Refresher Training
Instructions

• The following refresher training is intended for those 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 5 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:
  o http://safety.dal.ca/training/radiation.php
• Canadian Nuclear Safety Commission (CNSC)
  o 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.
  
  o The Nuclear Safety & Control Act and associated regulations can be viewed on the CNSC website at:
    • http://nuclearsafety.gc.ca/eng
Radiation Safety Committee

- Dr. Stan Cameron - Chemistry
- Dr. Richard Dunlap - Physics
- Dr. K Hall - Physics
- Dr. K. Hewitt - Physics
- Dr. David Hoskin (Chair) - Microbiology
- Mr. Raymond Ilson – Director EHS
- Ms. Melissa Michaud (Secretary) - RSO
- Ms. Kay Murphy - Pharmacology
- Dr. Neal Ridgway - Pediatrics
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.

- Workers within the research group who carry out their duties in a registered radiation lab must receive instruction relating to the radiation hazards even if they will not be handling nuclear substances themselves.
Worker Responsibilities

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

• Workers are required to:
  o Complete radiation safety training
  o Follow all Dalhousie policies and procedures
  o Maintain an up-to-date inventory record of RAM
  o Perform and document RAM surveys as required to control contamination and keep exposure ALARA
  o Follow required radiation safety and radioactive waste handling and disposal policies.
  o Understand the requirement to declare pregnancy
# 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 (2p + 2n)</td>
<td>High 2-8 MeV</td>
<td>A few centimetres</td>
<td>Paper, Skin, Clothing</td>
</tr>
<tr>
<td>Beta</td>
<td>Particle (electron)</td>
<td>keV to 5 MeV</td>
<td>Up to 7 metres</td>
<td>Plastic, glass</td>
</tr>
<tr>
<td>Gamma</td>
<td>Electromagnetic</td>
<td>keV to 6 MeV</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

Penetrating Distances

- Alpha
- Beta
- Gamma and X-rays

Paper | Plastic | Lead | Concrete
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.
    - E.g. mCi (milliCurie), MBq (Mega Bequerels)
  - Units of dose describe the amount of ionizing energy absorbed by an object or a person, such as yourself.
    - mSv(milliSievert), mREM
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>$^{18}F$</td>
<td>110 min.</td>
</tr>
<tr>
<td>Phosphorus 32</td>
<td>$^{32}P$</td>
<td>14.3 days</td>
</tr>
<tr>
<td>Phosphorus 33</td>
<td>$^{33}P$</td>
<td>25.4 days</td>
</tr>
<tr>
<td>Sulfur 35</td>
<td>$^{35}S$</td>
<td>87.5 days</td>
</tr>
<tr>
<td>Iodine 125</td>
<td>$^{125}I$</td>
<td>60.1 days</td>
</tr>
<tr>
<td>Tritium</td>
<td>$^{3}H$</td>
<td>12.3 years</td>
</tr>
<tr>
<td>Carbon 14</td>
<td>$^{14}C$</td>
<td>5,730 years</td>
</tr>
</tbody>
</table>

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Types of Exposure

• External Radiation Exposure
  - Radiation by a source which is outside the body.
  - External irradiation occurs when all or part of the body is exposed to penetrating radiation from an external source. During exposure this radiation can be absorbed by the body or it can pass completely through. A similar thing occurs during an ordinary chest x-ray. Following external exposure, an individual is not radioactive.
Types of Exposure

- **Internal Radiation Exposure**
  - The second type of radiation injury involves contamination with radioactive materials.
    - Contamination means that radioactive materials in the form of gases, liquids, or solids are released into the environment and contaminate people externally, internally, or both.
    - An external surface of the body, such as the skin, can become contaminated, and if radioactive materials get inside the body through the lungs, gut, or wounds, the contaminant can become deposited internally.
### Incorporation

The third type of radiation injury that can occur is incorporation of radioactive material. Incorporation refers to the uptake of radioactive materials by body cells, tissues, and target organs such as bone, liver, thyroid, or kidney. In general, radioactive materials are distributed throughout the body based upon their chemical properties. Incorporation cannot occur unless contamination has occurred.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Target Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-125</td>
<td>Thyroid</td>
</tr>
<tr>
<td>P-32, P-33</td>
<td>Bone</td>
</tr>
<tr>
<td>S-35</td>
<td>Whole body, testes</td>
</tr>
<tr>
<td>H-3</td>
<td>Body fluid</td>
</tr>
<tr>
<td>C-14</td>
<td>Fatty tissue</td>
</tr>
<tr>
<td>Tc-99m</td>
<td>Lower large intestinal wall</td>
</tr>
</tbody>
</table>
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 and;

- The dose equivalent to individuals shall not exceed the maximum exposure limit
  - Dalhousie occupational exposure limit 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
  o Time
    • The less time spent near a nuclear substance, the less dose received.
  o Distance
    • The more distance between you and the RAM, the less exposure received
      o Use tongs or other remote handling tools to reduce exposure to fingers and hands
  o Shielding
    • Choose appropriate shielding (if required)
      o Shield Beta emitters with Plexiglass
      o Shield X-ray or gamma emitters with lead
Required Laboratory Signage

• Red Coded Laboratory Door
  o Nuclear substance laboratories will be designated as red coded.
  o As such, non-approved personnel must be supervised in the area at all times, otherwise entry is restricted.
    • This includes but is not limited to visitors, custodial, trades and Facilities Management
  o The lab door must be locked when the area is unoccupied

• Nuclear Substance User Permit
  o Posted and signed by the P.I.
Laboratory Signage

• Basic or Intermediate poster must be posted in the lab with Security as the 24hr contact number

Basic Level Laboratory
Nuclear Substance Safety

A laboratory is classified as “basic level” when more than 3 EQ (excepting quantities) of a nuclear substance is handled and where the highest quantity (in Bq) handled by an individual worker does not exceed 5 times its corresponding SILI (several limit of influence) in Bq.

24 hour emergency contact (name and phone number)

Safety Precautions

1. Keep laboratory ticket when contacted.
2. Inspect nuclear substances at all times when in use.
3. Insure that all staff are aware of their responsibilities and obligations in radiation
   work.
5. Comply with Dalhousie University permit conditions.
6. Consumption or storage of food and/or drink is not permitted in this laboratory.
7. Wear required personal protective equipment.
8. Wear white shirts and any IED numbers are required by permit.
9. Classify impact path areas used for handling nuclear substances.
10. Use a firm level of handling dry powders or volatile substances
11. Do not scratch objects
12. Be sure that work surfaces are cleansed with isopropyl alcohol.
13. Follow proper procedures for packages containing nuclear substances.
14. Maintain up-to-date inventory sheets for all label catalogues of radioactive material.
15. Maintain laboratory for basic contamination at least weekly. Maintain records of results and determination of necessary actions.
17. Maintain good personal hygiene (shoe washed), and good housekeeping practices.

Storage and Waste Disposal

1. Store radioactive waste containers and control information in storage areas with large containers.
2. Transfer radioactive waste to designated storage areas regularly.

Accidents and Spills

1. Follow Dalhousie University’s “Radiological Spill Clean-Up Procedure”.

Emergency Numbers

<table>
<thead>
<tr>
<th>Emergency</th>
<th>Phone Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security</td>
<td>9 - 404 - 4100</td>
</tr>
<tr>
<td>FGU</td>
<td>9 - 404 - 2005 or 9 - 412 - 3294 (all phone)</td>
</tr>
</tbody>
</table>

Produced by the Radiation Safety Office, Dalhousie University (www.dal.ca/radiation)
Laboratory Signage

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

• You should know how to use a survey meter, if using an isotope that is detectable.
  o Remember that you must perform a pre-operational check each time you use the meter.
    • Battery
    • Get a background reading
    • Check calibration date (if applicable)
    • Source check meter response (if available)
    • Ensure correct scale or operating ranges are selected
  o If you are uncertain about how to perform the preoperational check or to do a survey, review the process with your lab manager or ask the RSO.
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
  - Wear ring so chip faces 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, but 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.
Frequently Identified by CNSC Inspectors

- **Evidence 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.
Transfers

• Nuclear substances and/or radiation devices can be transferred from one permit holder to another within the same dept., by making a notation on in the inventory of both parties. (No transfer form req)

• Transfers from one permit holder to another in a different dept. or physical location are permitted provided the material falls under the category “excepted radioactive material, limited activity”. In this case a transfer form is required, and the notation in the inventory. A copy of the transfer form must be forwarded to the RSO.

• All other transfers must be coordinated through 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
PPE

- Wear required PPE while working with nuclear substances
  - Below are 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 β emitter require eye protection.
What is not acceptable 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.

A MAN and CONTAMINATED CLOTHING are SOON PARTED!!!
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.
Receiving Shipments

• Follow proper receipt procedures for receiving nuclear substance shipments
• Refer to CNSC’s poster “Guidelines for Handling Packages Containing Nuclear Substances”
• Have you been certified to receive shipments of nuclear substances?
Maintain required records

- 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
Emergency response

- Have a spill response kit available
- Have a spill response training session
- Know who to call in the event of 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
RAM Contamination

- 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.

- Personal Contamination:
  - Notify the RSO immediately in the case of personal contamination.
  - Uninjured persons should remove contaminated clothing and use emergency shower or eyewash as needed.
  - If an injured person is contaminated, do not delay medical attention. We will decontaminate the area later.

- Area Contamination
  - Refer to the CNSC “Spill Procedures” poster
RAM Signage

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

- Jokes on fellow workers
- Labeling something as radioactive when it is not. This is “where I keep my stash of chocolate” in my office. No one will take it for sure.
RAM 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
    - 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 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.
Frequently Asked Questions

• **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.
  
  o E.g. The CNSC has revoked the licences of two health care facilities and two “industrial” operations within the last 10 years, and issued numerous orders suspending operations.
  
  o 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:
  – Melissa.michaud@dal.ca
  – Extension 1938

• Completed quizzes can be forwarded either by email, fax or interoffice mail.
  – Fax: 423-5242
  – Radiation Safety Office, 1391 Seymour St