For more information, refer to the Radiation Safety Manual, 2005, Section 300

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 gets successfully repaired.

When too many cells die we see cataracts developing, radiation burns, radiation illness or death.

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

In addition, exposure to radiation is cumulative and additive throughout your whole life.

Did you know that radioactive isotopes occur naturally in the human body! We are a source of exposure to ourselves.

<table>
<thead>
<tr>
<th>Isotopes</th>
<th>Amount of Radioactivity in Becquerel (Bq) for a 70 kg adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon-14</td>
<td>3,700 a</td>
</tr>
<tr>
<td>Polonium-210</td>
<td>40 b,d</td>
</tr>
<tr>
<td>Potassium-40</td>
<td>4,000 b</td>
</tr>
<tr>
<td>Radium-266</td>
<td>1.1 b</td>
</tr>
<tr>
<td>Thorium</td>
<td>0.21 b</td>
</tr>
<tr>
<td>Tritium</td>
<td>23 c</td>
</tr>
<tr>
<td>Uranium</td>
<td>2.3 a, b, d</td>
</tr>
</tbody>
</table>


How is exposure to ionizing radiation expressed?
What are the effects of over-exposure to Ionizing Radiation?
The effective dose is measured in Sieverts or millisieverts (mSv)

**Acute effects:**
- Cataracts
- Burns
- Radiation illness
- Death

**Dose Threshold to the whole body:**
- 100 mSv
- >100 mSv
- >1000 mSv
- >10 000 mSv

Let’s put the effects in perspective:

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

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

How can radiation risks be compared to other risks?

Another perspective:
This graph shows you how many days these factors will shorten on average a 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 the new term 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 are for instance, 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.
The Average Background Radiation for Winnipeg is 4.1 mSv/yr (Effective Dose)  
(Sources: Gratsky et al., 2004, UNSCEAR 2008, Geological Survey of Canada)

What is your real Personal Exposure?  
Your real personal exposure consists of exposure from background radiation, medical procedures and your occupational exposure.

What is Background Radiation?  
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
- 0.2 mSv from terrestrial source
- 0.3 mSv from your diet:
  - Red meat: 56 Bq
  - White potato: 63 Bq
  - Carrot: 63 Bq
  - Banana: 65 Bq
  - Lima beans: 86 Bq
  - Brazil nuts: 103 Bq
  1Brazil nuts also naturally contain radium-226
- 0.1 mSv from consumer products:

Restricted access: exposure rate over 25uSv/hr  
Must be a NEW or accompanied by a NEW to enter

Members of the public: 1mSv/yr, whole body (Effective Dose)  
(You, me and all)
U of M Employees 50mSv/yr, skin
Except NEWs) 50mSv/yr, hands and feet

Nuclear Energy Workers: max is 50mSv/yr, whole body and 100mSv averaged 5 yr period  
(NEW) 150mSv/yr, lens of eye (Equivalent dose)
500mSv/yr, skin
500mSv/yr, hands and feet

What is Background Radiation for Winnipeg? (Effective Dose)
And for the average Winnipegger most of it (3.1 mSv) is from the radioactive gas **Radon**:

![Image of radon exposure](image)

**What are the typical adult organ doses from various Medical Procedures?**


<table>
<thead>
<tr>
<th>Study Type</th>
<th>Relevant Organ</th>
<th>Equivalent Dose (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental x-ray</td>
<td>Brain</td>
<td>0.01</td>
</tr>
<tr>
<td>Chest x-ray</td>
<td>Lung</td>
<td>0.1</td>
</tr>
<tr>
<td>Screening mammography</td>
<td>Breast</td>
<td>3</td>
</tr>
<tr>
<td>Adult abdominal CT</td>
<td>Stomach</td>
<td>10</td>
</tr>
</tbody>
</table>

**How is the Occupational Exposure measured at the U of M?**

**External Exposures:**
The U of M 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 U of M.

- **InLight® (OSL) dosimeter**
  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

- **TLD – badge (whole body and skin dose)**
  No longer in use at the U of M
  If you find one in the lab, please let us know

**Internal Exposures:**
A Thyroid Bioassay method is used to determine an internal exposure from an uptake of I-124, I-125 or I-131 when in a 24 hour period the quantity of I-124, I-125 or I-131 used exceeds:

- 2 MBq in an open room
- Is involved in a spill of greater than 2 MBq
- On whom external contamination is detected

Please refer to the Radiation Safety Manual, 2005 RSP-310 & 320 for more details!
Do you require a Dosimeter?

- You do not if you are working with H-3, C-14, S-35 or Ca-45
- The OSL dosimeter is required to be worn when working with P-32, I-125, Cr-51 and Tc-99m, and
- A ring dosimeter is also required to be worn if working with more than 50 MBq (1.35mCi) of P-32

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
- Ring dosimeters should be worn facing the source of radiation
- Do not wear the badge when receiving an X-ray or during and after receiving medical procedures involving radioisotopes
- Check for contamination often
- Do not share a dosimeter with another person
- Only wear at the UM, do not take it with you if you go to another institution
- Store badge away from radiation source (your source vial, radioactive waste etc.)

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).

At The University of Manitoba:
What are your occupational radiation risks while working at the University?

History indicates that they are extremely low. These are the highest exposures recorded at the U of M:

<table>
<thead>
<tr>
<th>Year</th>
<th>Maximum Individual Exposure at U of M</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>0.3</td>
</tr>
<tr>
<td>2007</td>
<td>0.0</td>
</tr>
<tr>
<td>2008</td>
<td>0.0</td>
</tr>
<tr>
<td>2009</td>
<td>0.0</td>
</tr>
<tr>
<td>2010</td>
<td>0.0</td>
</tr>
<tr>
<td>2011</td>
<td>0.0</td>
</tr>
<tr>
<td>2012</td>
<td>0.22</td>
</tr>
<tr>
<td>2013</td>
<td>0.0</td>
</tr>
<tr>
<td>2014</td>
<td>0.0</td>
</tr>
<tr>
<td>2015</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Are some radioisotopes safer than others?

As long as you keep them outside of your body, it depends on several factors. Radiation hazards depend on the energy and type of radiation (emission).

At The University of Manitoba, the commonly used radioisotopes may be separated into two basic groups:

Low energy beta emitters such as H-3, C-14, S-35 and Ca-45 represent no external radiation hazard. As long as you keep them outside of your body, the radiation they emit can not harm you. The radiation cannot penetrate the outer layer of the skin.
**Mid-energy beta emitters and gamma emitters** such as P-32, I-125, Cr-51 and Tc-99m may represent an external radiation hazard. Even when they are not inside your body, the radiation they emit may penetrate the skin (medical imaging uses gamma emitters) – so you need to take action to reduce your potential exposure.

**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*!
- Minimize contamination

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

- Minimize the exposure time
- Increase the distance (inverse square law)
- Use effective shielding

Also avoid or limit time in restricted areas when exposure rate is higher than 25uSv/h. This will be determined by the Radiation Safety Officer.

**How can you control radioactive material from entering your body?**

Just like other hazardous products, the route of entry is inhalation, injection, adsorption and ingestion. Preventing an internal exposure is key.

- Wear your Personal Protection Equipment
- Use the fume hood when appropriate
- Do not eat, drink or apply cosmetics in a radioisotope lab
- Avoid personal mannerism such as adjusting your glasses, brushing hair away…
- Contamination monitoring:
  - Always weekly (within 7 days of use)
  - Direct monitoring after manipulation

**Monitor for radioactive contamination often!**

!ALARA!

**Keep your personal exposure to ionizing radiation As Low As Reasonably Achievable!**

For more details refer to the Radiation Safety Manual, Section 300.

**Remember, all personal contamination must be reported to the Radiation Safety Officer as soon as possible.**