	123	10^7
Iodine	125	10^6
Iodine	131	10^6
Molybdenum	99	10^6
Nickel	63	10^8
Phosphorus	32	10^5
Polonium	210	10^4
Strontium	90	10^4
Technetium	99m	10^7
Thallium	201	10^6

Values taken from the Canadian Nuclear Safety Commission – Nuclear Substances and Radiation Devices Regulations SCHEDULE: EXEMPTION QUANTITIES

APPENDIX G

Devices Containing Radium Luminous Compounds

APPENDIX G: DEVICES CONTAINING RADIUM LUMINOUS COMPOUNDS

Devices Containing Radium Luminous Compounds

Q1. What is radium?

A1. Radium is a radioactive element found naturally in the environment. It is a decay product of uranium which is found in almost all rocks and soils. Radium is long-lived (its half-life is over 1,600 years) which decays with time to radon gas and finally stabilizes to lead. It is hazardous to your health if it is ingested, inhaled or absorbed through the skin. Its scientific name is Ra-226.

Q2. What is a radium luminous compound?

A2. A radium luminous compound consists of radium salts mixed with a chemical phosphor. The resulting compound is luminescent. This compound was developed into a paint and its luminescence made it popular for use in watch and clock faces, maritime compasses, and a variety of military items and aircraft instruments.

Q3. What is a radium luminous device?

A3. A radium luminous device is an instrument that contains a radium luminous compound. The device itself is not radioactive. The radioactivity is associated with the radium luminous paint in the device, which causes it to glow in the dark.

Q4. Are these devices dangerous?

A4. There is a potential danger from exposure to the radium luminous paint. As long as the device is not disassembled or tampered with, the risk of contamination is minimal. Potential hazards can also exist from collections of radium luminous devices, as high levels of radiation may develop if many of these devices are grouped together. More information on radiation hazards may be found in the Radiation Hazards section.

Q5. Are these devices still being produced?

A5. In Canada, production of radium luminous products ended in the 1960s. The use of radium in consumer products pre-dates the establishment of regulatory control of nuclear materials in Canada. By today's standards, it is unlikely that the CNSC would permit the manufacture of radium luminous products.

Q6. How can I identify a radium luminous device?

A6. Radium luminous devices are generally not identified as containing radioactive materials. Although the radioactivity will remain for thousands of years, the radium luminous paint that was combined with it breaks down chemically after several years.

Therefore, the devices may no longer glow in the dark and there may be no visible signs that radioactivity is present. When new, the paint was often white; the whitish paint typically tarnishes to yellow.

Only a radiation survey meter can confirm if a device contains radium luminous compounds.

If a radium luminous device is no longer luminous, is it still dangerous?
Even if the device has ended its working life, the radium contained within the instrument is still radioactive and therefore a potential hazard remains. Over time, the radium luminous paint will chemically break down, and may no longer be luminescent. The radium will still remain, due to its 1,600 year half-life. More information on radiation hazards may be found in the Radiation Hazards section.

Q7. How should I handle and store radium luminous devices?

A7. Care should be taken when handling radium luminous devices in order to avoid contamination.

- Do not open radium luminous devices.
- Minimize the number of radium luminous devices stored or displayed in one location.
- When handling radium luminous devices, wear disposable gloves.
- Cracked or damaged radium luminous devices should be contained. The CNSC should be contacted for additional advice.
- Do not eat, drink or smoke in areas where radium luminous devices are handled or stored.
- Store radium luminous devices in a secure location away from occupied areas.

Q8. What about public displays?

A8. If a radium luminous device is on display, a public access boundary should be placed to exclude access to at least one metre from the display. Radium luminous devices should never be used in ‘hands-on’ displays.

Q9. Can radium luminous devices be painted or varnished to reduce the risks?

A9. Painting or varnishing radium luminous devices is not sufficient to shield the radiation emitted from the device, and will not decrease the radiation hazards. Radium luminous devices should never be opened to be painted.

Q10. Would dismantling a radium luminous device cause risk to the person?

A10. Do not open or tamper with a radium luminous device. Dismantling increases the risk of inhalation and ingestion of radium as well as the risk of contaminating the

surrounding area. More information on radiation hazards may be found in the Radiation Hazards section.

Q11. What should I do if I possess a radium luminous device that is cracked or damaged?

A11. If you possess a radium luminous device that is cracked or damaged, wear disposable rubber gloves and carefully contain the device. Seal the container and store the cracked or damaged device away from occupied areas.

Q12. Where can I have a radium luminous device serviced?

A12. Servicing of a radium luminous device is an activity that is licensed by the CNSC. Service activities include disassembling of radium luminous devices for repair or removal of radium luminous compounds. Members of the public can contact the CNSC to obtain information on licensed service providers.

Q13. How can I safely dispose of a radium luminous device?

A13. Since these devices contain long-lived radioactive nuclear substances, they cannot be disposed of in regular waste streams for equipment or general refuse. Requirements for transfer and disposal of these devices are defined under both federal and provincial legislation, and currently they must be disposed of with a radioactive waste management facility licensed by the CNSC. Please contact the CNSC to obtain information on licensed waste management facilities in your area.

Radiation Hazards from Radium Luminous Compounds

Q1. How dangerous is radium?

A1. Radium and its decay products contained within the luminous paint of these devices are radioactive and exhibit alpha, beta and gamma radiation. The hazards from exposure to these forms of radiation can occur in two ways: by external irradiation outside of the body and by exposure to internal contamination from radioactive material that has been inhaled, ingested or absorbed through the skin. For more information on radiation and its effects, the CNSC has published an introductory document entitled Understanding Radiation (PDF).

Q2. What are the radiation exposure hazards?

A2. Radium emits highly penetrating gamma radiation that may result in external radiation hazards to the whole body, extremities, skin and lenses of the eyes. Potential hazards can also exist from collections of radium luminous devices. High levels of radiation may develop if many of these devices are grouped together (e.g. in parts bins or cabinets).

The biggest hazards are from the intake of radium through ingestion (e.g. from contaminated hands), inhalation (e.g. breathing in loose radium luminous paint) and absorption through the skin (e.g. through open wounds).

Q3. What about radioactive contamination?

A3. Radioactive contamination is the uncontrolled distribution of radioactive material in a given environment. When radium luminous devices are opened, radioactive contamination may occur because the paint containing the radium luminous compounds becomes brittle with age and flakes off the surface of the device. Without proper handling procedures, a radiation risk can result. For those who believe they have a contamination problem resulting from unknowingly opening radium luminous devices, please contact the CNSC for further advice and information.

Q4. How can I decrease the radiation risks?

A4. Three factors come into play when decreasing the risks of radiation: time, distance, and shielding.

Time: The less time a person remains in the area of radiation, the less of a radiation dose that person will receive.

Distance: The intensity of radiation and its effects decrease as you move further away from the radioactive source.

Shielding: Different materials, such as lead, can act as a shield between a radioactive source and people, thereby reducing the amount of radiation a person is exposed to.

Never open radium luminous devices. Minimize the number of radium luminous devices stored or displayed in one location. Wear disposable gloves when handling radium luminous devices. If you possess a radium luminous device that is cracked or damaged, wear disposable rubber gloves, carefully contain the device and isolate it to a location with limited access. Do not eat, drink or smoke in areas where radium luminous devices are handled or stored.

Q5. What should people do if they suspect they've been exposed to contamination from a radium luminous device?

A5. For those who are concerned that they have been exposed to contamination from a radium luminous device, please contact the CNSC for additional information and advice.

Licensing Information for Radium Luminous Devices

Q1. Why is the CNSC interested in radium luminous devices?

A1. Radium, being radioactive, can be a potential hazard and must be treated accordingly. Radium is defined as a nuclear substance under the Nuclear Safety and Control Act, therefore its use is regulated by the CNSC.

As Canada's nuclear regulator, the CNSC is responsible for regulating the use of nuclear energy and materials to protect health, safety and the environment to respect Canada's international commitments on the peaceful use of nuclear energy. As such, the safety of anyone who potentially may be exposed to radium luminous devices is a concern to the CNSC.

Q2. Who needs a licence?

A2. A person may possess, transfer and use any number of radium luminous devices without a licence, provided that radium is the only nuclear substance in the device and the device is intact and not tampered with.

A CNSC licence is only required when radium luminous devices are serviced. Service activities include disassembling of radium luminous devices for repair or removal of radium luminous compounds. These devices must also be disposed of with a CNSC-licensed radioactive waste management facility.

APPENDIX H

Emergency Contacts

APPENDIX H: EMERGENCY CONTACTS

Radionuclide Locations
Emergency Contacts
Update July 2021
In case of emergency

LOCATION	DEPARTMENT	CONTACT PERSON	BCIT TEL	email
SW1 3115	Environmental Health	Fred Shaw	604-432-8972	fshaw@bcit.ca
SW3 4745	Physics	Glenn Lewis	604-412-7439	glewis@bcit.ca
SE12 404	Nuclear Medicine	Joe Cortese	604-451-6993	jcortese@bcit.ca
Bunker SW1 1474	Safety and Security	Joe Cortese	604-451-6993	jcortese@bcit.ca
SE 9 Process Lab	Industrial Instrumentation	Jim Armstrong	604-432-8814	Jim_Armstrong@bcit.ca
SW1 4056/4035/4044	Medical Radiography	Denise Poelzer	604-451-6918	Denise_Poelzer@bcit.ca

For 24 hours assistance call BCIT Security at 604-451-6856
In case of emergency involving any of these areas the following must also be contacted:
Joe Cortese - Radiation Safety Officer Loc. 6993 Cell 778-788-2396

Special Instructions

1. The radioactive storage bunker located near the east side loading dock of building SW1 in Room SW1-1474 adjacent to the hazardous chemicals storage bunkers is out of bounds to security personnel. Access is totally restricted to the Radiation Safety Officer and others may only entry while escorted by the Radiation Safety Officer.

2. It is important that fire crews are made aware of these radionuclide locations during fire emergencies.

APPENDIX I

Sample Continuous Open Source Radioisotope Inventory Record

BCIT™

APPENDIX I: SAMPLE CONTINUOUS OPEN SOURCE RADIOISOTOPE INVENTORY RECORD

Radiopharmaceutical: _____ Supplier: _____ Lot #: _____ (***Check on receipt)***

Total activity: _____ Date: _____ Time: _____

Expiry Date: _____Total volume: _____ Assay/ml: _____

Assay date: _____Expected activity: _____ Dose calibrator reading: _____

Visual Check of:

(1) package ☐ (2) inner content ☐ (3) wipe test of inner content ☐

Time of use		**Elapsed time**		**Decay Factor**	**Assay MBq/ml**	**Activity**		**Volume**		**Init.**	**Disposal**	
Date	time	Days	hours			Used	Left	Used	Left		method	amount

DISPOSAL METHOD:

1. Sewer
2. Decay and sewer
3. Solids — decay and garbage
4. Bulk organic solvent

APPENDIX J

Sample Sealed Source Inventory Record

APPENDIX J: SAMPLE SEALED SOURCE INVENTORY RECORD

Radioisotope User: _____ **Date:** _____

CNSC Licence Number: _____

Radioisotope	Activity	Device Make & Model Number	Serial Number	Location

APPENDIX K

Sample Contamination Control Record

APPENDIX K: SAMPLE CONTAMINATION CONTROL RECORD

Radioisotope User: _____ **Licence Number:** _____

Room Number: _____ **Radioisotopes Used:** _____

Method: _____
(e.g. wipes/LSC, NaI Counter):

Date	Wipe/Survey Location	Net Counts	Activity (Bq)	Initials & Action(if needed)
	BKG. (blank)			

APPENDIX L

Radiation Detectors

APPENDIX L: RADIATION DETECTORS

Detector	Radiation Detected	Normal Range	Application	Remarks
Geiger Muller (GM)	Alpha, Beta, or Gamma	300-600x1,10,100, etc counts per minute or mR/hr. µSv/hr	1. Survey meter to measure exposure rate in mR/h, or µSv/hr 2. Contamination monitor measures counts per minute.	mR/h accuracy is limited. Some models saturate (inaccurate readings) above 50 to 100 mR/h. Insensitive to alphas and low energy betas unless equipped with thin window. Will not detect betas from tritium.
Ionization Chamber	X-rays, Gamma and high energy Beta	Several models ranging from 1 mRad to 1000 mRad/hr full scale.	Measures radiation absorbed dose (RAD) in air of X-rays and gamma (10 Kev to 2 Mev). Note that 1 mr/hr = 0.877 mRad air.	Most widely used instrument for radiation surveys.
Sodium Iodide and Photomultip-lier tube	Gamma or X-rays, depending on size of crystal	A survey meter with several ranges starting from 0.001 mR/hr. As a gamma counter pulse height spectro-meter counts in a given energy range.	Used for very low level gamma or X-ray monitoring. Also used to measure activity of gamma emitting isotopes in a gamma counter.	Very useful gamma or X-ray analysis and monitoring. Sensitivity dependent upon the size of crystal. mR calibration is usually valid only for radiation of Cs-137 but can be calibrated at other energies.
Liquid Scintillation Detector	Beta		Low level measurement of beta emitting isotopes especially low energy beta such as tritium and carbon.	Research instrument can be used to detect beta activity on wipes.

Isotope	Prominent Radiation	Recommended[2] Radiation Survey Probe	Recommended[2] Counter For Wipe Tests
Cadmium-109	E, β	NaI, G,	Gamma or gas flow
Calcium-45	β^-	GM	Gas flow, GM, or liquid scint
Carbon-14	β^-	GM	Gas flow, GM, or liquid scint
Nickel-63	β^-	GM	Gas flow, GM, or liquid scint
Chromium-51	e, γ	GM, NaI	Gas flow, or liquid scint
Cobalt-57	e, γ	GM, NaI	Gamma or gas flow
Cobalt-60	β^-, γ	GM, NaI	Gamma or gas flow
Hydrogen-3	β^-	footnote 3	Liquid scintillation or gas flow
Iodine-125	E, γ	Thin, NaI, GM	Gamma - See footnote 4
Iron-59	β^-, γ	GM, NaI	Gamma, gas flow, or GM
Lead-210	β, e, γ , ά and daughter radiation from B-210 and Po-210	GM	Gas flow, GM, or liquid scint
Mercury-203	β^-	GM, NaI	Gamma, gas flow, GM
Phosphorus-32	β^-	GM	GM, gas flow, or liquid scint
Potassium-42	β^-	GM	Gas flow, GM, or liquid scint
Radium-226	ά, β^-, e, (and daughter radiation	GM, ZnS	Gas flow or GM
Selenium-75	E, γ	NaI, GM	Gamma, gas flow, GM
Sodium-22	β^+, γ	GM	Gamma, gas flow, GM
Strontium-90	β^-, + daughter radiation	GM	Gas flow, GM
Sulphur-35	β^-	GM	Gas flow, GM, or liquid scint
Zinc-65	β^-	NaI, GM	Gas flow, GM, gamma

1. β= beta, β^+ = positron, e = conversion electron, γ = gamma, ά = alpha
   The radiation that is easiest to detect is underlined.

2. Recommended instruments are listed in order of preference. GM thin window is preferred because it has better sensitivity for low energy radiation as does the gas flow counter. If the appropriate counter is not available, others on the list may be used.

3. Tritium and Nickel –63 emit a very low energy beta which cannot be detected by ordinary survey meters. Liquid scintillation counters are used to detect contamination.

4. Iodine-125 emits approximately 27 keV x-rays and 35 keV gamma rays. A thin NaI crystal is most suitable to detect contamination. Persons using I-125 should exercise more care and wipe test the lab regularly.

APPENDIX M

BCIT Radiation Safety Policy

APPENDIX M: BCIT RADIATION SAFETY POLICY

Policy Statement

BCIT promotes safe and healthy working conditions and attitudes for employees, students and visitors.
In order to simulate current industry practices and equipment for teaching purposes, it is important that BCIT possess and use instruments and sources emitting both ionizing and non-ionizing radiation. Radiation is potentially hazardous. Therefore, BCIT takes the following steps regarding radiation safety. The Institute:

- Educates, monitors, and advises those employees, students, and contractors, who are involved with radiation sources
- Provides guidelines and procedures to be followed for the safe handling and operation of related materials, instruments, and facilities
- Maintains compliance with applicable laws and regulations.

Purpose of Policy

The purposes of this policy are to:

1. Define the roles and responsibilities within the BCIT community for ensuring the safe and secure handling and use of radioactive materials and radiation emitting devices.
2. Provide information to facilitate the protection of the health and safety of all employees, students, contractors, and visitors, regarding radiation safety.
3. Inform the BCIT community of the relevant statutes, regulations, and standards of government agencies and regulatory authorities.

Application of this Policy

This policy applies to all members of the BCIT community, including all BCIT employees, students, contractors, and visitors, with respect to the use, storage, transportation, and disposal of radioactive materials and radiation-emitting devices.

Related Documents and Legislation

Canadian Nuclear Safety Commission
Canada *Nuclear Safety and Control Act*
General Nuclear Safety and Control Regulations
Radiation Protection Regulations
Nuclear Substances and Radiation Devices Regulations
Packaging and Transport of Nuclear Substances Regulations

Health Canada
Safety Code 20A, 24, 32, 33, 34 and 35

WorkSafe BC
Occupational Health and Safety Regulation
Part 7 Noise, Vibration, Radiation and Temperature

Canadian Standards Association
CSA Standard Z386-08

BCIT Safety, Security and Emergency Management Plans:
BCIT Matrix of Responsibility
http://www.bcit.ca/files/safetyandsecurity/pdf/oh_s_matrix_of_responsibilities.pdf

Definitions

radiation: emitted energy, which may consist or electromagnetic waves or moving subatomic particles. Examples: visible light, heat and microwaves.

ionization: the conversion of an atom or molecule to an ion by adding or removing charged particles such as electrons or other ions.

ionizing radiation: a process in which the radiated energy is able to ionize atoms or molecules of a substance in which the energy is absorbed. This leads to chemical changes that can damage biological tissues and structural materials.
Examples: X-rays, gamma rays, alpha particles, and beta particles.

Other Information
None

Duties and Responsibilities

Safety, Security and Emergency Management Department – Radiation Safety Officer
The overall objective of the Radiation Safety Officer is to educate, train, and audit students, staff, and other personnel at BCIT with respect to radiation safety. The Radiation Safety Officer's role is to promote and maintain rigorous compliance with all relevant regulation and licence conditions.

This position provides day-to-day administration and control of radiation safety programs at BCIT, working to implement the Institute's compliance with internal and regulatory agency requirements relating to radiation safety**.**

BCIT Radiation Safety Committee
The BCIT Radiation Safety Committee has representation from each department that utilizes radioactive materials, devices incorporating radioactive sources, or radiation emitting devices. Committee representatives will have expertise in their area with respect to radiation safety.
The Radiation Safety Committee is established to advise on, monitor, and oversee radiation safety matters at BCIT. The primary role of the committee is to advise the Radiation Safety Officer and BCIT management on the quality and effectiveness of radiation safety policies and programs and the safety of employee and student work practices.