



Epidemiological Evidence and Radiation Protection

Patsy Thompson, PhD

Director General
Directorate of Environmental and Radiation Protection
and Assessment
Canadian Nuclear Safety Commission

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nuclearsafety.gc.ca

Biography

Dr. Patsy Thompson is the Director General of the Directorate of Environmental and Radiation Protection and Assessment. Dr. Thompson is an environmental toxicologist with more than 20 years of experience assessing the impacts of metals, organic contaminants and radioactivity in the environment. She has served as an expert witness and consultant both nationally and internationally. Dr. Thompson is the Canadian representative on the International Atomic Energy Agency's Radiation Safety Standards Committee and was appointed in 2009 to the Scientific Advisory Board of the French Institute of Radiation and Nuclear Safety.

In her current position at the CNSC Dr. Thompson is responsible for the CNSC's health and environmental programs.

Overview

- Updated epidemiological studies of the relationship between radon decay products (RDP) and lung cancer among Canadian uranium workers
- Health effects of people living near uranium processing facilities

This presentation will discuss:

1. Main findings from these studies
2. International consensus
3. Knowledge gaps
4. Plans for international collaborative studies
5. Importance of epidemiological evidence for radiation protection and evidence-based decision making
6. International radon interest

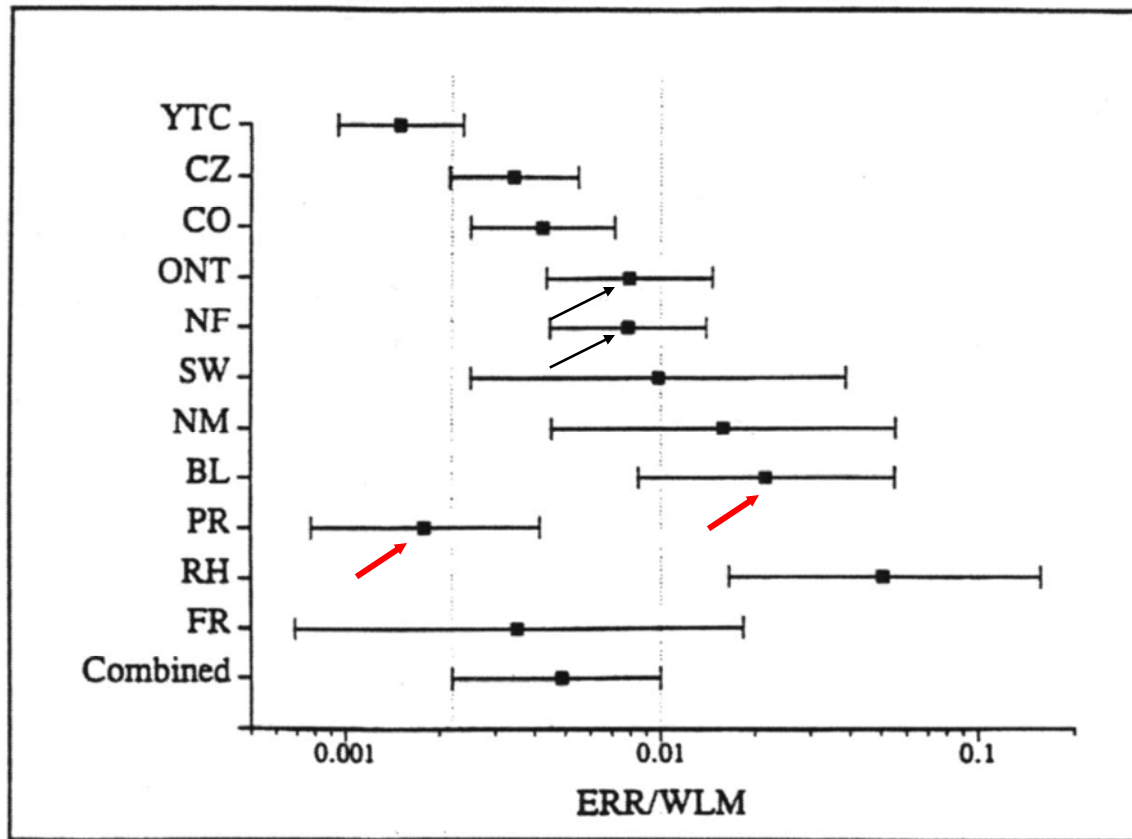
Canadian Regulatory Framework

- Canadian *Radiation Protection Regulations* are based on the recommendations the International Commission on Radiation Protection (ICRP)
- Dose limits for workers are 50 mSv annually, and a maximum of 100 mSv for 5 years
- These recommendations are based on the most recent advances in scientific evidence and literature reviews by international organizations:
 - United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)
 - Biological Effects of Ionizing Radiation (BEIR)
- The CNSC needs to ensure that the *Radiation Protections Regulations* are up-to-date with the latest scientific findings

11 Miners' Combined Study, 1994

- Colorado Plateau
- Ontario
- Czech Uranium
- Swedish Iron
- Beaverlodge
- German Uranium
- Port Radium
- French Uranium
- Newfoundland Fluorspar
- Chinese (uranium and tin)
- Other miner studies

Estimates of Excess Relative Risk of Lung Cancer Per Working Level Month (WLM)



* Lubin et al (1994)

11 Miners' Combined Study, 1994 - BEIR VI

- Radon progeny causes lung cancer
- The risk of lung cancer significantly increases with radon progeny exposure
- Several modifying factors affected miners' risk
 - time since exposure, age at risk, exposure rate
- Tobacco has between an additive and multiplicative effect
- Forms the basis of today's radiation protection programs for uranium miners

Perspective

- Canadian miner cohorts are important
 - NCRP 1978
 - BEIR IV, VI
 - NCRP 1988
 - UNSCEAR 2000, 2008
- Updates of Eldorado miners (**Port Radium** and **Beaverlodge**) at the similar time as update of **Newfoundland Fluorspar** miners and **Ontario uranium miners**
- Great interest in a new Canadian and European combined analysis of miner studies

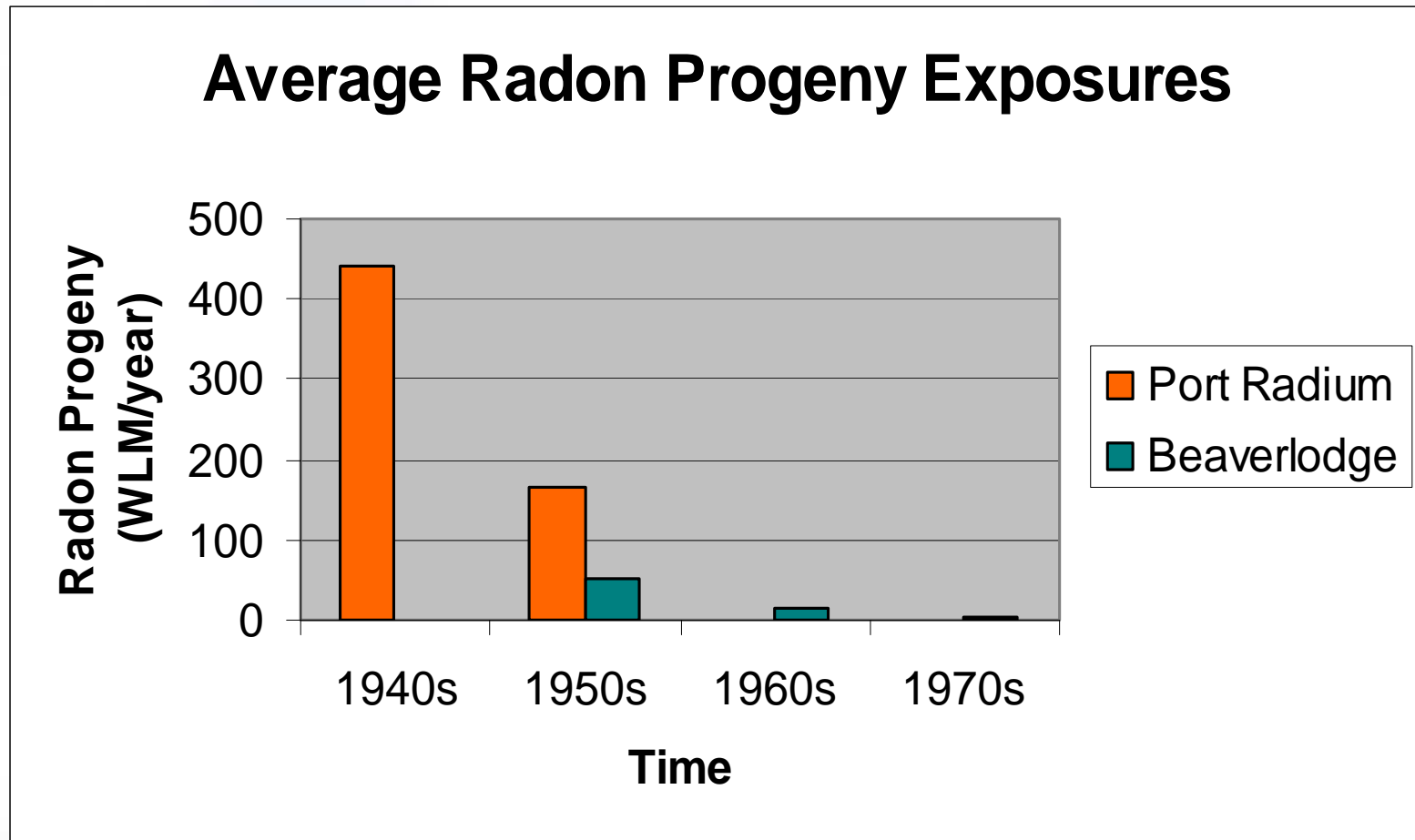
Update of the Eldorado Uranium Workers Study (1)

- Main objective:
 - to assess relationship between RDP exposure and lung cancer risk
 - dose response, modifying effects of age at risk, time since exposure and exposure rate
 - assess relationship between RDP and other cancers and other causes of death
 - assess relationship between gamma radiation dose and other cancers and other causes of death

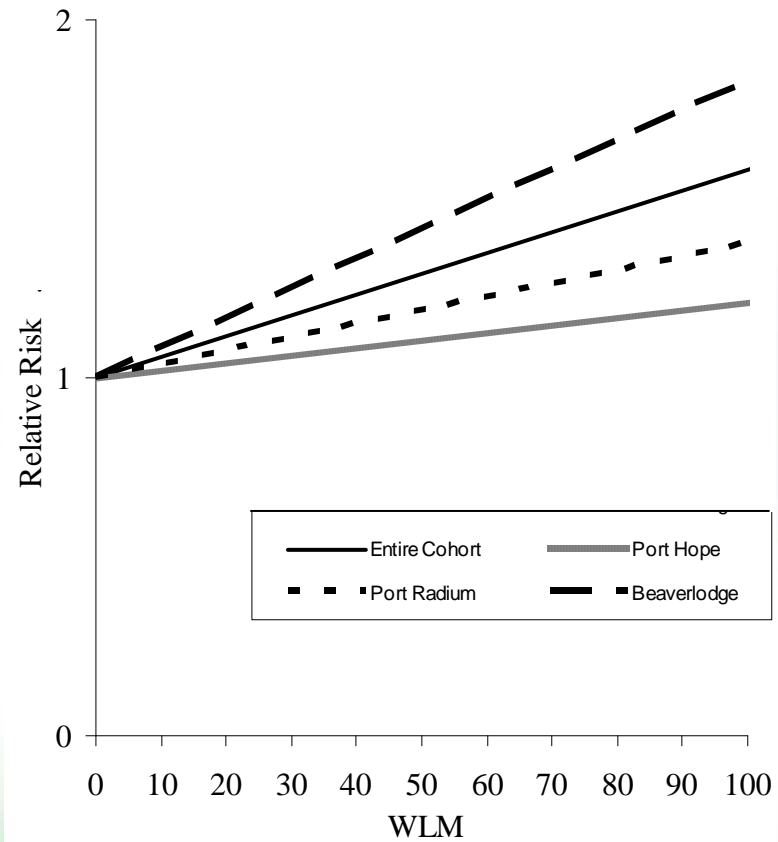
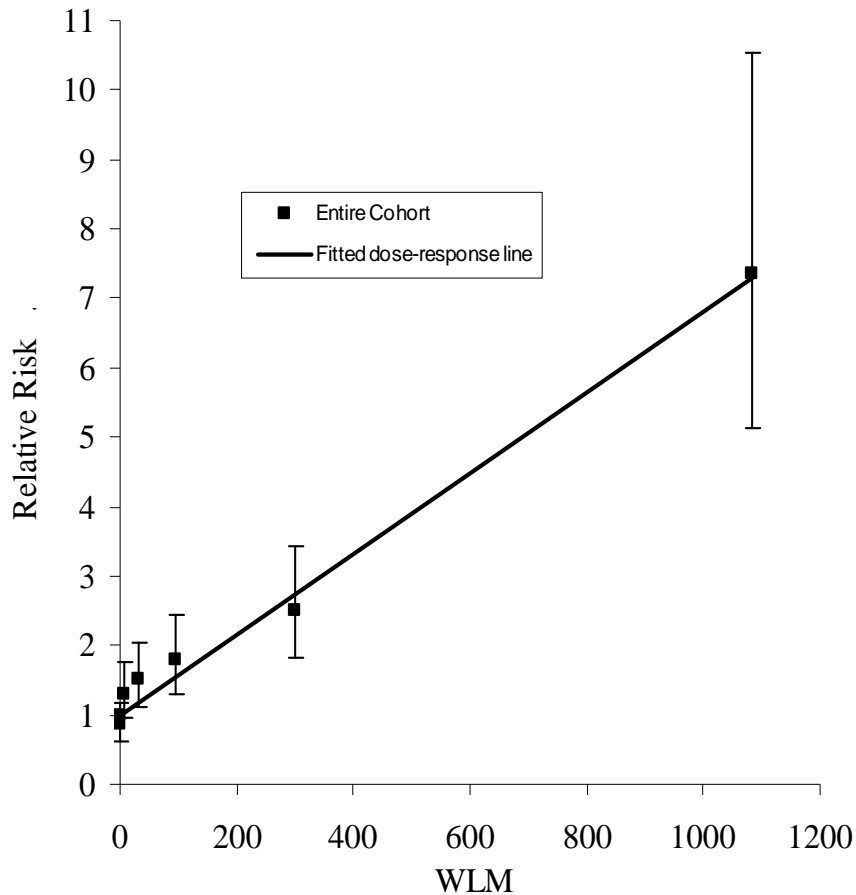
Update of the Eldorado Uranium Workers Study: Findings (2)

- Overall, workers were as healthy as the general Canadian male population
 - Except workers had significantly higher rates of lung cancer compared to general male population
- Statistically significant excess risk of lung cancer mortality and lung cancer incidence with RDP exposure
 - Linear dose response relationship
 - Risk decreased with increasing time since exposure, age at risk and exposure rate
- No relationship between RDP exposure and any other cancer site or other cause of death
- No relationship between gamma radiation dose and any cancer site or cause of death

Update of the Eldorado Uranium Workers Study - Comparison of Past and Current Exposures (3)



Plot of the Relative Risk Estimates of Lung Cancer Mortality (95% Confidence Intervals)



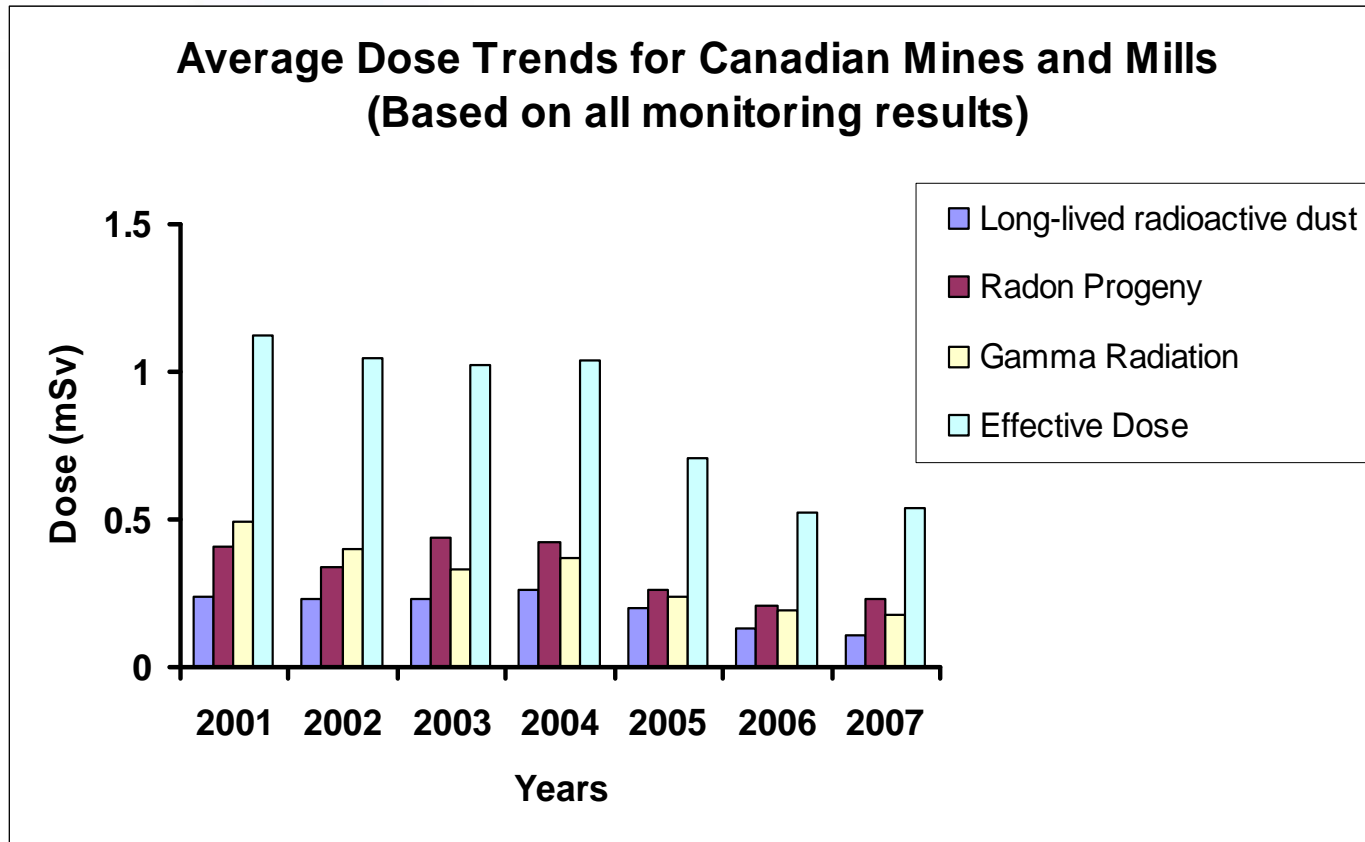
a Male

bA trend in RR from Table 2 with person-year-weighted means in WLM exposure categories.

Feasibility Study of Modern Uranium Miners

- Workers from 1970 to 2000 . . . 2030
- About 24,000 workers would spend some time working at a Saskatchewan mine by the year 2030
- Issues:
 - Very small workplace radon and other exposures
 - Cigarette smoking
 - Residential radon
 - Follow-up of miners' work histories after mining
 - Very low statistical power to detect excess risk
- During this time, approximately 141 miners could expect to develop lung cancer (primarily from smoking)
- One (1) miner may expect to develop lung cancer from radon exposure in the workplace

Average Effective Dose for Workers at Uranium Mines and Mills 2001-2007



Update of the Newfoundland Fluorspar Miners Study

Results:

- Workers were as healthy as the general male population of Newfoundland
- Dose-response relationship between RDP and lung cancer mortality
 - Relationship modified by time since last exposure, duration of exposure and exposure rate
 - Increased risk of lung cancer with number of cigarettes smoked daily
- No evidence of a link between RDP and coronary heart disease mortality

Update of the Ontario Miners study

- Initial study followed up to 30,000 Ontario Uranium miners from 1950 up to the late 1990s
- RDP and gamma radiation obtained from company records and NDR
- Update will provide 20 years of mortality (1955-present) and 30 years of cancer incidence (1969-present)
- Linkage of the cohort to the mortality and cancer incidence databases should be completed in August 2011

Study on Population Living Near Uranium Processing Facilities (1)

- Port Hope, Ontario has been home to a radium and uranium processing facility since 1932
- Waste management practices in early days resulted in wide spread contamination
- Most serious contamination was remediated from 1976 to 1981, but 600,000 tons of waste were left in Port Hope at 11 storage sites
- Since 1984, waste management practices are in place
- Despite better environmental practices today, there is still public concern about the remaining low level radioactive waste and on its effect on health

Study on Population Living Near Uranium Processing Facilities (2)

- In 2009, the CNSC published a study: *“Understanding Health Studies and Risk Assessments Conducted in the Port Hope Community from the 1950s to the Present”*
- Over 30 environmental and 13 epidemiological studies, over a period of 10 years.
- Weight of evidence approach
- To determine the likelihood of adverse environmental and health effects from the presence of the nuclear industry in Port Hope

Study on Population Living Near Uranium Processing Facilities (3)

- Based on the toxicological, experimental and epidemiological evidence of the most likely health effects of contaminants on health, the CNSC's findings were:
 - No evidence to link occupational or environmental uranium exposures to kidney disease, cancer, or any other cause of death
 - Only lung cancer is known to be associated with RDP exposure
 - Radium has to be ingested and deposited in the bones to cause bone cancer; the dose threshold for such an effect is about 10 Sv

Study on Population Living Near Uranium Processing Facilities (4)

| Annual Radiation Doses | mSv/year |
|---|-----------------|
| Radon (indoor) in Port Hope (1955-1993) | 0.69-0.99 |
| Gamma (indoor) in Port Hope (1955-1993) | 0.25-0.27 |
| Cameco Port Hope Conversion Facility (2007) | 0.064 |
| Cameco Fuel Fabrication Facility (2007) | 0.004 |
| Worldwide annual average effective dose from radiation sources (2000) | 2.4 (1-10) |

Study on Population Living Near Uranium Processing Facilities (5)

- Findings from the environmental and epidemiological studies conducted in Port Hope are consistent and support each other
- Considering all the available lines of evidence and their relative strengths, the CNSC concluded:
 - there was no evidence that adverse health effects have occurred or are likely to occur in Port Hope as a result of the operations of the nuclear industry

How CNSC Communicates its Findings to Interested Parties?

CNSC communicates the findings of epidemiological and other research findings to stakeholders and members of the public through:

- Presentations in scientific fora, at Commission meetings, to other governmental departments, NGOs, workers, unions, and to the public
- Targeted materials such as reports, fact sheets, Qs and As that are published on the CNSC Web site
- Open houses
- Peer-reviewed scientific journals

Knowledge Gaps to be Filled in the Future

A number of scientific and regulatory issues to be addressed, such as:

- refinement of risk estimates
- health effects of gamma radiation and long-lived radioactive dust
- health impact below 50 WLMs and low exposure-rates
- presence of other carcinogens in mines
- improvements in dosimetry (organ doses)
- consideration of leukaemia, other cancers (pulmonary)
- consideration of non-cancer causes of death (cardiovascular)
- uncertainty, measurement errors, modifiers of risk and confounding factors
- special populations (women)

This will require larger cohorts to increase the statistical power of future studies

Plans for Future Studies

- Pooling the Canadian miners' studies (Eldorado, Ontario, and Newfoundland) to get a cohort of 50,000 workers
- Collaboration with several European countries (France, Germany, Czech Republic) that have a common interest to resolve research gaps
- This collaboration will increase the size of the cohort to 100,000 workers and will significantly increase the statistical power to assess RDP risk
- The CNSC is presently working with l'Institut de radioprotection et de sûreté nucléaire (IRSN), France to put in place this collaborative study

International Radon Interest

The UNSCEAR, ICRP and the World Health Organization (WHO) have recently issued updated reviews and revised advice on radon:

- UNSCEAR 2006 Report (2008): “*Sources-to-effects assessment for radon in homes and workplaces*”
- “*The WHO handbook on indoor radon -a public health perspective*” (2009) set the optimal level of radon in dwellings to 100 Bq m⁻³
- ICRP
 - Statement on radon
 - Draft report for consultation: Lung cancer risk from radon and progeny
- The CNSC is participating in the international review of the ICRP draft document

Conclusions

- Ongoing research on the health effects of occupational radiation exposures is critical for up-to-date knowledge on health risks
- Necessary to ensure radiation protection programs are appropriately protecting worker's health in today's mining environment
- CNSC is committed to disseminate objective scientific and regulatory information and to improve the scientific understanding of the potential health effects of uranium mining, refining and processing in order to be able to respond effectively to the demand during this time of uranium industry growth