

Radon in Canada's Uranium Industry

April 2010

What is radon?

Radon is an odourless and colourless radioactive gas that occurs naturally in the environment as a result of the decay of uranium in soils and rocks. Uranium is widely dispersed throughout the Earth's crust and can be more concentrated in certain locations due to natural variation.

Radon emits alpha radiation and has a short half-life, meaning that it emits radiation at a fast rate.

This fact sheet uses the term "radon" to refer to both radon and radon progeny in order to simplify the text.

How does radon form?

Radon comes from the decay of uranium, part of a series of 14 transformations, called a decay chain. This process takes several billion years to complete. At the end of its decay chain is lead-206 — a stable, non-radioactive element.

As uranium undergoes radioactive decay, it emits alpha, beta and gamma radiation, along with a series of products that include radon. In turn, radon decays through a series of four very short-lived radioactive radon decay products, in the form of solid, electrically-charged particles that are called radon progeny: polonium-218, lead-214, bismuth-214, and polonium-214.

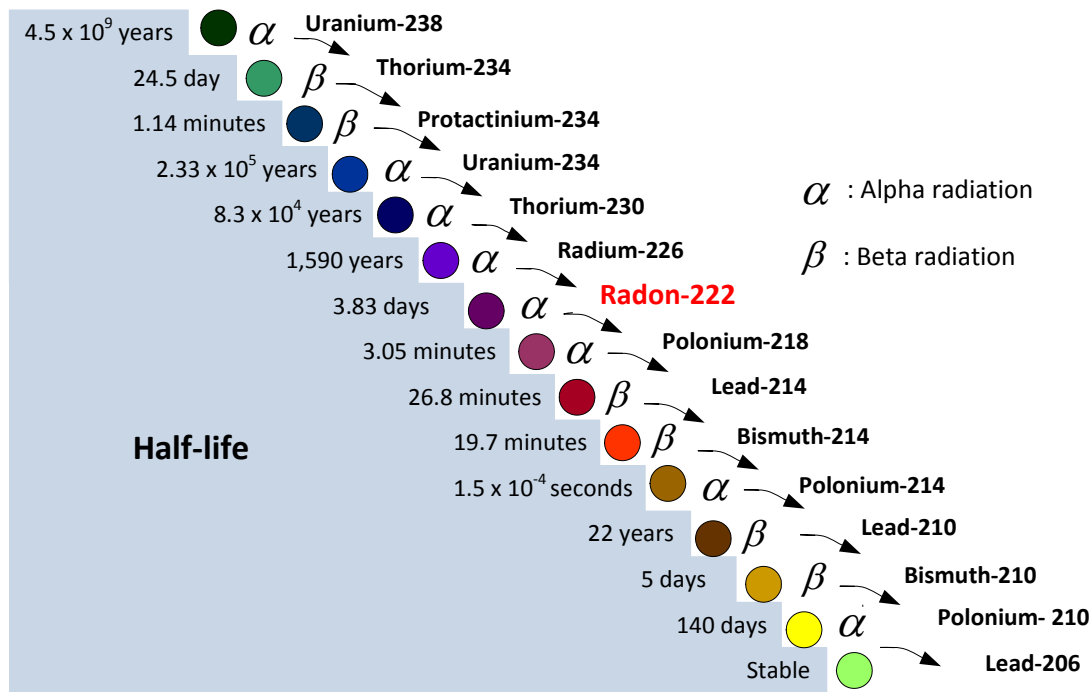
Because of their short half-lives, radon progeny emit radiation more quickly and present greater health risks than radon itself. The two that pose a health risk are polonium-218 and polonium-214.

Figure 1 shows the decay chain of Uranium-238, the most common form of uranium.

Quick facts

- Radon is produced by the decay of uranium, which is naturally present in rock and soil. Radon gas is released into the air when uranium ore is mined and, to a lesser extent, during the production of uranium fuel for nuclear power plants.
- The CNSC regulates radon in Canada's nuclear facilities to protect workers, members of the public and the environment.
- Long-term exposure to elevated levels of radon increases the risk of developing lung cancer, which is why the CNSC ensures that the air quality in a uranium mine is tightly controlled with good ventilation.
- As a result, the lung cancer risk for today's uranium mining and processing workers is the same as that for the general Canadian public.
- Presently, worker exposures to radon in the uranium mining and processing industry are as low as, or only slightly greater than, public exposure from natural radon.
- Radon exposure to members of the public from CNSC-regulated activities is virtually zero.

Figure 1: Uranium-238 decay chain



What are the radon-related health risks for uranium workers?

Many studies looking at the health effects of radon have been conducted throughout the years. These studies have helped understand the importance of controlling radon.

The main finding is that long-term exposure to above-background levels of radon increases the risk of developing lung cancer. Exposure to radon has not been linked to other cancers or causes of death.

The health risk related to radon is caused by exposure to its progeny, which are produced when radon decays. If radon gas is present, the decay products will become suspended in the air. Because they are electrically charged, most will attach to dust particles or the surface of solid materials; some may remain unattached. Both attached and unattached fractions may be inhaled. Once deposited in the lungs, radon emits alpha radiation, irradiating and possibly damaging the living cells lining the lung.

From the 1930s to the 1950s, underground uranium miners developed lung cancer at higher-than-normal rates from their exposure to higher and largely uncontrolled concentrations of radon progeny. Today's uranium miners are much better protected from the health effects of radon.

The impact of smoking

Smoking poses a greater lung cancer risk than radon. Most miners are also smokers. Exposed to both cigarettes and radon, their combined risk for developing lung cancer is higher than the straight sum of the individual risks.

Do uranium mines and mills increase radon levels in the environment?

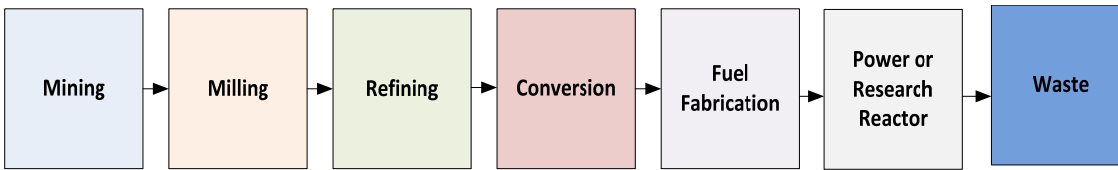
No. Studies have shown that uranium mining and milling activities do not increase radon levels above background levels in the environment away from the mine site.

How is radon regulated in today's uranium mines and processing facilities?

As Canada's nuclear regulator, the Canadian Nuclear Safety Commission (CNSC) regulates radon and radon progeny in Canada's nuclear facilities to protect the health of uranium workers and the public.

Concentrations of radon in uranium mines and mills and uranium processing fuel fabrication facilities are strictly controlled and must be monitored in air to protect workers. Controls include sophisticated detection and ventilation systems that effectively protect Canadian uranium workers. Figure 2 illustrates the nuclear fuel cycle in Canada.

Figure 2: Nuclear fuel cycle in Canada



The average effective dose for workers at uranium mines and mills in 2007* from all sources—including external sources, radon and radioactive dust—was about 1 mSv. Less than half of that dose was due to radon. All doses are significantly below the regulatory nuclear worker limit of 50 mSv per year. Because radon gas and its progeny rapidly decay once leaving the mine, they pose little risk to members of the public.

The International Commission on Radiological Protection (ICRP) is the international body that sets the framework for radiological protection. The CNSC incorporates the ICRP recommendations in its regulatory framework to protect Canadians from the radon that is released from the activities of the uranium industry.

As part of the ongoing review of radon and health risks, in December 2009, the ICRP proposed reducing radon exposure limits. The CNSC will participate in the international review of this proposal.

(*Based on the most recent available data from Health Canada)

How do today's uranium mines and processing facilities control radon?

Modern systems ensure radon and radon progeny are continuously monitored and controlled in today's uranium facilities.

Some of the measures in place include:

- Ventilation systems that quickly reduce radon concentration in the air.
- Ore containment systems to prevent radon emissions into the air.
- Continuous monitoring systems that warn of changing concentrations of radon and radon progeny concentrations in work areas.
- Personal alpha dosimeters worn by workers to measure their exposure to radon progeny, with measurements reviewed regularly by CNSC staff and submitted to Health Canada's National Dose Registry.



Underground monitors continually check the level of radon and display the results like a traffic light.

How are the health effects of radon being tracked?

The CNSC — in partnership with universities and provincial, federal and industry stakeholders, including uranium miners and uranium processing workers — has been involved in many health studies about radon.

Some of the populations studied include:

- Ontario uranium miners**
- Eldorado uranium workers**
- Newfoundland fluorspar miners**
- Saskatchewan uranium miners

*(** Data for these populations are collected on an on-going basis to update the studies)*

The recently updated Eldorado Studies followed the health of 17,660 uranium miners and uranium processing workers over the past 50 years.

The study concludes that:

- Former uranium workers who received high exposures to radon progeny had higher-than-normal rates of lung cancer because of radon exposure.
- Radon exposure is not linked to any other type of cancer or cause of death.

These findings are consistent with the results of other uranium miner studies and a combined analysis of data from 11 underground miner studies.

The findings are also consistent with the conclusions of a recent report published by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), which gives a comprehensive review and summary of all radon-related research.

The CNSC and other stakeholders recently completed a feasibility study of present day Saskatchewan miners. The study concluded it would be nearly impossible to detect an excess lung cancer risk from working in today's uranium mines, because miners' exposure to radon is so low:

- The exposure of today's workers ranges from 100 to 1,000 times lower than that of past uranium miners, such as those included in the Eldorado studies.
- On average, uranium miners today have lower radon exposure in the workplace than in their homes. Their risk of lung cancer from exposure to radon is therefore comparable to that of the general public.

How is the public exposed to radon?

Radon is the largest source of naturally-occurring radiation exposure for Canadians. It varies with the concentration of uranium in the Earth's crust and represents about half of the total exposure from natural background radiation. In Canada, the average radiation exposure due to background radiation ranges from 2 to 3 mSv per year.

A report published in July 2009 by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) highlights the importance of taking measures to protect people from radon at home and at work.

The report provides a comprehensive review and summary of radon research worldwide.

Did you know?

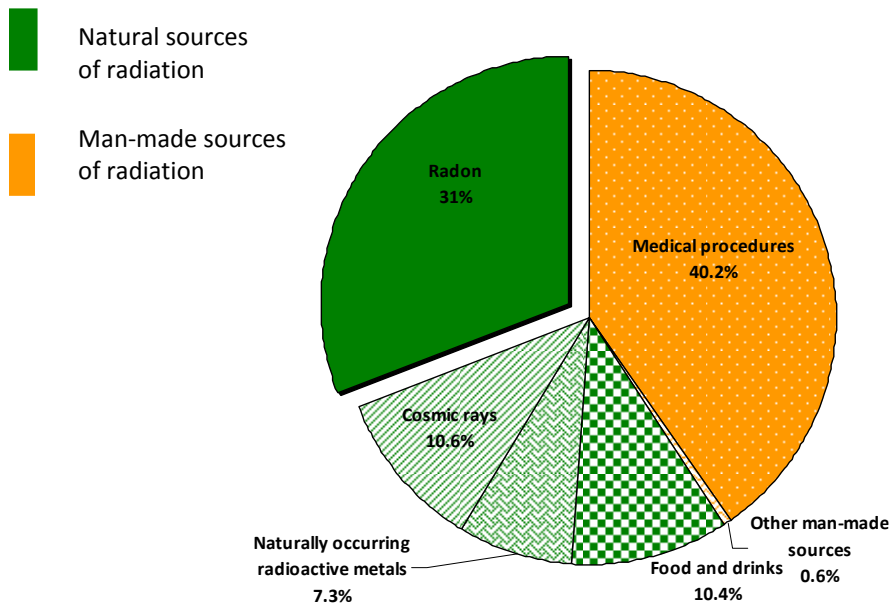
Canada is one of the world's largest uranium producers with 20.5% (9,000 tonnes) of global output in 2008.

Figure 3 shows the sources of radiation exposure for an average adult Canadian. The sources of natural background radiation, shown in **green**, include:

- radon
- food and drinks, like bananas which naturally contain potassium-40
- naturally-occurring radioactive metals in the Earth's crust and rocks, like uranium
- cosmic rays from the sun and outer space

Man-made, or artificial, sources of radiation are shown in **orange**. The dominant source is from medical procedures. Controlled releases from nuclear facilities are included in the category of "Other man-made sources" which collectively account for 0.6 per cent of total radiation exposure.

Figure 3: Sources of radiation exposure for an average adult Canadian



The CNSC does not regulate radon in homes; that authority falls to Health Canada. Contact Health Canada for more information on the steps taken to protect Canadians from the potential dangers of radon gas.

For more information:

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