Radiation Safety: Refresher Training
Refresher Training Instructions

The following refresher training is intended for nuclear substance workers who have previously attended the full day Radiation Safety training course.

This module is not intended to substitute for the full training session. Refresher training is required every 3 years to maintain a valid nuclear substance worker status.

Refresher training will be documented by reviewing this power point and submitting the associated quiz to the Radiation Safety Office.

The quiz can be found at:

Canadian Regulations

Canadian Nuclear Safety Commission (CNSC) is the governing body for nuclear substances. The CNSC regulates the use of nuclear energy and materials to protect the health, safety and environment, and to respect Canada’s international commitments to the peaceful use of nuclear energy.

The Nuclear Safety & Control Act and associated regulations can be viewed on the CNSC website at:

http://nuclearsafety.gc.ca/eng
Radiation Safety Committee

Members:
- J. Fawcett – Chair
- J. Robertson – RSO
- J. Aguinaga – Director EHS
- R. Thompson – Biosafety & Radiation Safety Technician
- Paul Bourgeois – Tupper Building Manager
- N. Ridgway – Pediatrics, Biochemistry & Molecular Biology
- N. McMullin - Microbiology & Immunology
- R. Nadaradjan - Biochemistry – DMNB
- S. Roberts – Pediatrics – IWK
Principal Investigator (P.I.) Responsibilities

It is the responsibility of the P.I. to ensure that all workers in their research group who will be handling nuclear substances are registered with the Radiation Safety Office and have completed required radiation safety training. This would include not only full time staff but also summer students, honors students, visiting scientists, etc.

Only individuals directly working with radioisotopes are required to complete and maintain Radiation Safety Training.
Worker Responsibilities

All staff must be aware of their responsibilities and obligations as radiation workers.

Workers are required to:

• Complete and maintain radiation safety training
• Follow all Dalhousie policies and procedures
• Maintain an up-to-date inventory record of radioactive materials
• Perform and document contamination surveys as required to control contamination and keep exposure ALARA
• Follow required radiation safety and radioactive waste handling and disposal policies.
• Understand the requirement to declare pregnancy
• Ensure the security of the lab and the nuclear substances in their possession
• Wear a dosimeter when required
• Report any unusual incidents or breach of security, contamination to personnel, and shipment irregularities
## Types of Ionizing Radiation

<table>
<thead>
<tr>
<th>Radiation</th>
<th>Type of Radiation</th>
<th>Approx Energy</th>
<th>Range in air</th>
<th>Shielding Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha</td>
<td>Particle</td>
<td>High 2-8 MeV</td>
<td>A few centimetres</td>
<td>Paper, Skin, Clothing</td>
</tr>
<tr>
<td>Beta</td>
<td>Particle</td>
<td>keV to 5MeV</td>
<td>A few metres</td>
<td>Plastic, glass, plexiglass</td>
</tr>
<tr>
<td>Gamma</td>
<td>Electromagnetic</td>
<td>keV to 6MeV</td>
<td>Very long range</td>
<td>Dense metals (i.e. Lead) Concrete</td>
</tr>
<tr>
<td>Neutrons</td>
<td>Particle (emitted upon fissioning of some heavy nuclides or light nuclei bombarded by alpha particles or gamma rays)</td>
<td>Variable (depending on kinetic energy)</td>
<td>Variable (depending on kinetic energy)</td>
<td>Water, concrete, oil</td>
</tr>
</tbody>
</table>
Penetrating Distances

Alpha

Beta

Gamma and X-rays

Paper

Plastic

Lead

Concrete

RADIATION SAFETY REFRESHER

8
Units of Radioactivity

There are two types of units you have to be familiar with when working with radioactive material. These are the units of activity and dose.

Units of activity are used to describe the amount of radioactive material you work with, such as when you take isotopes from a stock solution to run a reaction. These are measured in mCi (milliCurie) or MBq (Mega Bequerels)

\[ 1\text{mCi} = 37\text{MBq} \]

Units of dose describe the amount of ionizing energy absorbed by an object or a person, such as yourself. These are measured in mSv (milliSievert) or REM

\[ 0.1\text{REM} = 1\text{mSv} \]
# Common Research Isotopes

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Symbol</th>
<th>Half life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluorine 18</td>
<td>$^{18}\text{F}$</td>
<td>110 min.</td>
</tr>
<tr>
<td>Phosphorus 32</td>
<td>$^{32}\text{P}$</td>
<td>14.3 days</td>
</tr>
<tr>
<td>Phosphorus 33</td>
<td>$^{33}\text{P}$</td>
<td>25.4 days</td>
</tr>
<tr>
<td>Sulfur 35</td>
<td>$^{35}\text{S}$</td>
<td>87.5 days</td>
</tr>
<tr>
<td>Iodine 125</td>
<td>$^{125}\text{I}$</td>
<td>60.1 days</td>
</tr>
<tr>
<td>Tritium</td>
<td>$^{3}\text{H}$</td>
<td>12.3 years</td>
</tr>
<tr>
<td>Carbon 14</td>
<td>$^{14}\text{C}$</td>
<td>5,730 years</td>
</tr>
</tbody>
</table>
Types of Exposure

1. External Radiation Exposure
   This occurs when our body is partly or completely exposed to a source. This can occur when you are not properly shielded from a source. When you properly shield the source you will no longer be exposed.

   In order to reduce external radiation exposure use ALARA principles:
   • Time
   • Distance
   • Shielding
Types of Exposure

2. Internal Radiation Exposure

This is exposure from a source that has inadvertently been deposited into the body and decays. The radiation will continue until it decays or has been excreted. It enters the body through:

• Inhalation (mouth and nose)
• Ingestion (from hands to mouth or contaminated food or drink)
• Absorption (through skin)

To reduce the chance of internal exposure you can:

• wear proper PPE
• cover wounds with waterproof bandages
• do not eat or drink in any radiation designated area
Radiation Principles

No practice shall be adopted unless its introduction produces a positive net benefit.

All exposures shall be kept ALARA (As Low As Reasonably Achievable), economical and social factors being taken into account.

The dose equivalent to individuals shall not exceed the maximum exposure limit:

- Dalhousie occupational exposure limit (for non-NEW’s) is 0.3 mSv/quarter and 1 mSv annually.
ALARA In Practice

In order to maintain an ALARA work environment with Radioactive Materials (RAM) we utilize the following principles:

**Time**
- The less time spent near a nuclear substance, the less dose received.

**Distance**
- The more distance between you and the RAM, the less exposure received
- Use tongs or other remote handling tools to reduce exposure to fingers and hands

**Shielding**
- Choose appropriate shielding (if required)
- Shield Beta emitters with plexiglass
- Shield X-ray or gamma emitters with lead
Required Laboratory Signage

The main corridor door to enter the lab will have a hazard identification sign posted. The hazard identification sign will specify whether custodial services are permitted with or without an escort.

Custodial services are only permitted with an escort in all nuclear substance labs.
Laboratory Signage

A copy of the nuclear substance permit must be posted in the lab.
Laboratory Signage

Basic or Intermediate posters must be posted in the lab with Security (4109) as the 24hr contact number.

These posters are NOT required for exempt or sealed source only labs.

Basic Level Laboratory

Basic or Intermediate posters must be posted in the lab with Security (4109) as the 24hr contact number.

Intermediate Level Laboratory

A laboratory is classified as "intermediate level" if it has the potential quantity of radiation to handle and the individual handling the radioactive material must be present in the lab.

Emergency Procedures:

1. Call 911 or local emergency services.
2. Follow emergency procedures outlined in the laboratory's emergency plan.
3. Alert all personnel to the emergency.
4. Evacuate the area immediately.
5. Do not use elevators.
6. Use available exit routes.

Radiation Safety:

1. Know the limits of radiation exposure.
2. Use protective clothing and equipment.
3. Follow proper handling techniques.
4. Maintain a safe working environment.
5. Keep radiation levels below permissible limits.

Laboratory Equipment:

1. Use proper personal protective equipment.
2. Use designated storage areas.
3. Use approved radiation safety procedures.

Emergency Contacts:

1. Transportation: 804-443-6369
2. EOD: 804-443-3151 or 804-432-1304 (all phone)

Prepared for the Radiation Safety Office, Dominion Power (www domains.com)
Laboratory Signage

CNSC package receiving and spill posters must be posted.
Survey Meter Use

You should know how to use a survey meter, if you are using an isotope that is detectable. Remember that you must perform a pre-operational check each time you use the meter, which includes:

- Battery
- Getting a background reading
- Checking calibration date (if applicable)
- Source check meter response (if available)
- Ensure the correct scale or operating ranges are selected

If you are uncertain about how to perform the pre-operational check or to do a survey, review the process with your PI.
Dosimeters

Dosimeters are required when working with high energy beta and gamma emitters (e.g. P-32, I-125)

A whole body TLD (Thermoluminescence Dosimeter) is worn on the torso in a location where it is likely to receive the highest exposure.

Ring dosimeters are worn underneath disposable gloves and are worn so the chip faces towards the source.
Radioactive Waste

Working with radioactive material generates contaminated waste. Although it is now waste, this radioactive material must still be tracked and controlled.

Arrange with the RSO to remove radioactive waste from labs. It is the responsibility of the lab workers to properly prepare and maintain their waste for disposal.

There are three types of waste, solid (box), liquid (4 litre container), and sharps.

Please make sure to package appropriately as containers will be inspected prior to disposal.

Waste disposal tags are required for solid and liquid waste. The waste disposal tag must be completely filled out. Please contact the RSO for waste disposal tags.
Lab Conditions Frequently Identified by CNSC Inspectors

Evidence of Food/Drink
Refuse containers located within the lab must not contain food remnants, the inspector will interpret this as evidence of food or drink.

Dosimeters(s) Worn
If dosimeters are not readily available when the inspector arrives they will assume it is lost.

Meters Available/ Operational
Anyone using RAM must be able to properly operate a contamination meter, if it is appropriate to the isotopes in the lab.

Evident RAM Security
The inspector will look for open locks on fridges, vacant labs with doors open.

Record Keeping
The inspector will go through all records to ensure compliance with internal policy – every record MUST be accounted for.
Transfers

All transfers from one permit holder to another must be approved by the RSO. The transfer form can be located on the Radiation Safety website. One form must be completed by both parties, which then needs to be sent to the RSO. Once the RSO has approved the transfer and returned the form to both parties, the physical transfer of the isotope can be completed.

The RSO will transfer the inventory upon approval. There should be NO transfer of a Nuclear Substance without the authorization of the RSO.
Security

All nuclear substances must be secure against unauthorized removal. Ensure that stock solutions are locked away whenever the lab is unoccupied by an authorized worker. Immediately report missing RAM to the RSO.
PPE

Workers must wear the required PPE while working with nuclear substances.

Beside are pictures of two lab workers prepared to work with a nuclear substance. Note the lab coat, gloves, closed toes shoes and pants.

Dosimeters and safety glasses may also be required depending on the isotope.

- Operations involving a high energy $\beta$ emitter require eye protection
- Safety glasses should be worn when there is a risk of splashing while using any chemical substance – which includes the use of any/all radioisotopes.
Unacceptable Laboratory Attire

Here is a lab worker at a “rad bench” who is in violation of lab rules for working in a rad lab.

The worker is not wearing a lab coat, gloves and has open toed shoes.
Avoid Ingesting Radioactive Material

NO

• EATING or DRINKING
  Cups found in the lab waste bin is considered “evidence” by the inspectors that food or drink has been consumed in the lab
• SMOKING
• APPLYING COSMETICS
• MOUTH PIPETTING

Always wash hand thoroughly after using RAM
Working with Volatiles, Powders, etc..

Ensure that any work involving nuclear substances that could create an airborne hazard is confined to the fume hood

- Including any work with known volatile isotopes
- Any manipulation of the compound that will cause the release of particles, aerosols, or gasses. Including pipetting, heating the compound, forcefully discharging a syringe etc.
- Ex. Cs-137 and I-131 are volatile at high temperatures
Receiving Shipments

Follow proper receipt procedures for receiving nuclear substance shipments

Refer to CNSC’s poster “Guidelines for Handling Packages Containing Nuclear Substances”

Is your TDG training up to date?
Record Requirements

Records of the following must be kept:
• Inventory (cradle to grave)
• Direct monitoring results (if applicable)
• Weekly wipe test results
• Leak test records for sealed sources (if applicable)
• Incident reports
• Personal exposure records
• Non-use Periods
• Routine hand/personnel monitoring
• Survey meter calibration records
• Self-inspection survey
• Isotope transfers
• Packing slip and all documents associated with the purchase, shipping and receiving of Nuclear Substances
Emergency Response

All labs should have a spill response kit available in case of an emergency. Spill kits should be checked every 6 months to ensure all necessary supplies are available and in condition to promote clean up and decrease contamination (no expired items).

Know who to call in the event or an emergency:
- RSO (1938) during business hours
- Security (4109) after hours

In the event of a fire follow standard fire instructions, but make sure to notify the RSO.
Emergency Response

In the event of an emergency involving radioactive material, the immediate objectives are to:

- Prevent or reduce the chance of personnel contamination
- Prevent dispersal of the contaminant

Begin personnel decontamination (if necessary) and decontaminate the area under supervision.

If someone is injured, you must attend to the needs of the injured person BEFORE containing and cleaning the spill.

Personal Contamination

The RSO should be notified immediately. All uninjured persons should remove contaminated clothing and use the emergency shower or eyewash as needed. If an injured person is contaminated, do NOT delay medical attention.

Area Contamination

Refer to the CNSC “Spill Procedures” poster
Spill Kit

All radiation labs should contain a spill kit in case of an emergency. Each spill kit should contain:

- Radioactive warning signs and tape
- Disposable gloves
- Small, medium and large plastic bags
- Masking tape
- Grease pencil
- Forceps/tongs
- Gauze sponges
- Decontamination detergent
- Commercial scouring powder
- Identification tags
- Filter paper wipes
- Scissors
- Disposable absorbent pads
- Floor plan
RAD Signage

The CNSC deems that any use of RAM signage on materials that are not radioactive is “Frivolous”

Examples of frivolous behaviour include:
- Jokes on fellow workers
- Labeling something as radioactive when it is not
RAD Work Area

Dalhousie uses purple dots and hatched tape to identify rad areas and materials.

- Purple dots should be placed on material that are potentially contaminated, to prevent them from leaving the rad area and notify other users.
- Hatched tape delineates the rad work area, nuclear substance work should not be performed outside this area.

Radioactive material sign must be placed in rad work areas, such as the refrigerator, doors, Plexiglas and waste containers. A single sign can be added to the area (or an item) that is consistently used.
What’s Wrong?

Over the next few slides we show some things that are unsafe and could also lead to the “Compliance Enforcement Policy” being activated.

List 8 of the violations on your quiz.
What’s Wrong Here?
What’s Wrong Here?
What’s Wrong Here?
What’s Wrong Here?
Frequently Asked Questions

**Q:** So, I have to work late tonight, can I have a friend drop by to visit me?

**A:** With the approval from your Supervisor, you could have a friend drop by, provided that any unsecured nuclear substance is under **CONSTANT** supervision.
Q: Is it okay to eat in my office?

A: Food and drink is permitted in adjacent offices provided the area is separated by the laboratory by walls and a door.
Frequently Asked Questions

Q: How much power does the CNSC have?

A: The Canadian Nuclear Safety Commission has the power to cease operations and revoke nuclear substance licences.

Sections 48 and 51 of the Nuclear Safety and Control Act outlines a list of offences and punishments. If a person or persons is found guilty of an indictable offence that perm may be liable for a fine not exceeding $1,000,000 imprisonment for a term not exceeding five years or both.
End of Refresher

If you have any questions regarding this refresher presentation or accompanying quiz please contact:

jrobertson@dal.ca
Phone: 1-902-494-1938

Completed quizzes can be forwarded either by email, fax or interoffice mail.
Fax: 1-902-423-5242
Environmental Health & Safety Office, 1435 Seymour St