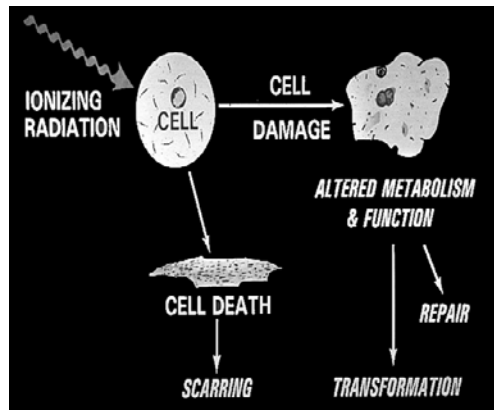




For more information, refer to the Radiation Safety Manual, 2017 RSP-6



What are the potential outcomes of exposure to ionizing radiation?



Damage to cells can lead to a transformed cell, to cell death or the cell is successfully repaired.

When too many cells die we see cataracts developing, radiation burns, radiation illness or death. Dead cells do not cause cancer or negative genetic effects. Dead cells cause injury or scarring and if enough of the cells are killed, the result can be dangerous to health (cataracts, radiation illness).

When the cell is not repaired successfully, the transformation can lead to cancer or negative reproductive effects.

In addition, exposure to radiation is cumulative and damage is additive throughout your whole life. Considering the potential dangers, it is important to find perspective on the risk related to your planned work at the University. Let's get started by considering our own bodies!

Did you know that radioactive isotopes occur naturally in the human body!

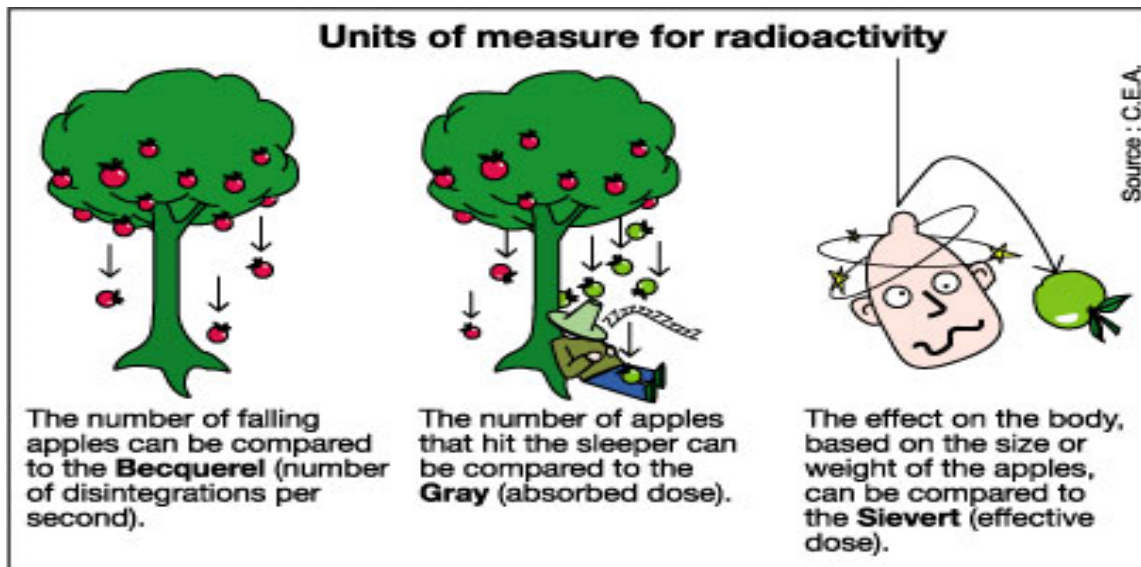


Isotopes for a 70 kg adult	Amount of Radioactivity in Becquerel (Bq)
Carbon-14	3,700 ^a
Polonium-210	40 ^{b, d}
Potassium-40	4,000 ^b
Radium-266	1.1 ^b
Thorium	0.21 ^b
Tritium	23 ^c
Uranium	2.3 ^{a, b, d}

^a ICRP, 1975, ^b Eisenbud and Gesell, 1997, ^c UNSCEAR, 2000, ^d ICRP, 1980

How does the amount of activity relate to the potential risk?

Let's start by considering how exposure to ionizing radiation is expressed:



What are the effects of over-exposure to Ionizing Radiation?

The effective dose is measured in Sieverts or millisieverts (mSv)

Acute effects	Dose threshold to the whole body
Cataracts	100mSv
Burns	>100mSv
Radiation illness	>1000mSv
Death	>10 000mSv

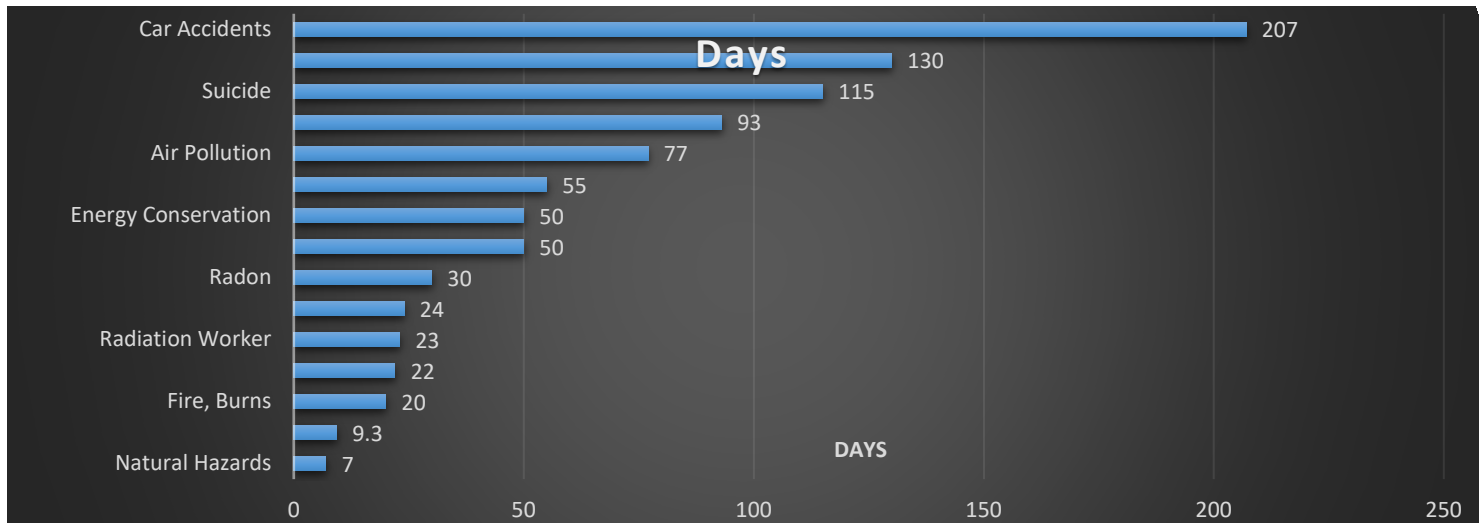
Let's put the effects in perspective

Annual radiation dose for a smoker (1 pack/day) is 30-80 mSv (from the fertilizer containing alpha-emitters Po-210 and Pb-210).

Radiation dose used clinically to kill cancer cells is 50,000-60,000 mSv (not whole body, site specific)

How can radiation risks be compared to other risks?

This graph shows you how many days these factors will shorten an average person's life.



Note: The Radiation worker – and you are not a Radiation worker unless..... you signed an “Acceptance of Nuclear Energy Worker Status Form”.

When do I become a Radiation Worker or Nuclear Energy Worker (NEW)?

You only become a NEW if it is anticipated, based on the history or type of experiment, that your annual exposure will exceed the limit for a member of public. Nuclear Energy Workers work as radiopharmacy workers, cyclotron operators, nuclear power employees, industrial radiographers, nuclear medicine technicians or researchers working on certain research projects.

You will know if you have been designated a NEW because you will be required to sign an Acceptance of Nuclear Energy Worker Status Form.

Regulatory Dose Limits for Radiation Exposure

Classification of worker	Dose Limit
Member of the Public	1 mSv/yr, whole body (Effective Dose)
You, me and all employees at the University of Manitoba (except NEWs)	15 mSv/yr, lens of eye (Equivalent Dose)
	50 mSv/yr, skin
	50 mSv/yr hands and feet
Nuclear Energy Workers (NEW)	Maximum is 50 mSv/yr, whole body with no more than 100 mSv averaged over 5 year periods
	150 mSv/yr, lens of eye (Equivalent Dose)
	500 mSv/yr, skin
	500 mSv/yr hands and feet
Restricted Access at the University	If exposure rate could be over 25 uSv/hr, only enter with lab personnel listed on the permit

Personal Exposure

The average background radiation for Winnipeg is 4.1 mSv/yr (Effective Dose).

(Sources: Gratsky et al., 2004, UNSCEAR 2008, Geological Survey of Canada)

Your real personal exposure is the sum of exposure from background radiation, medical procedures and your occupational exposure.



Background



Medical



Occupational

Where does background radiation come from?

Recall the background radiation in Winnipeg. This contributes an effective dose of 4.1 mSv per year to your personal exposure. Background radiation in Winnipeg comes from different sources

0.4 mSv from cosmic radiation



0.3 mSv from the food we eat



K-40 content Bq per 500 grams of certain foods

Red meat	56
White potato	63
Carrot	63
Banana	65
Lima beans	86
Brazil nuts ¹	103

Source: Brodsky, 1978.

¹Brazil nuts also naturally contain radium-226

0.2 mSv from terrestrial sources

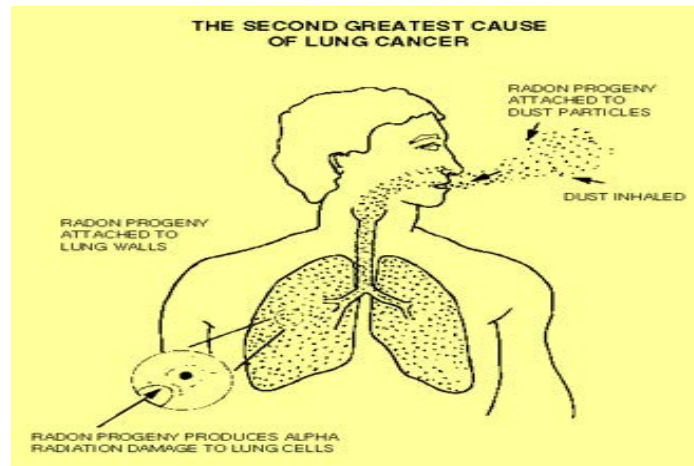


0.1 mSv from consumer products

Radioactive Consumer Products

- ✦ Fiesta Ware
 - with uranium paint
- ✦ 1970's tape dispenser
 - with thorium sand
- ✦ Smoke detector
 - with americium
- ✦ Lantern mantles
 - with thorium
- ✦ Exit signs
 - with tritium

For the average Winnipegger most background radiation some comes from the radioactive gas Radon (3.1mSv)



What are the Typical (adult organ) Doses from Various Medical Imaging Procedures?

Study Type	Relevant Organ	Equivalent Dose (mSv)
Dental x-ray	Brain	0.01
Chest x-ray	Lung	0.1
Screening mammography	Breast	3
Adult abdominal CT	Stomach	10

(source: <http://nuclearsafety.gc.ca/eng/resources/radiation/introduction-to-radiation/radiation-doses.cfm>)



How is occupational dose measured at the University?

External Exposures

The University uses dosimeters from Health Canada's National Dosimetry Service. Dosimeters measure the amount of radiation to which you are externally exposed. Below are the commonly used dosimeters at the University..



InLight® (OSL) dosimeter or Optically Stimulated Luminescence technology

It contains elements that absorb radiation and stores the energy in the form of excited electrons.



Ring dosimeter (extremity dose)

Thermo Luminescent technology

No longer in use at the University - If you find any of these badges in the lab that are no longer in use, please inform EHS (badges that are not returned, can result in late fees).



Do you require a Dosimeter?

The OSL dosimeter is required to be worn when working with a sealed source that over 0.37 MBq (100 uCi) AND is not in a radiation device.

A ring dosimeter is also required to be worn if working with more than 50 MBq (1.35mCi).

If you are working only with a radiation device such an electron capture detector (ECD) in a gas chromatograph or a liquid scintillation counter, you would not wear a dosimeter.



How should you take care of your Dosimeter?

These are the rules:

- Wear the dosimeter on your chest or waist with your name facing outward
- Wear ring dosimeters with the wider part facing the source of radiation
- Do not wear the badge when receiving an X-ray or during and after receiving medical procedures involving radioisotopes (example, bone scan, thyroid scan, stress test)
- Do not share a dosimeter with another person
- Only wear at the University.
- If you need a dosimeter at another institution, you cannot use the one assigned from the University. Store the University one AT the University so we can get it back at changeover time.
- Store badge away from radiation source (your sealed sources, radiation device).

The results of your dosimeter readings will be mailed to the Radiation Safety Officer and you will be personally informed about a measured exposure at 0.2 mSv (that is equal to 2 chest X-rays).



UNIVERSITY
OF MANITOBA

What kinds of occupational exposures are measured at the University?

History indicates that they are extremely low. These are the highest exposures recorded at the University:

Year	Maximum individual exposure
2007	0
2008	0
2009	0
2010	0
2011	0
2012	0.22
2013	0
2014	0
2015	0.21
2016	0.33 (worn after a medical imaging procedure)

How can you control your whole body exposure?

- Reduce the amount of radiation you work with (Activity in MBq or uCi)
- When possible, choose a Low energy beta emitter!

If the work requires the use of Mid-energy beta emitters and gamma emitters, then add the following control measures:

- Use effective shielding. Keep the shielding between you and the source.
- Minimize the exposure time. Limit the time you handle unshielded sources.
- Increase the distance (inverse square law). Double the distance, quarters your dose.

Radioisotope	Type of Emission	Energy (MeV)	Half-life	Shielding
Am-241	Alpha, gamma	5.49, 0.60	432 years	Lead
Ba-133	gamma	0.36	10.51 years	Lead
Co-57	gamma	0.122	270 days	Lead
Co-60	Beta-, gamma	0.32, 0.17 and 1.33	5.27 years	Lead
Cs-137	Beta-, gamma	0.51, 0.662	30.17 years	Lead
Ge-68	Beta+, gamma	,0.511	271 days	Lead
Na-22	Beta+, gamma	0.54, 0.511 and 1.27	2.6 years	Lead
Ni-63	Beta-	0.067	101 years	Plastic or Wood
Ra-226	Alpha, gamma	4.78, 0.19	1602 years	Lead
Sr-90	Beta-	0.54 and 2.28	28.8 years	Plastic or Wood
Tl-204	Beta-	0.76	3.78 years	Plastic or Wood

Also avoid or limit time in restricted areas when exposure rate is higher than 25 uSv/h (access is restricted to these areas).

ALARA means keep your personal exposure to ionizing radiation As Low As Reasonably Achievable

Can you get radioactive material from sealed sources inside your body?

There is always a chance that the radioactive sealed source can start to leak and when not handled properly, it can get inside your body.

That is why sealed sources containing more than 50 MBq are tested to ensure they are not leaking.

- A written procedure for leak testing should be available in the lab.

- Sealed sources that are in use must be leak tested every 6 months.
- Sealed sources listed on Internal Radioisotope Permits with “Storage Only” approved usage (see section 5 on a permit) will be leak tested every two years.
- Radiation devices such as Electron Capture Detectors (ECDs) are leak tested every three years.
- How can I tell if a sealed source requires leak testing?

Look at section 3, Approved Radioactive Sources, on the permit.

If your source or device requires leak testing, follow the information on the Radiation Safety Records binder Quick Step divider and be sure to keep the required records.

The Permit Holder is responsible to make arrangements with EHS to conduct the leak test. The wipes will be analyzed by radiation safety and a certificate will be mailed to the permit holder and Laboratory Radiation Supervisor (LRS).

For more details, refer to the Radiation Safety Manual, RSP-4.
