Radon Exposure in Ontario non-Uranium Mines: Preliminary report from a pilot study

Curtis Caldwell, Ph.D., MCCPM
Chief Scientist
Radiation Safety Institute of Canada
Outline

• Radon
• Lung Cancer Risks
• Regulations/Guidelines
• Radon in Ontario non-uranium mines pilot study
• Summary
• Acknowledgements
Radon is an odourless, colourless radioactive gas that is formed naturally by the breakdown of uranium in soil, rock and water.

- Alpha emitter
- Half life of 3.8 days
- Inert gas (non-reactive)
- Water soluble
- Denser than air
- Accumulates in enclosed spaces
Radon-222 and Short-Lived Progeny


Radon Daughters or Radon Progeny
Radon Progeny attach to aerosols (dust particles) in the air. When we breathe in air, these radioactive aerosols enter into our lungs.

As these decay in the lung, they emit alpha radiation which transfers energy to the cells.

This radiation can damage lung cells:
- No immediate symptoms
- Mutations possible

This cell damage leads to an increased risk of developing lung cancer.

Health Canada estimates that 14% of Canadian lung cancers are caused by radon exposure.
Ontario Regulations in Non-Uranium Mines

• Ontario Regulation 854
  – Under the Occupational Health and Safety Act

• Contains some requirements for workplace monitoring of radon daughters and related remedial actions
  – Air samples are tested (not long term)
  – At opening of mine, and after 6 months
  – Monthly or quarterly if elevated (at levels > 0.06 WL (200 Bq/m³), which result in personnel doses ≥ 4 mSv per year)
  – No monitoring required at lower levels
Canadian Naturally Occurring Radioactive Material (NORM) Guidelines

- Provide guidance to control exposure to radon in non-uranium mines

- Developed by the Federal Provincial Territorial Radiation Protection Committee

- Published by Health Canada

- These are guidelines but not regulations

- More stringent
Radon in Non-Uranium Mines Pilot Project

• Perform monitoring of radon gas and radon progeny in 3 non-uranium mines in Ontario
  – Radon progeny by Personal Alpha dosimeters worn by 20 miners per facility, changed monthly, for a minimum of 3 months
  – Evaluate if readings approach 5 mSv/y regulatory level
RSIC’s Personal Alpha Dosimetry

- Personal Alpha Dosimeter (PAD)
  - Unique technology
  - Portable
  - Light-weight
  - Measures individual exposures
    - Radon progeny
    - Thoron progeny
    - Long-Lived Radioactive Dust (LLRD)
- Dose can be calculated from the exposure
- Mandated for use in Uranium mines (CNSC)
- Required by Canadian NORM Guidelines for doses above 5 mSv per year
• **K + S Windsor Salt Mine (3 month study)**
  – Number of PAD heads provided: 25 for Feb, 27 for March, 27 for April, 27 for May
  – Site Data received from the site: For the months of Feb, Mar and April (3 months; 2 months analyzed)

• **Goldcorp Timmins (6 month study)**
  – Number of heads provided: 20 for Feb, 25 for March, 25 for April, 25 for May
  – Number of heads to be provided: 25 for June, 25 for July.
  – Site Data received from the site: For the months of Feb, Mar and April (3 months)

• **Glencore Sudbury Integrated Nickel Mine (? month study)**
  – Number of heads provided: 22 for May, 22 for June, 22 for July
  – Site Data received from the site: heads received for May; not yet analyzed
Miner exits Mine in Timmins Ontario wearing PAD

Source: Vancouver Sun 24 June 2017 Tyler Anderson/Files
PAD results for Uranium Mine

Uranium Mine

Pooled data for 3 months

Radon Progeny Exposure to Individual Miners (mWLM/month)
Salt Mine

Pooled data for 2 months

Radon Progeny Exposure to Individual Miners (mWLM/month)

Frequency
Results: Gold Mine

Gold Mine

Pooled data for 3 months

Radon Progeny Exposure to Individual Miners (mWLM/month)
### Preliminary results

<table>
<thead>
<tr>
<th>Mine type</th>
<th>Mean exposure/month (mWLM)</th>
<th>Maximum exposure/month (mWLM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt</td>
<td>2.5</td>
<td>8</td>
</tr>
<tr>
<td>Gold</td>
<td>12</td>
<td>26*</td>
</tr>
<tr>
<td>Uranium</td>
<td>13</td>
<td>64</td>
</tr>
</tbody>
</table>

*if this exposure were maintained for 12 months, the effective dose received by that miner would be 1.56 mSv using 1 WLM = 5 mSv

*Note: air is changed every 30 to 60 minutes in uranium mines as opposed to hours in non-uranium mines*
To assign risk to a radiation exposure, we need to translate “WLM” to effective dose in mSv (i.e., 1 mSv results in a roughly 1 in 20,000 risk of inducing a fatal cancer).

In the past, the effective dose per WLM was assumed to be 5 mSv.

Newer data suggests that a different conversion factor should be used. In the case of mines with forced ventilation, the recent data suggest value the value should be between 8 and 12 mSv per WLM (for workers) (Canada still uses the 5 mSv/WLM guide).
Summary

• A pilot study is on-going to assess exposure to radon progeny in 3 Ontario, non-uranium mines
• While there is variability in the data, no excessively “high” exposure values have been found as yet (data from 2 of 3 mines available)
• Further study is needed to better understand the variability of exposure levels among non-uranium mines
Acknowledgements

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Thank you! Any Questions?