

# Indoor air quality assessments: Radon

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# Outline

## Introduction

- What is RADON
- Sources
- Health effects

## Sampling and Interpretation

- Sampling methods
- Reference values
- Interpretation

## Management

- Ways to reduce exposures

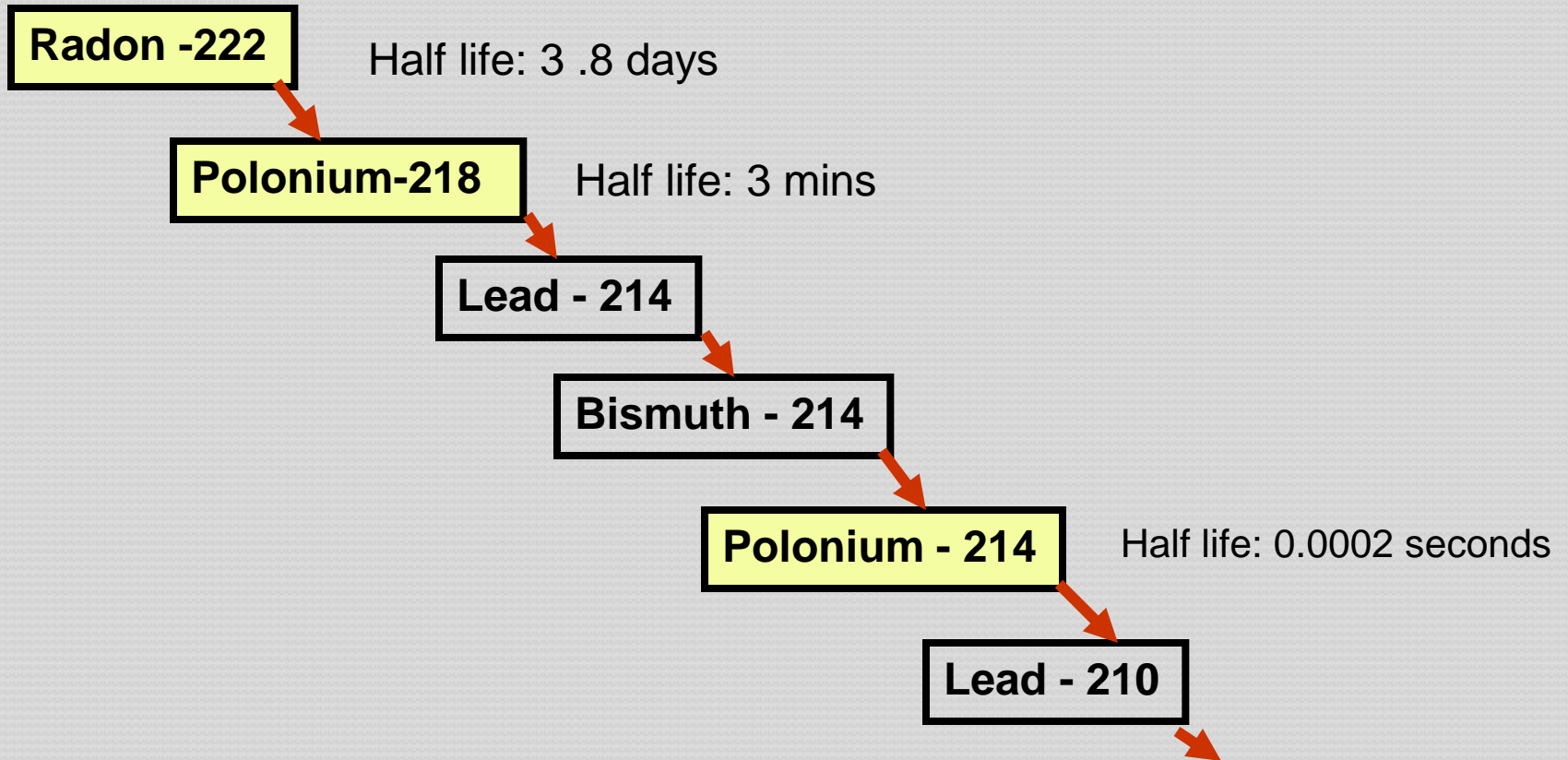


# Introduction

# What is radon?

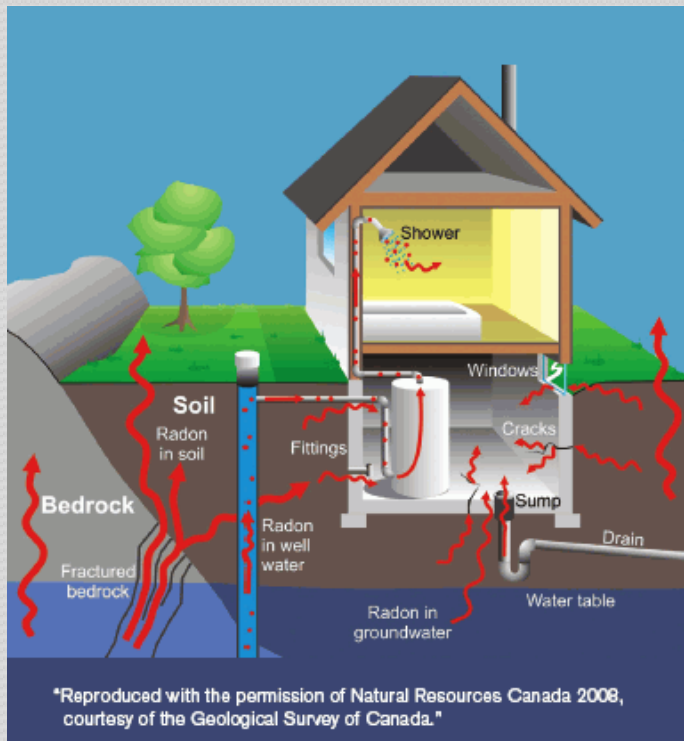
- Inert gas
- Rn (atomic number 86)
- Naturally occurring – outside
- Part of the uranium decay chain
- half-life 3.8 days
- Odourless, colourless, tasteless, radioactive
- Measured in units of Bq/m<sup>3</sup>

# Radon Decay Chain



Indicates an alpha emitter

# Sources



- Decay product in Uranium decay chain
- Builds up to elevated levels in buildings which are air-tight
- Some emanation sources, but little evidence that they add to indoor levels
- Well water

Courtesy of Health Canada

[http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radon\\_brochure/index-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radon_brochure/index-eng.php)

**Concentrations are generally higher indoors vs. outdoors**

# Health Effects

- The only known health effect is lung cancer
- Symptoms of lung cancer are similar to common flu/cold illnesses

## Vulnerable populations:

- Radon and smoking increase a smoker's risk of lung cancer
- Smoker with high radon level has a 1 in 3 chance of developing lung cancer

# Leading Causes of Death in Canada Statistics Canada, 2009 (released July 2012)

Total, all causes of death 2009	Rank	Number of deaths 238,418	100.0 (percent)
<b>Malignant neoplasms (cancer)</b>	<b>1</b>	<b>71,125</b>	<b>29.8</b>
Diseases of heart (heart disease)	2	49,271	20.7
Cerebrovascular diseases (stroke)	3	14,105	5.9
Chronic lower respiratory diseases	4	10,859	4.6
Accidents (unintentional injuries)	5	10,250	4.3
Diabetes mellitus (diabetes)	6	6,923	2.9
Alzheimer's disease	7	6,281	2.6
Influenza and pneumonia	8	5,826	2.4
Intentional self-harm (suicide)	9	3,890	1.6
Nephritis, nephrotic syndrome and nephrosis (kidney disease)	10	3,609	1.5

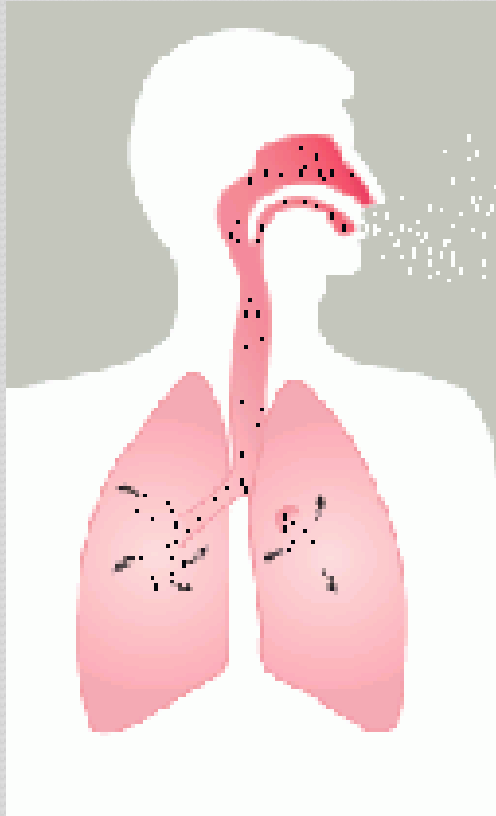


## Estimated Deaths and Age-Standardized Mortality Rates for Cancers by Sex, Canada 2011

	Total*	Male	Female
All Cancers	75,000	35,900	35,100
<b>Lung</b>	<b>20,600</b>	<b>11,300</b>	<b>9,300</b>
Colorectal	8,900	5,000	3,900
Breast	5,100	55	5,100
Prostate	4,100	4,100	-
Non-Hodgkin Lymphoma	3,000	1,700	1,350
Leukemia	2,500	1,450	980
Bladder	1,850	1,300	520
Esophagus	1,850	1,450	410
Stomach	1,800	1,150	750
Brain	1,800	1,050	750
Ovary	1,750	-	1,750
Kidney	1,650	1,050	580
Multiple Myeloma	1,350	730	640
Oral	1,150	760	370
Melanoma	950	590	360
Liver	810	640	170
Body of Uterus	750	-	750
Larynx	490	390	95
Cervix	350	-	350
All other Cancers	10,400	5,300	5,000

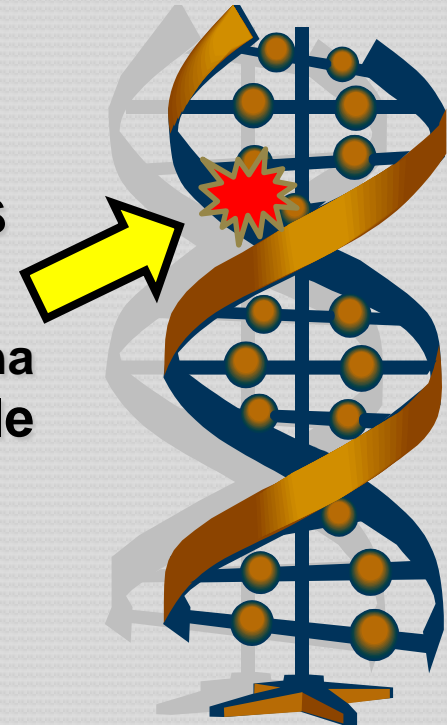
\*column totals may not sum to row totals due to rounding.  
Canadian Vital Statistics Death database at Statistics Canada,  
Canadian Cancer Society, Canadian Cancer Statistics 2011

# Biological Mechanism - Radon Health Effects



Inhalation of  
Radon and  
decay products

Alpha  
Particle



Radiation Damage  
to DNA

Courtesy of Health Canada

[http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radon\\_brochure\\_profession/index-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radon_brochure_profession/index-eng.php)

**Damage to DNA = Mutation = Cancer**

# Research

## Historical

- Miner Cohort Studies
- Epidemiological Studies
- Winnipeg Studies

## Current Initiatives

- Health Canada – Cross Country Survey 2011
- National Research Council

# Epidemiology: Occupational Exposure

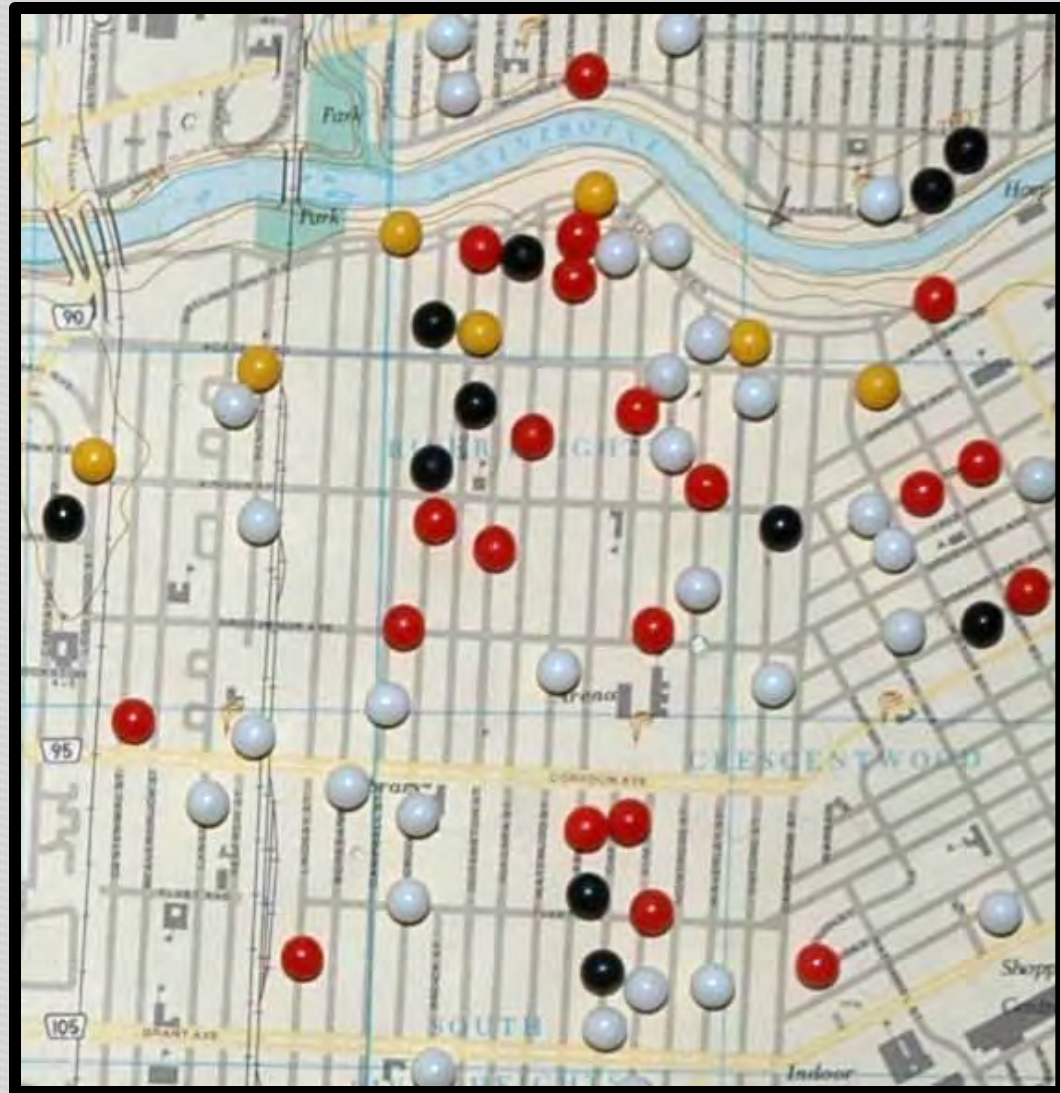
<b>STUDY</b>	<b>SUBJECTS</b>
<b>Czech Uranium Miners</b>	<b>9,403</b>
<b>Ontario Uranium Miners</b>	<b>15,984</b>
<b>New Mexico U Miners</b>	<b>3,469</b>
<b>Swedish Iron Miners</b>	<b>1,415</b>
<b>Colorado U Miners</b>	<b>44,127</b>
<b>Eldorado U Miners</b>	<b>8,487</b>
<b>Newfoundland Miners</b>	<b>1,772</b>

# Epidemiology: Radon Exposure in Homes

<b>META ANALYSES</b>	<b># LUNG CANCERS</b>	<b># CONTROLS</b>
<b>European: Darby et al, 2005,2006 (13 studies)</b>	<b>7,148</b>	<b>14,208</b>
<b>N. America: Krewski et al, 2005, 2006 (7 studies)</b>	<b>3,662</b>	<b>4,966</b>
<b>Chinese: Lubin et al, 2004 (2 studies)</b>	<b>1,050</b>	<b>1,995</b>

# Historic Radon Data

- River Heights, Winnipeg
- White: 0-150
- Red: 150-300
- Black: 300-450
- Yellow: 450+
- Bq/m<sup>3</sup>



Source: Gren Yuill



# Sampling & Interpretation

# Sampling: Testing Methods

- Long term testing:
  - 91 days to 1 year

Short term testing:

- 48 hours to 91 days

C-NRPP Approved Device list:

[www.nrpp.info/c-nrpp-documents/C-NRPP Device Lists.pdf](http://www.nrpp.info/c-nrpp-documents/C-NRPP_Device_Lists.pdf)



# Long Term Test Devices

- Electret Detectors



- Alpha Track



# Short Term Test Devices

- Electret Detectors



- Continuous Radon Monitor (CRM)



- Charcoal Canister



# Reference Values

Country	Reference Value
Canada	200 Bq/m <sup>3</sup>
-post mitigation	As low as reasonably practicable
United States	148 Bq/m <sup>3</sup>
World Health Organization	100 Bq/m <sup>3</sup>

# Interpreting Results

- Levels below  $200 \text{ Bq/m}^3$ 
  - Health Canada recommends no remediation
- Levels between  $200 \text{ Bq/m}^3$  and  $600 \text{ Bq/m}^3$ 
  - Health Canada recommends remediation within 2 years
- Levels above  $600 \text{ Bq/m}^3$ 
  - Health Canada recommends remediation within 1 year



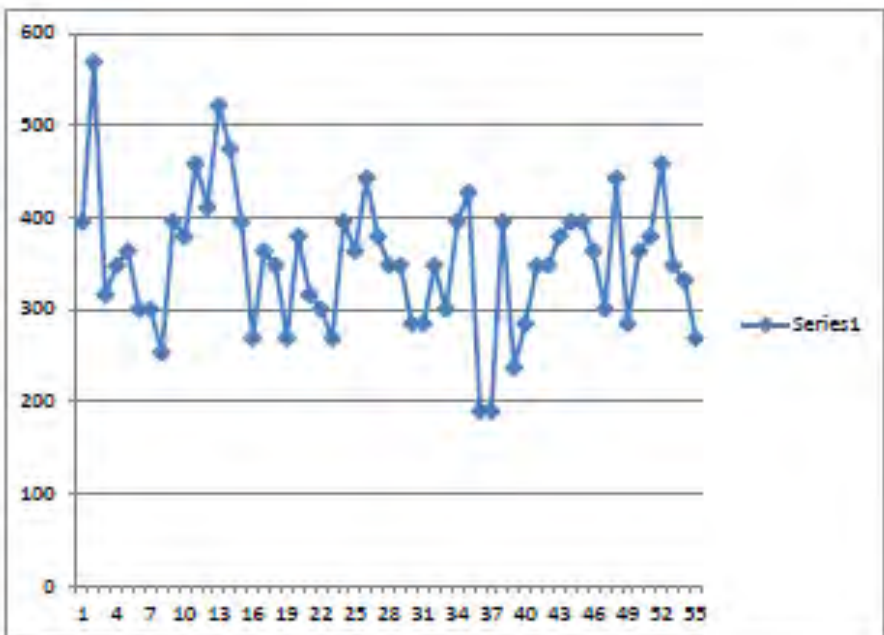
# Management

# Reducing Levels

## Three Standard Methods

- Sealing
- Heat Recovery Ventillation System
- Sub slab Mitigation System



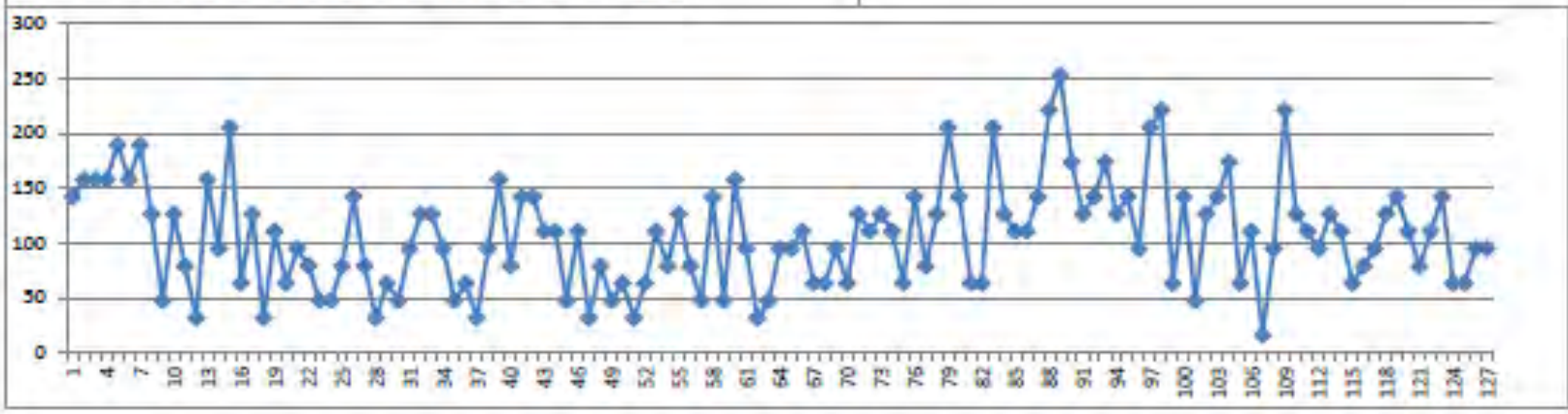


Levels without fan running (left)

Average: 350 Bq/m<sup>3</sup>

Levels with fan running (below)

Average: 110 Bq/m<sup>3</sup>



# References and Additional Resources

1. Guide for Radon Measurements in Residential Dwellings (Homes), Health Canada
2. Guide for Radon Measurements in Public Buildings, Health Canada
3. Reducing Radon Levels in Existing homes A Canadian Guide for Professional Contractors, Health Canada

[www.nrpp.info/cnrpp.shtml](http://www.nrpp.info/cnrpp.shtml)