Safety Guidelines For The Cleaning & Maintenance Of Nuclear Substance Laboratories
Telephone Numbers

1. Radiation Incidents

Radiation Safety Officer:

Pauline Jones 2055 (office)
452-1294 (cell phone)
876-7361 (home)

Director of EH&S 2495

2. Emergency Numbers

EMERGENCIES 4109
Dalhousie Security 6400
Dalhousie Health Service 2171
Poison Control 428-8161
Dalhousie maintenance 3345/6400 (after hours)

3. Members of the Radiation Safety Committee

Dr. John Andrew 473-6017
Dr. Amares Chatt 2474
Dr. Melanie Dobson 7182
Dr. Rich Dunlap 2394/3887
Pauline Jones (Secretary) 2055
Dr. William Louch 2495
Dr. Roger McLeod 7013
Susan Powell 7073
Dr. Andy Stadnyk 428-8509
Safety Guidelines For The Cleaning & Maintenance Of Nuclear Substance Laboratories

1. Introduction

Ionizing radiation in the form of radioisotopes and radiation emitting devices are used in research in many departments at Dalhousie University. Possession and use of all radioactive material is regulated in Canada by a licence issued to Dalhousie by the Canadian Nuclear Safety Commission (CNSC). Dalhousie University is responsible for ensuring that Principal Investigators using radioactive materials or radiation emitting devices are compliant with licence conditions.

This guide is specifically designed to assist in the instruction of Dalhousie University Facilities Management personnel (custodians, and maintenance personnel such as electricians, plumbers, painters, carpenters, etc.) Who service areas where radioactive materials are used or stored. This guide will also serve to remind Principal Investigators and their laboratory or clinic staff of their responsibilities in regard to assisting Facilities Management personnel to carry out their maintenance tasks in a timely and safe manner.

CLEAN AND WELL MAINTAINED RESEARCH WORK AREAS LEAD TO GOOD RESEARCH AND A SAFE WORKING ENVIRONMENT FOR THE ENTIRE UNIVERSITY COMMUNITY.
2. **General**

Laboratory work areas and spaces where radioactive materials or radiation emitting devices are used or stored are designated with a radiation trefoil as one of the symbols on the “Hazard Identification” sign (see Appendix) on the door(s) leading into the work area from the main corridor. As well, storage refrigerators, fume hoods and sinks used to store or dispose of radioactive materials are required to be signed. The sign on the storage refrigerator or freezer must show 24 hour contact information in the event of an emergency. These signs do not indicate that the worker is entering a high risk area. These signs *do indicate*, however, that the work area may require individuals to follow special instructions in order to assure that the work area remains at low risk. Facilities Management personnel who service these areas should check with their area supervisor, the Principal Investigator or the Radiation Safety Officer before entering.

3. **What is radiation?**

Simply put - *Radiation is energy sent out in the form of waves or particles.*

To illustrate: What do you do when you see a calm pond of water, perhaps with some wood chips or leaves floating on the surface? My grandson loves to see how far he can throw a rock out into the water. From the point that the rock hits the water, ripples radiate in rings. The ripples represent the movement of energy imparted by the rock when it hit the water. As each ripple reaches a wood chip, they rise to the crest of the wave. The lifting of the wood chip shows that the waves have energy and that some energy has been moved from the spot where the rock hit the water to the place where the wood chip was lifted. The general idea is the same as for other types of radiation.
There is one particular characteristic of all radiation that helps to identify and describe it. That is wavelength, the distance from the crest of one wave to the crest of the next wave.

Waves in water are one form of radiation. There is another class, that we call electromagnetic radiation. This is the type if radiation that Dalhousie University’s Radiation Safety program is concerned with.

Some Types Of Radiations:

Non-Ionizing Electromagnetic Radiation

Radio
Microwaves
Infrared (heat)
Visible light (color)
Ultra-violet

Ionizing Electromagnetic Radiation

X-Rays
Gamma Rays (γ)
Cosmic Rays

Ionizing Atomic Particle Radiation

Beta Particles (β)
Alpha Particles (α)
Neutrons
4. WHERE DOES RADIATION COME FROM?

Natural Radioactivity:

*Cosmic radiation* comes through the earth’s atmosphere, some from the sun and energy sources inside or outside our galaxy. Those from the sun are more intense during solar flares. The density is affected by the earth’s magnetic field, which makes it greater nearer the poles and the equator. Cosmic radiation dose increases with latitude. The earth’s atmosphere is a partial shield to the radiation. As one goes higher there is a lower shielding effect, thus, radiation dose increases.

*The earth’s crust,* is made up of materials that are naturally radioactive. Uranium is dispersed throughout rocks and soil, as are thorium and potassium - 40. They all emit gamma rays which irradiate the whole body uniformly. Since building materials are extracted from the earth, they are slightly radioactive.

*Radon* is a naturally occurring radioactive gas that comes from the uranium in the earth’s crust. It is emitted from rocks or soil at the earth’s surface and disperses in the atmosphere unless it enters a building where the concentration may build up.

*Food and drink.* Since radioactive materials occur everywhere in nature it is
inevitable that they make their way into drinking water and food. Potassium -40 in particular is a major source of internal irradiation.

**Artificial Radiation:**

*Radiation in the work place.* Persons in many occupations encounter above background levels above normal background as part of their job. Some of these occupations include doctors, nurses, technologists, astronauts, dental hygienists, pharmacists, welders and flight crews. It is interesting to note that flight crews receive higher occupational radiation exposure than does the average research worker in a university.

*Medical uses of radiation* are roughly broken down into diagnostic and therapeutic. Therapy is primarily used for tumor killing of cancer, but in the past has been used for other treatments. Most of the dose is received in a small area of the body. Diagnosis runs from routine x-rays and blood tests to injections of radioactive material for imaging. The physician who prescribes radiation treatment must weigh the risk of the radiation exposure with the benefit of the treatment.

*Radioactive fall-out* from nuclear weapons testing carried out in the atmosphere is the most widespread environmental contaminant but doses to the public have declined from the relatively high values of the early 1960’s to very low levels now.

The *nuclear power industry* releases small amounts of a wide variety of radioactive materials at each stage in the nuclear fuel cycle.

*Non-nuclear industries*, including the processing of ores containing radioactive materials as well as the element for which the ore is processed (phosphorus ores contain radium), and the generation of electricity by coal-fired power stations, results in the release of naturally occurring radioactive material from the coal.
Radiation in consumer products. Minute radiation doses are received from the radioactivity in consumer goods such as in smoke detectors and luminous watches, and from the natural radioactivity in cigarettes and gas mantles.

5. EXAMPLES OF NATURAL AND MAN MADE SOURCES OF RADIATION EXPOSURE:

T A 150 pound person contains 150 grams of potassium - 42, mostly in muscle

T Tobacco smokers and many Laplander and Eskimos whose diets consist largely of reindeer meat (reindeer feed on lichens) are exposed to levels of lead - 210 and polonium - 210

T The dose at the top of Mt. Everest is about 20 millisievert/year

T Beaches in Brazil which are composed of monazite sand emits up to 175 millisievert/year

T In Morro do Ferro, Brazil where there is a rich deposit of thorium, plants growing there have absorbed so much radiation that they can produce X-ray photographs of themselves.

T Phosphate fertilizers have a concentration of uranium and thorium. Potassium fertilizers add approximately 111 terabecquerel (Tbq) to United States farmlands each year.

T In 1977 there were an estimated 8.4 million radium timepieces in use in the United States, delivering a collective dose of 2500 person-rem/yr.

T Uranium ores are used in some ceramic glazes to produce a shiny orange or yellow color in crockery and decorative glassware.

T About 10% of the enamel used in enameled jewelry contains uranium or thorium.
Uranium is used to give porcelain false teeth the brightness of natural teeth.

Thorium and uranium are often present in the silica and other natural materials from which lenses are made.

Camping lanterns use thorium to improve the quality of the light they emit.

Hospitals, clinical laboratories and physicians need no licence to buy some radioimmunoassay kits in the United States. Industry sources estimate that a million or more of these kits are sold annually in the U.S.

6. WHAT ARE THE RISKS OF RADIATION EXPOSURE?

Radiation is all around us. Humans have been exposed to radiation from natural sources since the dawn of time. This radiation cannot be avoided. For those workers who must be occupationally exposed to radiation, we strive to maintain their exposures "ALARA" (as low as reasonably achievable). Occupationally exposed workers receive no benefit from their exposure. Patients undergoing x-ray or Nuclear Medicine procedures to diagnose disease or broken bones, however, do derive a benefit from their risk taken in being exposed. Personnel exposure limits are reported in millisievert (mSv) units. The Canadian Nuclear Safety Commission requires that radiation exposures to "A person who is not a Nuclear Energy Worker (NEW)" (which includes all occupationally exposed workers at Dalhousie) does not exceed 1 millisievert per year. The average dose to an occupationally exposed worker at Dalhousie does not exceed 0.5 millisievert per year.

Radiation causes ionizations in the molecules of living cells. These ionizations result in the removal of electrons from the atoms, forming ions or charged atoms. The ions formed then go on to react with the other atoms in the cell, causing damage. An example of this would be if a gamma ray passes through a cell, the water molecules of DNA might be ionized and the ions might react...
with the DNA causing a break.

At low doses, such as what we receive from background radiation, the cells repair the damage rapidly. At higher doses (1 Sv), the cells might not be able to repair the damage, and the cells may either be changed permanently or die. Most cells that die are of little consequence; the body replaces them.

7. What Are The Hazards Associated With Ionizing Radiation?

There are three main hazards associated with the types of radioactive materials handled and used at Dalhousie University. These are:

a) *external radiation exposure*

b) *skin contamination and/or deposition in the body (internal exposure)*

c) *spread of contamination*

![External Exposure](image1)

![Internal Exposure](image2)

A radioisotope present in a working area is outside the body and thus constitutes a potential *external exposure*. This radioisotope becomes an *internal exposure* hazard if the material is *ingested, inhaled* or *absorbed* through either intact skin or an open wound. Small quantities of radioactive material may represent an insignificant external hazard, however, once inside the body may concentrate in one or more organs referred to as *target organs*. These target areas will continue to be irradiated until the material has decayed or biologically eliminated from the body.
8. Radiation Protection Concepts

<table>
<thead>
<tr>
<th>Time</th>
<th>Distance</th>
<th>Shielding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimize</td>
<td>Maximize</td>
<td>Incorporate</td>
</tr>
<tr>
<td>Time</td>
<td>Distance</td>
<td>Shielding</td>
</tr>
</tbody>
</table>

**Time:**

If you decrease the amount of time you spend near a source, you will decrease the amount of radiation exposure you receive. Think of a trip to the beach as a comparison. If you spend a lot of time on the beach exposed to the sun you will get a sunburn. If you spend less time in the sun and more time in the shade, your sunburn will be less severe.

**Distance:**

The farther you are from a source of radiation the less exposure you will receive. Think of an outdoor concert. You can sit directly in front of the speaker, 50 yards from the stage, or on the grass in the park across the street. If you sit directly in front of the speaker you may suffer some hearing damage, 50 yards away from the stage you will be exposed to an average amount of music, but across the street in the park the sound is even further reduced and you might not even hear the concert, or even know what song is being played.
Shielding:

Increased shielding around a radiation source will decrease your exposure. If you stand in the rain without an umbrella you will get wet. But, if you use an umbrella to shield you from the rain, you will remain dry and protected. This is similar to the idea of shielding in radiation protection.

9. Radiation Safety In The Research Laboratory

a) Floors - In the event of an accidental spill of radioactive material in a radioisotope laboratory, the condition of the floor before the spill occurs determines the subsequent amount of person and economic effort necessary to control and clean up the spill. It is, therefore, important that floors in laboratories where radioisotopes are used be kept in a quality maintenance condition.

The floor should be initially and at a minimum annually cleaned and sealed with wax. Subsequent routine wet and dry mopping should be conducted by custodial staff to maintain the sealed condition. The principal investigator is responsible for doing weekly wipe tests of select floor areas as their permit requirements. Prior to any reconditioning of the floor, custodial staff should be assured that testing for contamination has been carried out prior to work.

Laboratory items such as broken glass, paper towelling, plastic fragments, etc., should be picked up by laboratory workers. Custodial staff are not required to handle this debris, because of contamination concerns. Principal investigators and their workers should police their floor areas daily to ensure that floors are ready for custodial staff. The presence of accumulated debris sends a signal to everyone that a sloppy operation exists. Continual foot traffic on this debris will cause wear through the protective wax barrier.

Damaged floor should be reported and every effort made to have repairs made as soon as possible.
b) **Laboratory Bench Tops:** Laboratory table and/or bench tops and any items on them *are not to be touched or cleaned* by custodial staff.

c) **Waste Containers:** Custodial staff should empty regular trash at the required frequency. Any container bearing the label or the words "*Caution - Radioactive Materials*" or bearing the following symbol must not be touched.

![Radioactive symbol]

General safety practices require that broken glass and sharps be placed in an approved sharps container.

d) **No eating, drinking or smoking policy:** Because of concerns for internal uptake of radioactive materials which could exist as contamination as well as radioactive materials in use in the laboratory, the above policy *must be strictly enforced.*

e) **Security:** Radioisotope laboratory workers are required to be very security conscious around their work areas. Doors leading into laboratories must be locked whenever a laboratory is left unattended. Custodians are also required to secure these areas even if they leave the area for a work break.

f) **Emergency:** If a suspected radioactive spill occurs after hours in a radioisotope laboratory the situation should immediately be reported to *Security* at 6400. During normal day time working hours, the situation should be reported to the laboratory personnel who will inform the *Radiation Safety Officer* at 2055. The Radiation Safety Officer may also be called directly at any time if any concern remains.
g) **Laboratory Fume Hoods:** The proper functioning of fume hoods is very important in some operations using radioactive materials to assure that air flow is sufficient and away from the worker. Maintenance workers who are, at times, called upon to repair broken fans belts, burned out motors, replace filters in these systems should first check with laboratory personnel to determine if any radioactive work is carried out in the hood. Check with the Radiation Safety Officer at 2055 to ensure that appropriate contamination checks have been done so that necessary work can be carried out safely.

h) **Sink Waste Disposal Drains:** Leaking sink drains are a common problem in all laboratories. Before proceeding with the repair of a designated radioactive disposal sink, the plumber should call the Radiation Safety Officer at 2055 to report the location of the sink in question so that a determination can be made as to whether the inside of the drain pipe should be wipe tested before going ahead with the repair.

10. **Responsibilities Of Custodial Staff**

a) Before entering a signed laboratory for the first time, custodial staff shall be informed by their supervisor of any special precautions associated with a particular laboratory space.

b) Custodial staff are not permitted to clean bench or table tops or move any items on these surfaces while cleaning in a signed laboratory.

c) Custodial staff should not sweep laboratory floors, but rather wet or dry mop these areas. *Wet or damp mopping is preferable to dry.*

d) Custodial staff are permitted to empty regular waste containers. Waste bearing containers labelled with the “Caution - Radioactive Materials” sign or bearing a radiation warning sign are not to be emptied by custodial staff.

e) Custodial staff are required to secure laboratory doors in signed areas whenever the areas are left unattended.
f)  Custodial personnel are not permitted to eat, drink, smoke or apply cosmetics in radioisotope laboratories.

g) Custodial staff shall report any suspected spill in a radioisotope laboratory to laboratory staff during normal working hours or to Security at 6400 after hours.

11. Responsibilities Of Facilities Management Maintenance Workers

Before proceeding with repairs to sinks, sink drains, fume hoods, floors etc., in any radioisotope laboratory, contact the Radiation Safety Officer at 2055 to ensure that all necessary radiation checks have been carried out PRIOR to the actual start of work.

12. Radiation Warning Signs Used At Dalhousie

Symbols used shall be the conventional radiation colours of magenta or black on a yellow background. The radiation warning symbol is the conventional three bladed (trefoil) design illustrated below.
Nuclear Substance (Radioisotope) Laboratories
Dalhousie University

Every effort has been made to ensure that the laboratory list is accurate and up to date at the time of printing of this manual, however, to ensure the most accurate and up to date listing of designated laboratories you should refer to our web site at http://www.dal.ca/safety

This table has been deleted from the web site for security reasons
Dalhousie University's "Hazard Identification" System

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable or combustible liquids in amounts in excess of 10 liters present</td>
<td></td>
</tr>
<tr>
<td>Any reactive as defined by WHMIS present</td>
<td></td>
</tr>
<tr>
<td>Compressed gas cylinders greater than lecture bottle size normally present</td>
<td></td>
</tr>
<tr>
<td>Cryogenic material(s) normally present</td>
<td></td>
</tr>
<tr>
<td>Equipment operating at a temperature in excess of 250 °C present</td>
<td></td>
</tr>
<tr>
<td>Any noise source present which operates at a continuous noise level of 85 dB(A) or impact noise in excess of 140 dB</td>
<td></td>
</tr>
<tr>
<td>Static magnetic field in excess of 1.0 mT (10G) present</td>
<td></td>
</tr>
<tr>
<td>Hearing protection required</td>
<td></td>
</tr>
<tr>
<td>Eye protection required</td>
<td></td>
</tr>
<tr>
<td>Biohazardous materials including body fluids, unfixed cell tissue or organ cultures, viral, bacterial, mycobacterial, fungal or parasitic agents requiring BSL 2 or greater present</td>
<td></td>
</tr>
<tr>
<td>Any radioactive material present</td>
<td></td>
</tr>
<tr>
<td>An array emitting device present</td>
<td></td>
</tr>
<tr>
<td>Equipment capable of generating microwave energy in excess of 10 mW/cm² averaged over 0.1 hour present</td>
<td></td>
</tr>
<tr>
<td>Class 3 or Class 4 lasers present</td>
<td></td>
</tr>
<tr>
<td>Corrosives in excess of 10 liters or 10 kilograms present</td>
<td></td>
</tr>
<tr>
<td>Toxic chemicals (as defined by WHMIS) present in amounts in excess of 10 kilograms</td>
<td></td>
</tr>
<tr>
<td>Ultraviolet light sources operating at a wavelength capable of germicidal irradiation present</td>
<td></td>
</tr>
<tr>
<td>Exposed electrical (110 V or higher) contacts or any equipment which operates at 600 V or above present</td>
<td></td>
</tr>
</tbody>
</table>

In Case Of Emergency Call 4109
Standard Radiation Warning Signs

Laboratory doors, fume hoods, etc.,

Storage freezer/refrigerator

Radioactive Shipment Package Labels
Risk Comparison

The Problem:

Today, for many people, the word **RADIATION** conjures up visions of atomic bombs, nuclear power plant accidents, nuclear wastes, or radioactive fallout; it summons up the fear of cancer. When people are asked about their source of information about radiation, most people cite newspaper articles, movies, or just casual gossip. Media rarely try to educate with facts; they tend to emphasize the dangerous and sensational to appeal to emotions. People tend to base their opinions about radiation on well publicized accidents such as Three Mile Island and Chernobyl.

*Uncontrolled use of ionizing radiation can be hazardous* ———— but so can uncontrolled use of almost anything, even salt and pepper. There is no such thing as absolute safety in any human activity.

The following tables are intended to put the potential risk of radiation into perspective when compared to other occupational and daily activities.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Days of Life Lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Being an unmarried male</td>
<td>3,500</td>
</tr>
<tr>
<td>Smoking (1 pack/day)</td>
<td>2,250</td>
</tr>
<tr>
<td>Being an unmarried female</td>
<td>1,600</td>
</tr>
<tr>
<td>Being a coal miner</td>
<td>1,100</td>
</tr>
<tr>
<td>Being 25% overweight</td>
<td>777</td>
</tr>
<tr>
<td>Drinking alcohol (Cdn average)</td>
<td>365</td>
</tr>
<tr>
<td>Being a construction worker</td>
<td>227</td>
</tr>
<tr>
<td>Driving a car</td>
<td>207</td>
</tr>
<tr>
<td>All industry</td>
<td>60</td>
</tr>
<tr>
<td>Being exposed to 1 mSv/yr of radiation for 70 yrs</td>
<td>10</td>
</tr>
<tr>
<td>Drinking coffee</td>
<td>6</td>
</tr>
</tbody>
</table>
## Activities with One-in-a Million Chance of Causing Death

<table>
<thead>
<tr>
<th>Activity</th>
<th>Risk Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiving 0.1 mSv of radiation</td>
<td>Cancer</td>
</tr>
<tr>
<td>Smoking 1.4 cigarettes</td>
<td>Lung cancer</td>
</tr>
<tr>
<td>Eating 40 tablespoons of peanut butter</td>
<td>Liver cancer</td>
</tr>
<tr>
<td>Eating 100 charcoal broiled steaks</td>
<td>Cancer</td>
</tr>
<tr>
<td>Spending 2 days in New York City</td>
<td>Air pollution</td>
</tr>
<tr>
<td>Driving 40 miles in a car</td>
<td>Accident</td>
</tr>
<tr>
<td>Flying 2,500 miles in a jet</td>
<td>Accident</td>
</tr>
<tr>
<td>Canoeing for 6 minutes</td>
<td>Accident</td>
</tr>
</tbody>
</table>