



Canadian Radon Initiatives and Comparison of Consumer-Grade Electronic Radon Monitors

Third National Conference on Radiation Awareness
and Detection in Natural Environment



- March 2021



Canadian Radon Initiatives and Comparison of Consumer-Grade Electronic Radon Monitors

Overview:

- Canada 101
- Radon from our perspective; buildings/radon levels
- Building a strong Foundation of Radon Awareness
 - Strong collaboration
 - Measurement in Existing Buildings - Workplaces
 - Effective methods of Radon Reduction
- Digital Device Intercomparison



- **Large Land Mass**

Canada is 3 times the size of India

- **Sparsely populated areas with large remote areas**

Canada vs India
37.7 million vs 1.326 billion



- Broad range of geographical and Physical conditions

Temperatures range from 40C to -40C



We heat our homes in winter.



We cool our homes in summer.



Canada 101:

We have an
EXTREME CLIMATE



Canada 101:

We LOVE our
fresh air

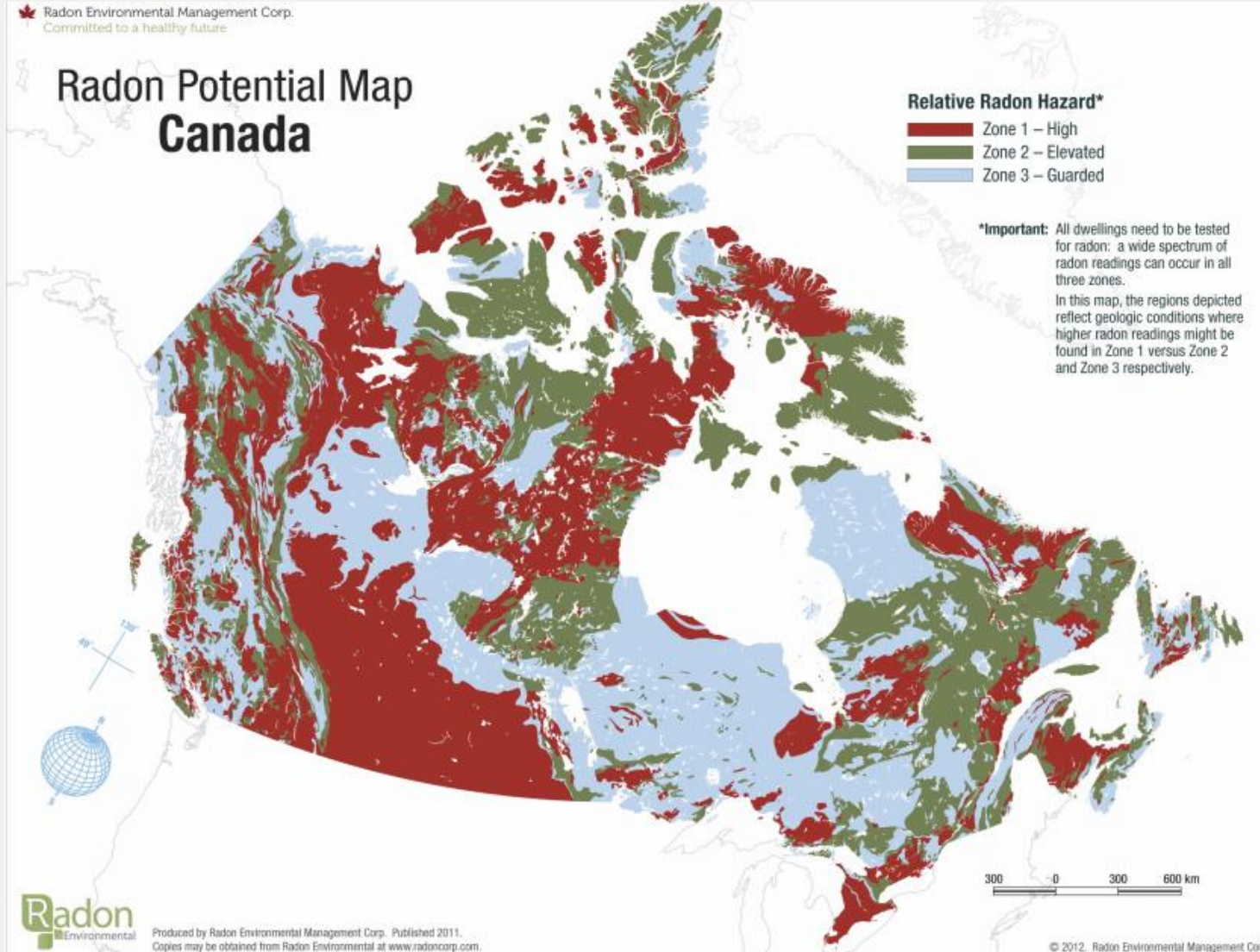
Third National Conference on Radiation Awareness and
Detection in Natural Environment

Radon Potential Map Canada

Relative Radon Hazard*

- Zone 1 – High
- Zone 2 – Elevated
- Zone 3 – Guarded

***Important:** All dwellings need to be tested for radon; a wide spectrum of radon readings can occur in all three zones.
In this map, the regions depicted reflect geologic conditions where higher radon readings might be found in Zone 1 versus Zone 2 and Zone 3 respectively.



Produced by Radon Environmental Management Corp. Published 2011.
Copies may be obtained from Radon Environmental at www.radoncorp.com.

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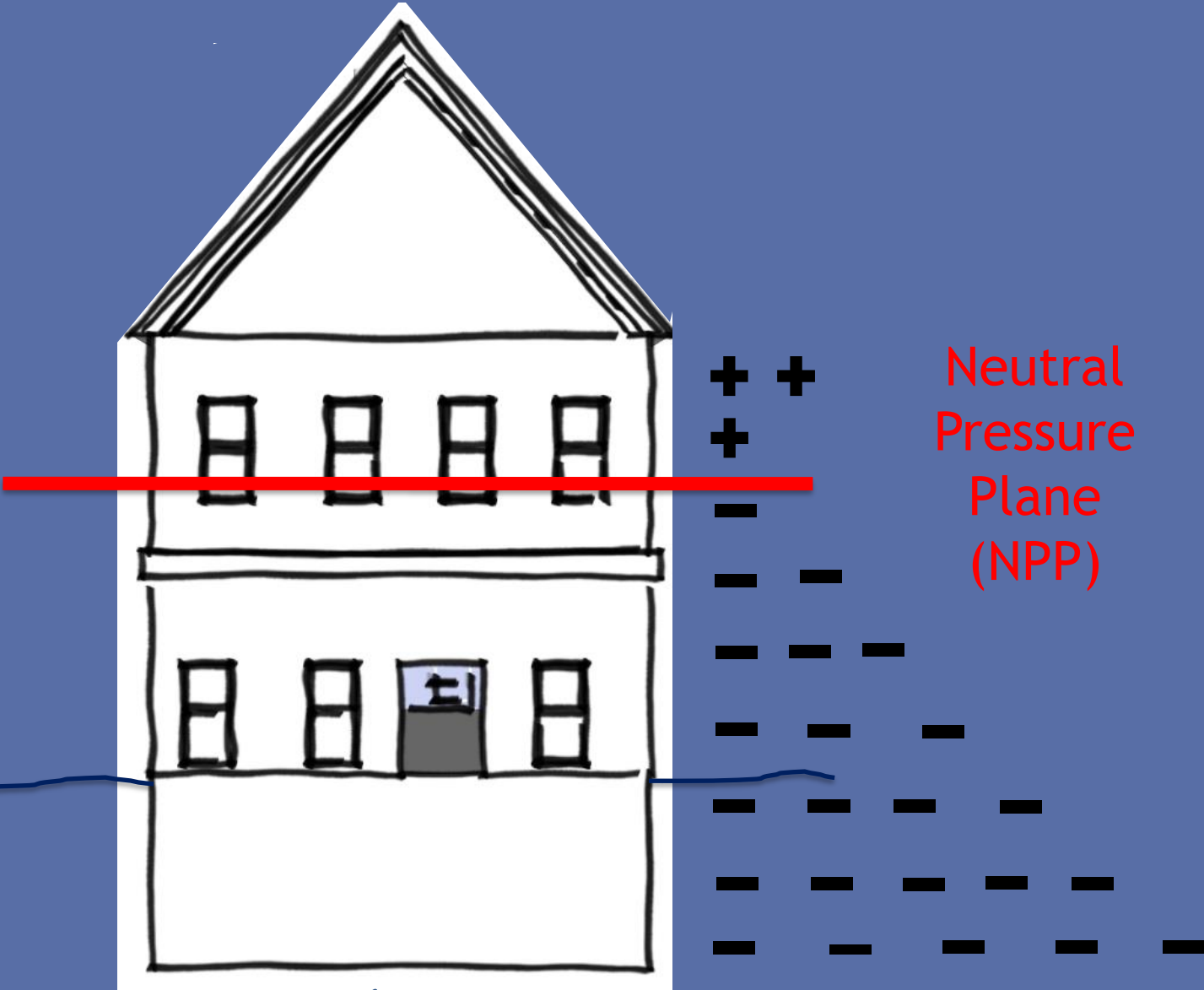
ISBN 978-0-8877645-1-5



Radon from our perspective

Geological Radon Potential

Thermal Stack:
Major
Driving
Factor
in
Cold
Climate

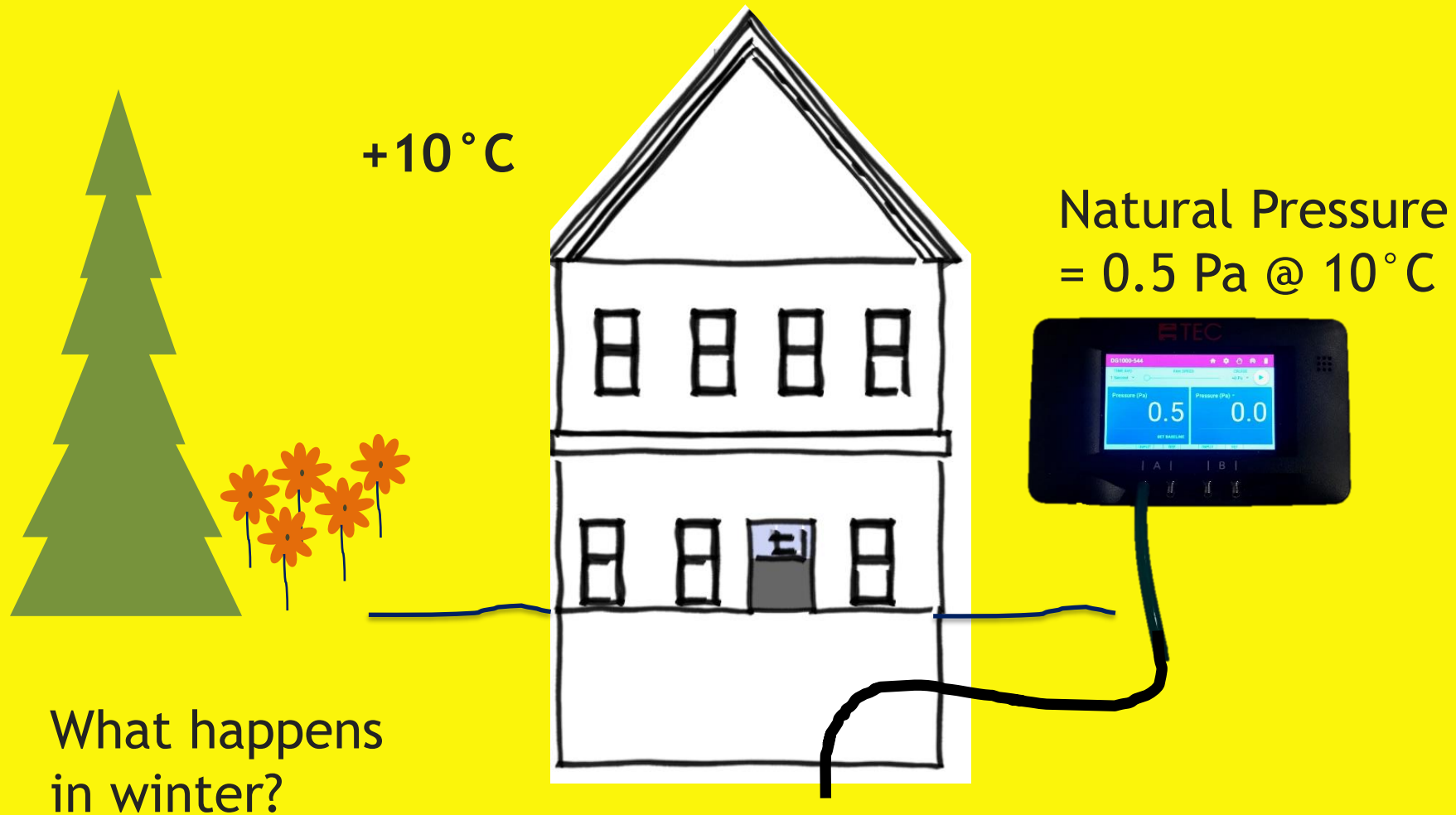


Neutral
Pressure
Plane
(NPP)

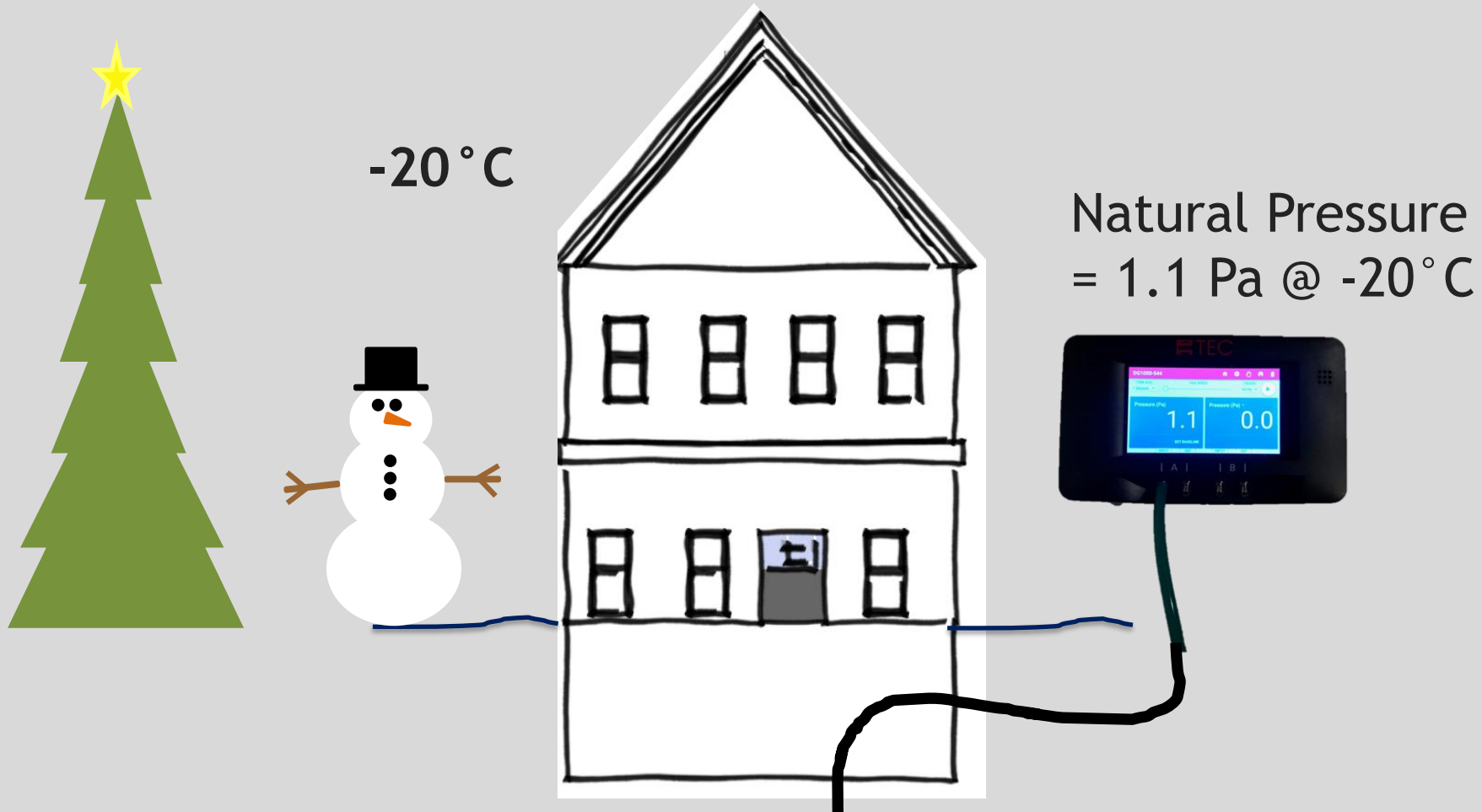


Radon

Natural Pressure (Spring)



Natural Pressure (Winter)



REPORT OF THE RADON WORKING GROUP
ON A NEW RADON GUIDELINE FOR CANADA

REV. 03-10-2006

Submitted to the
FEDERAL PROVINCIAL TERRITORIAL
RADIATION PROTECTION COMMITTEE

2006 Report on Radon

- Recognized that radon was a significant health risk at a lower level than previously considered in Canada
 - **Reduced the Canadian guideline from 800 Bq/m³ to 200 Bq/m³**
- Set our standard for measuring radon in buildings on a long-term radon test
 - **Long-term test = 3 months (90 days+)**
- Developed recommendations for reducing radon levels in Canadians homes
- Recognized the importance of building codes to reduce or control radon within new construction
- Recommended a National Radon Action program prioritizing testing in homes, schools and hospitals, and also recommended testing in workplaces



Radon from our
perspective

Recent History
with Radon



Radon from our
perspective

Measurement

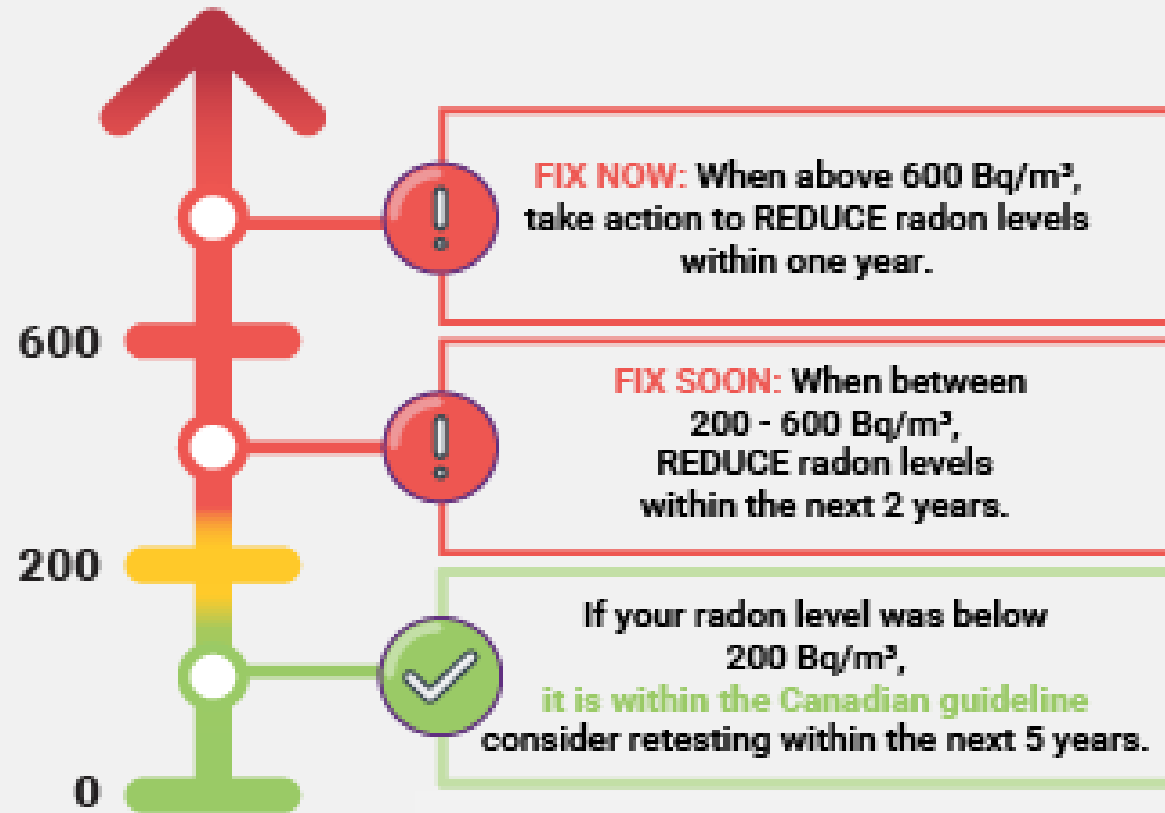
- Canada's Radon Guideline level is 200 Bq/m^3
- Long-term radon tests 91 days or longer (alpha track) during the heating season





Radon from our perspective

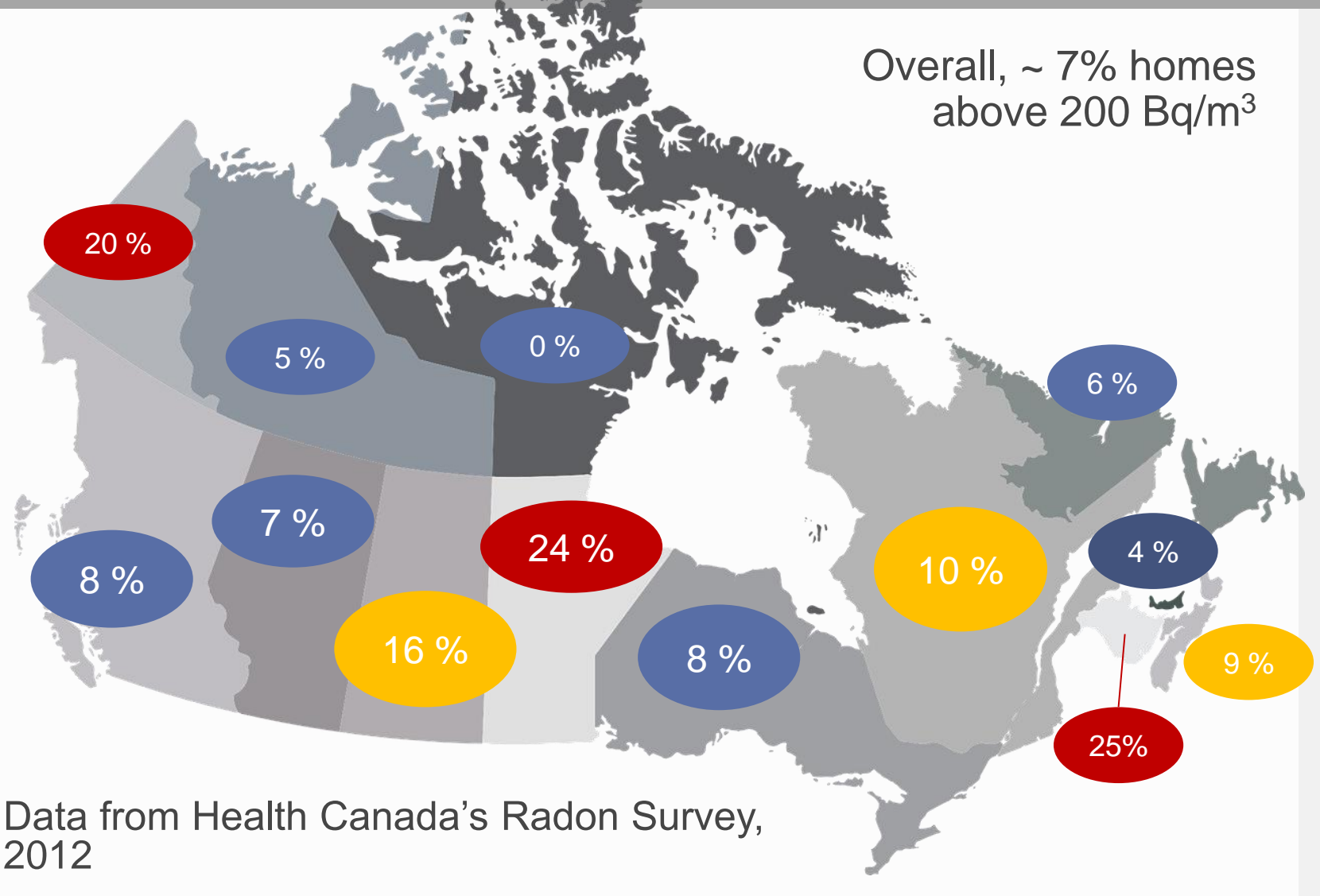
Measurement





Radon from our perspective

Canada's Radon Levels

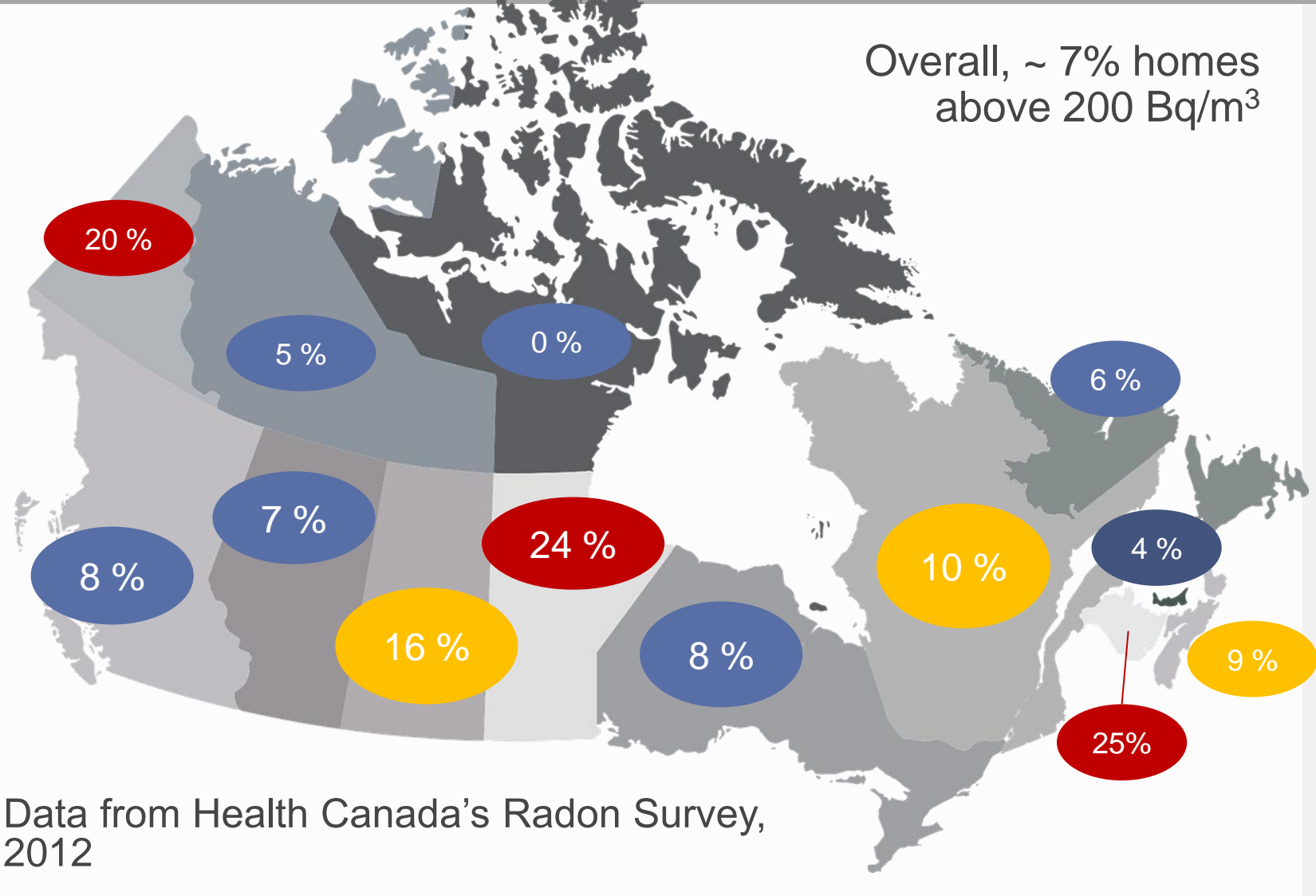




Radon from our perspective

Canada's Radon Levels

3 000 Canadians diagnosed with lung cancer per year.

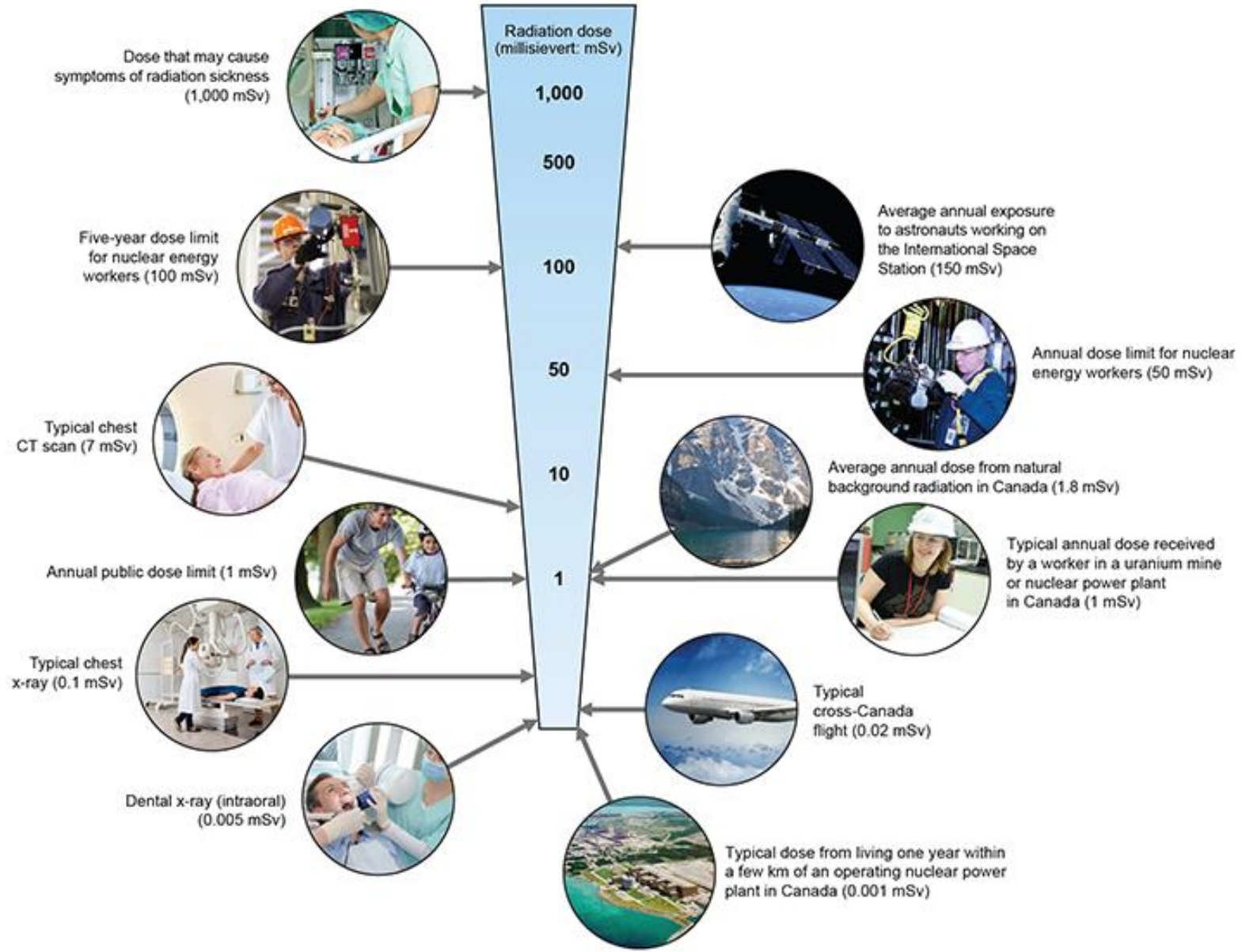


Radiation dose examples

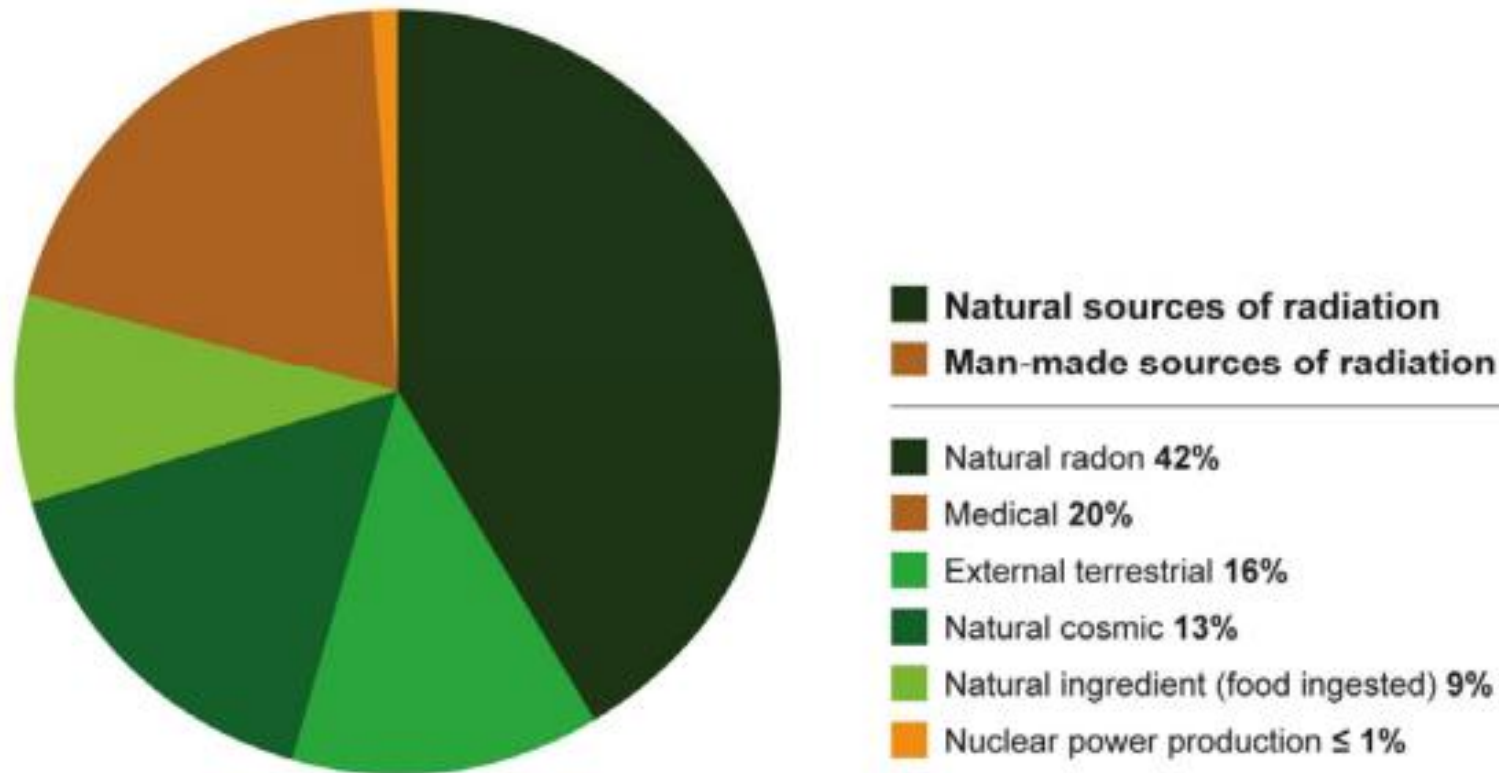


Radon from our perspective

Canada's Radon Levels



Sources of Radiation to Which an Individual is Exposed in Everyday Life – Total Dose: 3.0 mSv/year



Radon from our perspective

Geological Radon Potential



Radon from our perspective

Canada's Radon Levels

(based on our current COVID reality of spending 22/24 hours in a home)



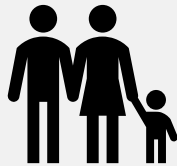
Person A

- Lives in a home at half the Canadian guideline level, or 100 Bq/m^3 .
- Has an effective dose of 2.67 mSv/year .



Person B

- Lives in a home right at the Canadian guideline level of 200 Bq/m^3 .
- Has an effective dose of 5.35 mSv/year .
- This is nearing the typical 7 mSv dose received during a chest CT scan.



Person C

- Lives in an average home in Dauphin, MB, at 557 Bq/m^3 .
- Has an effective dose of 14.9 mSv/year .

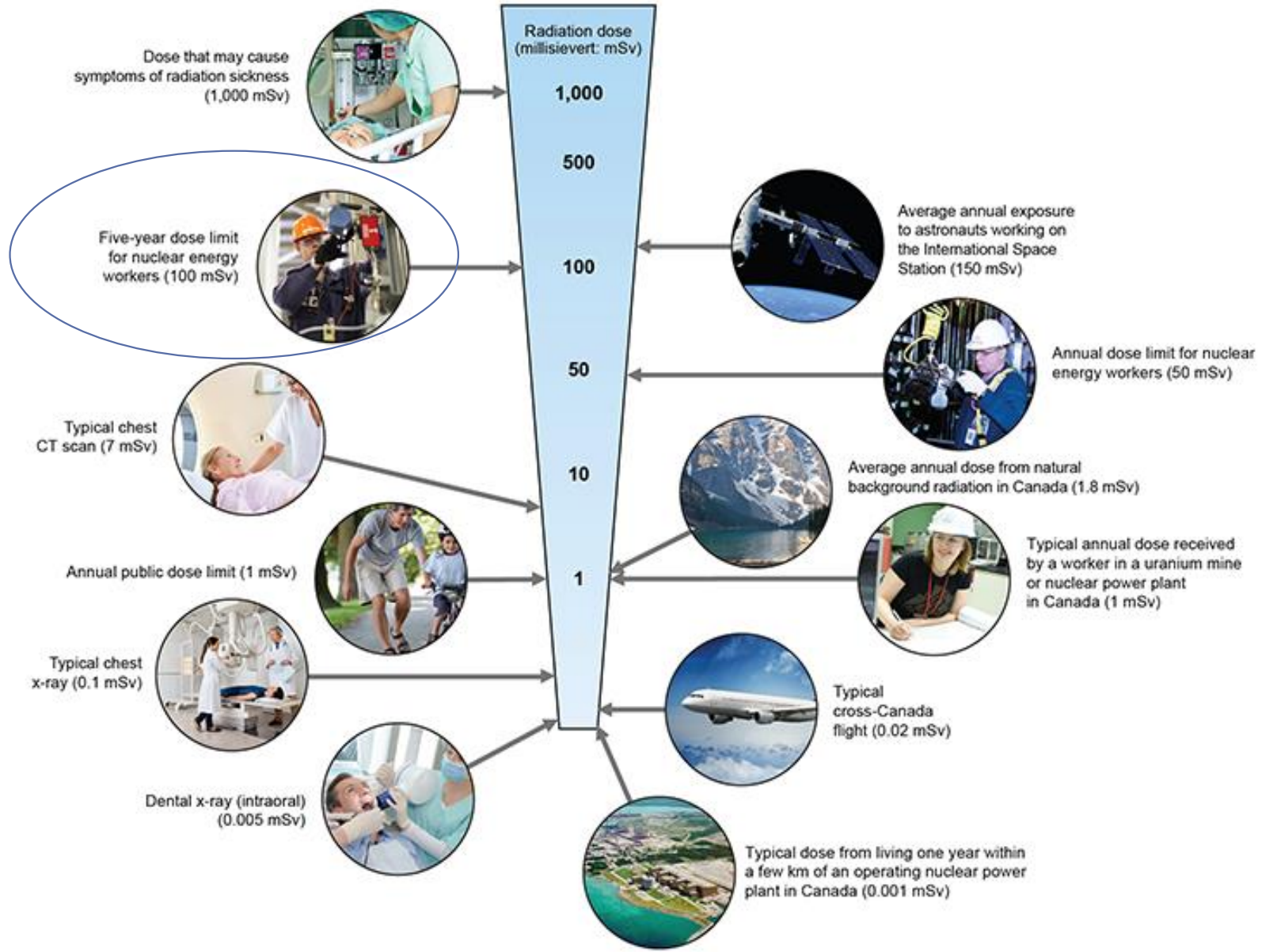
Person C's five-year dose ($14.9 \text{ mSv/year} \times 5 \text{ years} = 74.5 \text{ mSv}$), we see that, simply by virtue of where they happen to live (in a home with average radon levels for their town) this person is approaching the five-year dose limit for nuclear energy workers (100 mSv).

Radiation dose examples



Radon from our perspective

Canada's Radon Levels



Collaboration – A Canadian Success Story



Health
Canada Santé
Canada

- Represents, supports and assists radon professionals
- Provides outreach and awareness to all Canadians
- A certification program that establishes guidelines, standards of excellence and best practices
- Created National Radon Program and Survey
- Developed guidance on measurement and mitigation
- Established the C-NRPP
- Provides funding to C-NRPP
- Maintains communication and provides input on direction



Building a strong
Foundation

Collaboration



Building a strong
Foundation

Collaboration

TAKE ACTION ON RADON

A graphic element consisting of a black outline of a house roof. A blue maple leaf is positioned under the peak of the roof. Below the roofline is a purple radiation symbol (a circle with three curved lines radiating from the center).

National Stakeholder Program
funded by Health Canada

Recruit, motivate, engage and bring together stakeholders
to increase radon awareness

Motivate Canadians to take action to reduce radon and to
promote radon action month.

Collaboration – A Canadian Success Story

Government Organizations (Federal, Provincial/Territorial and Municipal)



Health-based Organizations



Other Industry Associations



Not-for-Profit Organizations



Private Sector Companies

Driving forces...

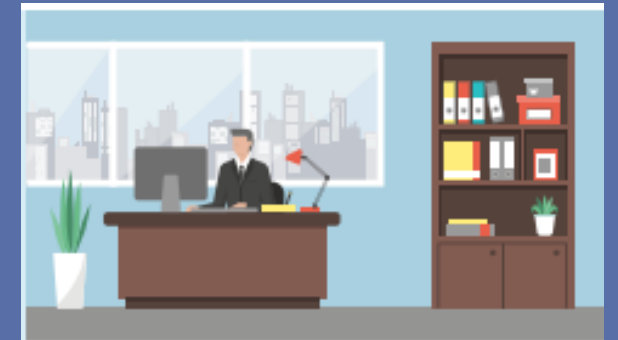
How do we protect Canadians? - **Workplaces**

Method:

- Legislation (limited)... Canadian Labour Code
- Reduce liability/Risk averse companies
- Strong health and safety policy/culture
- Strong union presence
- BOMA Best and LEEDS certification points



Building a strong
Foundation –
Measurement in
Workplaces



Driving forces...

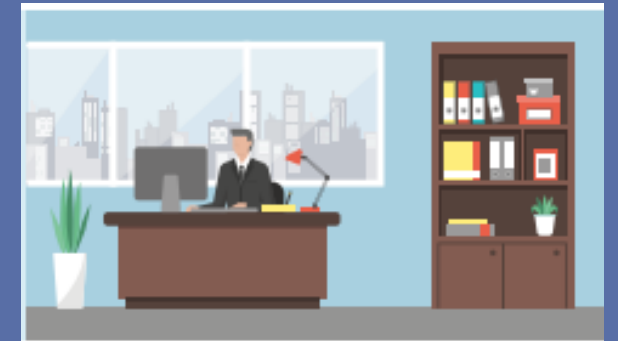
How do we protect Canadians? - **Workplaces**

Challenges:

- Lack of awareness
- Cost
- Deciding how to prioritize a large number of buildings
- Cooperation with employees, access to spaces or disappearing detectors



Building a strong
Foundation –
Measurement in
Workplaces





Building a strong
Foundation –
Measurement in
Homes



Driving forces...Why do Canadians care about radon? - **HOMES**

Motivations:

- Personal health
- Protect ones they love (Grandkids, children, pets)



Building a strong
Foundation –
Measurement in
Homes



Driving forces...Why do Canadians care about radon? - **HOMES**

Challenges:

- Lack of awareness
- Indifference
- Cost
- “If I have a high level then I’ll have to fix it”

Radon Guidelines and Standards



Reducing Radon Levels in Existing Homes: A Canadian Guide for Professional Contractors

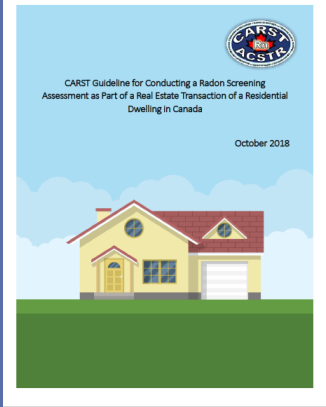
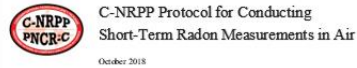


Guide for Radon Measurements in Public Buildings

(Workplaces, Schools, Day Cares, ...)



Guide for Radon Measurements in Residential Dwellings (Homes)



National Standard of Canada

Radon mitigation options for existing low-rise residential buildings

Canadian General Standards Board CGSB



CAN/CSG-149.11-2015 CD-01

Iss: 2015-07-10
149-149.11-2015
Comité des normes 149-CP-9

Radon control options for new construction in low rise residential dwellings

ICS 91.040.30

Document type: National Standard of Canada

Document stage: 40 - Approval

Warning

This document is not a National Standard of Canada. It is a draft distributed to CGSB committee members and other interested persons for review and comment. This draft is subject to change without notice and must not be referred to as a National Standard of Canada.

Recipients of this document are invited to submit their comments, to advise the CGSB committee of any relevant patent rights that they are aware of, and to provide supporting documentation. This information should be provided on or before 2015-09-12, to:

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Canadian General Standards Board
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Guidance Documents



Best Practices

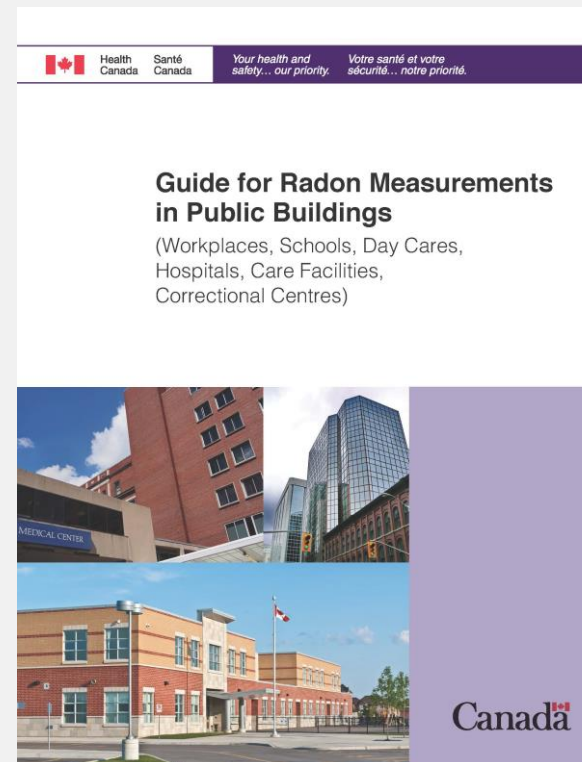
Standards



In 2010 Health Canada created our first mitigation guideline

Canadian Approach:

- A **design** process to address unique Canadian climate
- Priority on quiet, energy efficient systems
- Priority on reducing radon levels to as low as possible



Canadian Mitigation

Reducing Radon



Canadian Mitigation

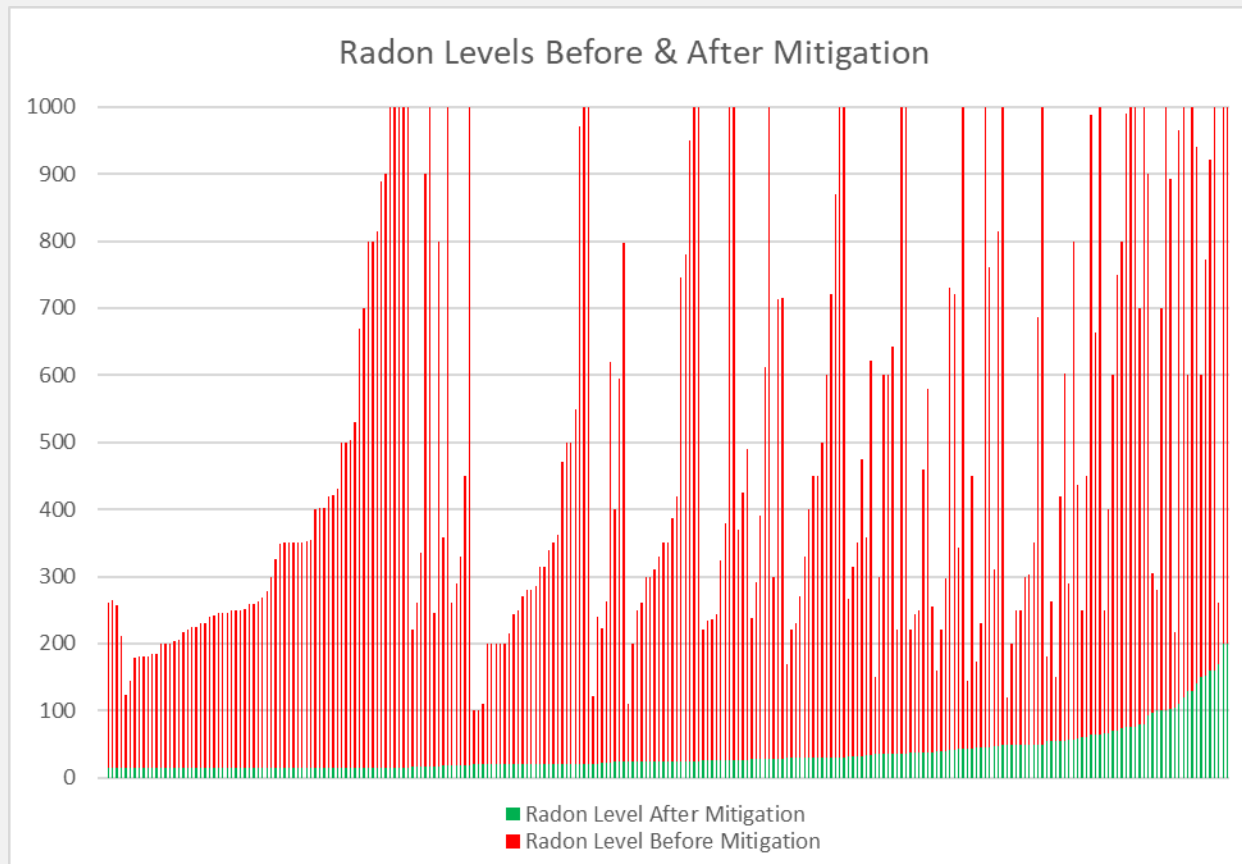
Region	# of Entries	Highest Radon Level	Average Post Mitigation Radon Level	Average % of Reduction
<i>BC and Yukon</i>	<i>26</i>	<i>1800</i>	<i>49</i>	<i>92.0</i>
<i>Alberta and NWT</i>	<i>165</i>	<i>2281</i>	<i>26</i>	<i>91.0</i>
<i>MB/SK</i>	<i>94</i>	<i>3700</i>	<i>42</i>	<i>91.3</i>
<i>ON</i>	<i>24</i>	<i>1500</i>	<i>57</i>	<i>90.4</i>
<i>QC</i>	<i>25</i>	<i>1200</i>	<i>29</i>	<i>91.9</i>
<i>Atlantic & Nunavut</i>	<i>23</i>	<i>1765</i>	<i>39</i>	<i>91.5</i>
	357	3700	35	91.2

Data from CARST Radon Sweepstakes mitigation program



Canadian Mitigation





Data from CARST Radon Sweepstakes mitigation program



Canadian Mitigation





Building a strong
Foundation –
Measurement in
Homes



Win a rebate of up to **\$1000**
towards the cost of reducing the
high radon level in your home.



10 prizes of \$1000 are available.

The National Building Code addresses radon

- Gravel under the slab
- Sealed sump pit
- Well-sealed liner
- Radon rough-in for future installation



New Construction

Comparison of Consumer-Grade Electronic Radon Monitors

- Growing in Popularity among homeowners
- Quick results
- Continual reminder
- Useful for pre-mitigation testing
- Useful for monitoring effectiveness of mitigation systems in maintaining low radon levels
- Library Loan Programs



Digital Radon Monitors





Digital Radon Monitors

We exposed 5 different types of devices controlled environment

Purpose: to evaluate their precision and accuracy

Manufacturer's Name	Device Name	Radon Sampling Method	Detection Method
Airthings AS	2900 Wave	Passive diffusion chamber	Alpha spectrometry
Airthings	Wave Plus	Passive diffusion chamber	Alpha spectrometry
Corentium	Home	Passive diffusion chamber	Alpha spectrometry
Safety Siren	Pro Series 3		Ionization Chamber
Radon Eye	Radon Eye Plus		Pulsed ion chamber
Radon Eye	Radon Eye RD200		pulsed ion chamber



Radiation Safety Institute of Canada's radon chamber, Saskatoon, SK

Chosen exposures:

1. **Round 1 – Radon Chamber**
 - a. Radon concentration: 200 Bq/m³
 - b. Temperature: 18-22° C
 - c. Humidity: 20-50% RH
 - d. Duration: 7 days
2. **Round 2 – Radon Chamber**
 - a. Radon concentration: 200 Bq/m³
 - b. Temperature: 30° C
 - c. Humidity: 70% RH
 - d. Duration: 7 days
3. **Round 3 – Radon Chamber**
 - a. Radon concentration: 400 Bq/m³
 - b. Temperature: 18-22° C
 - c. Humidity: 20-50% RH
 - d. Duration: 7 days
4. **Round 4 – Radon Chamber**
 - a. Radon concentration: 1000 Bq/m³
 - b. Temperature: 18-22° C
 - c. Humidity: 20-50% RH
 - d. Duration: 7 days



Digital Radon Monitors





Digital Radon Monitors



Methodology is based on Public Health England's Intercomparison of Passive Radon Detectors

Accuracy – Relative Percent Error between the average radon monitor radon concentration and radon chamber reference radon gas concentration

Accuracy

$$\text{Relative Percent Error (\%)} = \frac{(\text{Measured Mean} - \text{Reference Value})}{\text{Reference Value}} \times 100\%$$

10



Digital Radon Monitors



Precision – Relative Standard Deviation for the results measured for each model of individual radon monitor tested

Precision

$$\text{Relative Standard Deviation (\%)} = \frac{\text{Standard Deviation}}{\text{Measured Mean}} \times 100\%$$

10



Digital Radon Monitors



Measurement Error

Measurement Error (%)

$$= \sqrt{(\text{Relative Percent Error})^2 + (\text{Relative Standard Deviation})^2}$$

10

In an attempt to provide an easily accessible format for evaluation by consumers, the devices were given a grade based on their performance during each of the test exposure conditions.

Radon Monitor Performance Classification Grade

Measurement Error (%)	Performance Grade
≤ 10	A
> 10 and ≤ 20	B
> 20 and ≤ 30	C
> 30 and ≤ 40	D
> 40	E

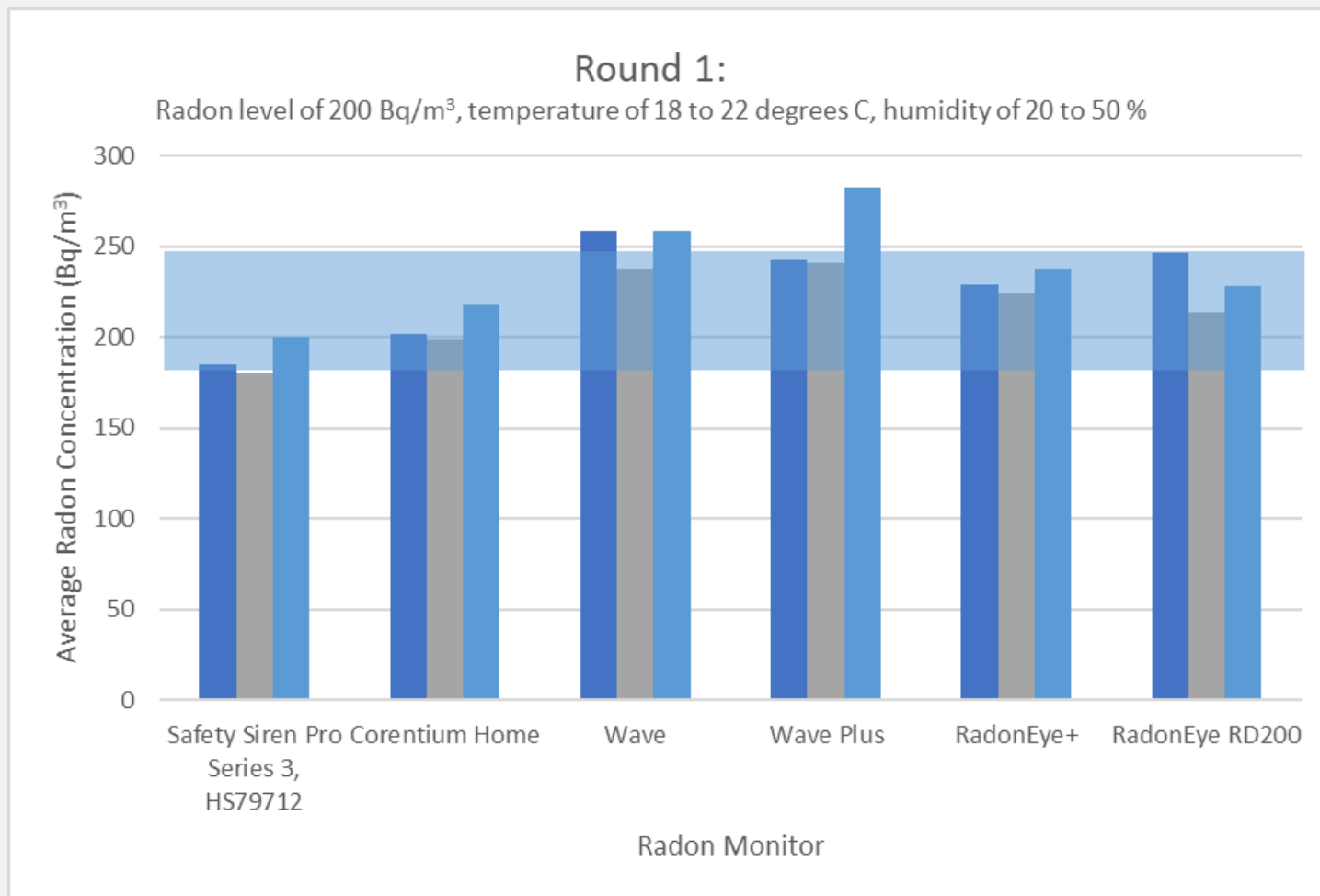


Digital Radon Monitors

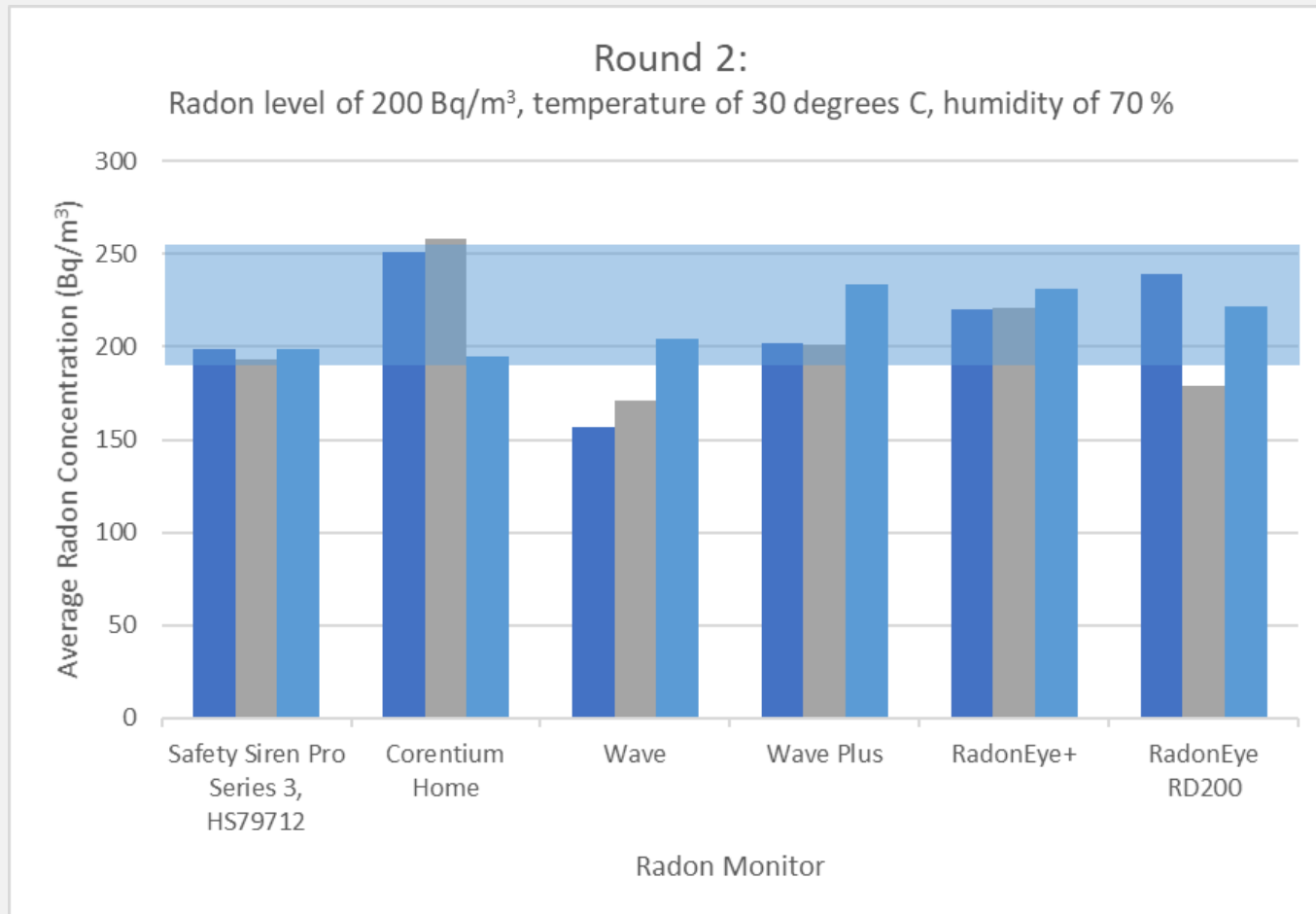




Digital Radon Monitors



Manufacturer's Name	Device Name	Accuracy Grade for Round 1
Safety Siren	Pro Series 3	B
Airthings	Corentium Home	A
Airthings	2900 Wave	C
Airthings	Wave Plus	C
Radon Eye	Radon Eye Plus	B
Radon Eye	Radon Eye RD200	B

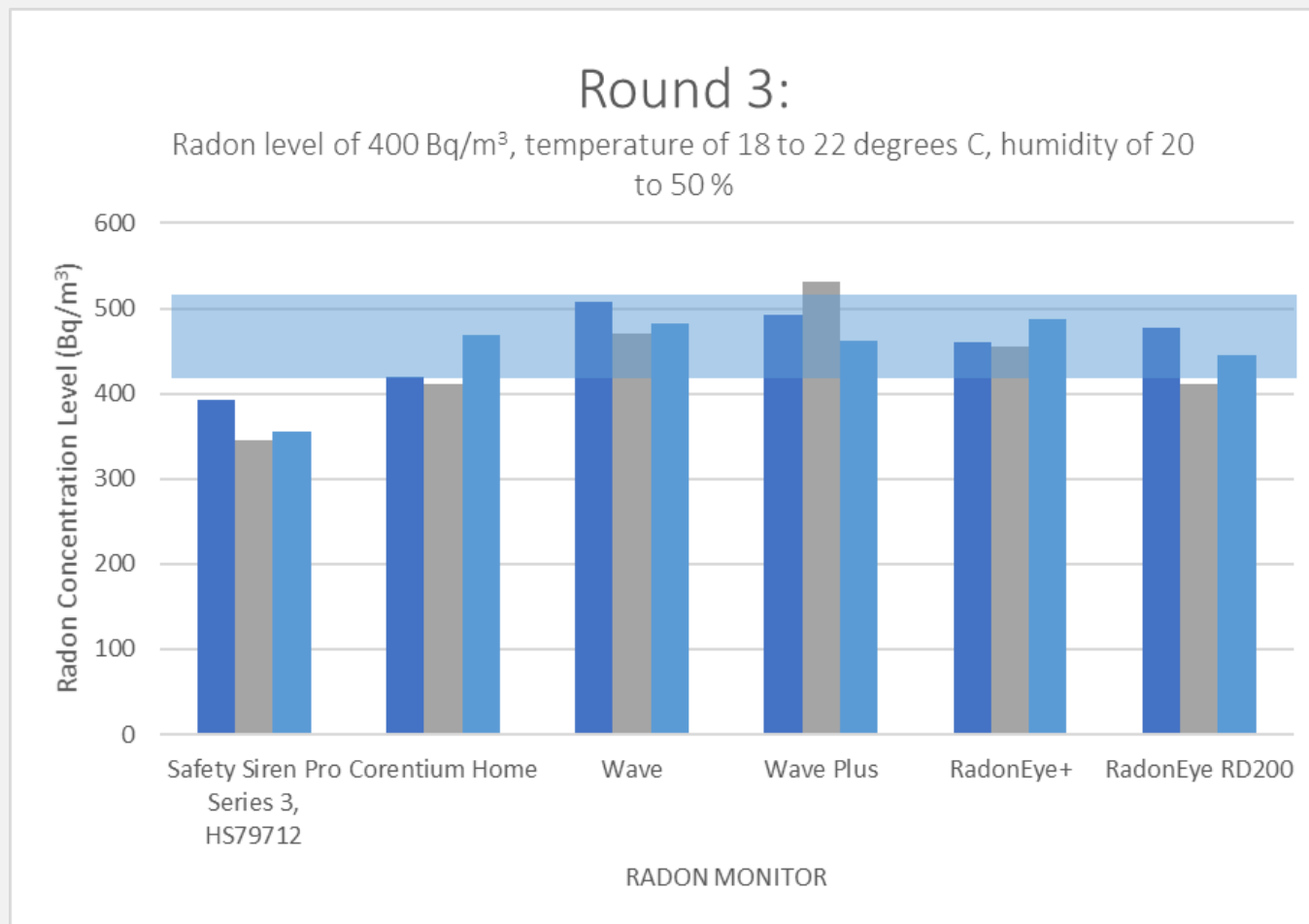


Digital Radon Monitors

Manufacturer's Name	Device Name	Accuracy Grade for Round 2
Safety Siren	Pro Series 3	A
Airthings	Corentium Home	B
Airthings AS	2900 Wave	C
Airthings	Wave Plus	A
Radon Eye	Radon Eye Plus	A
Radon Eye	Radon Eye RD200	B



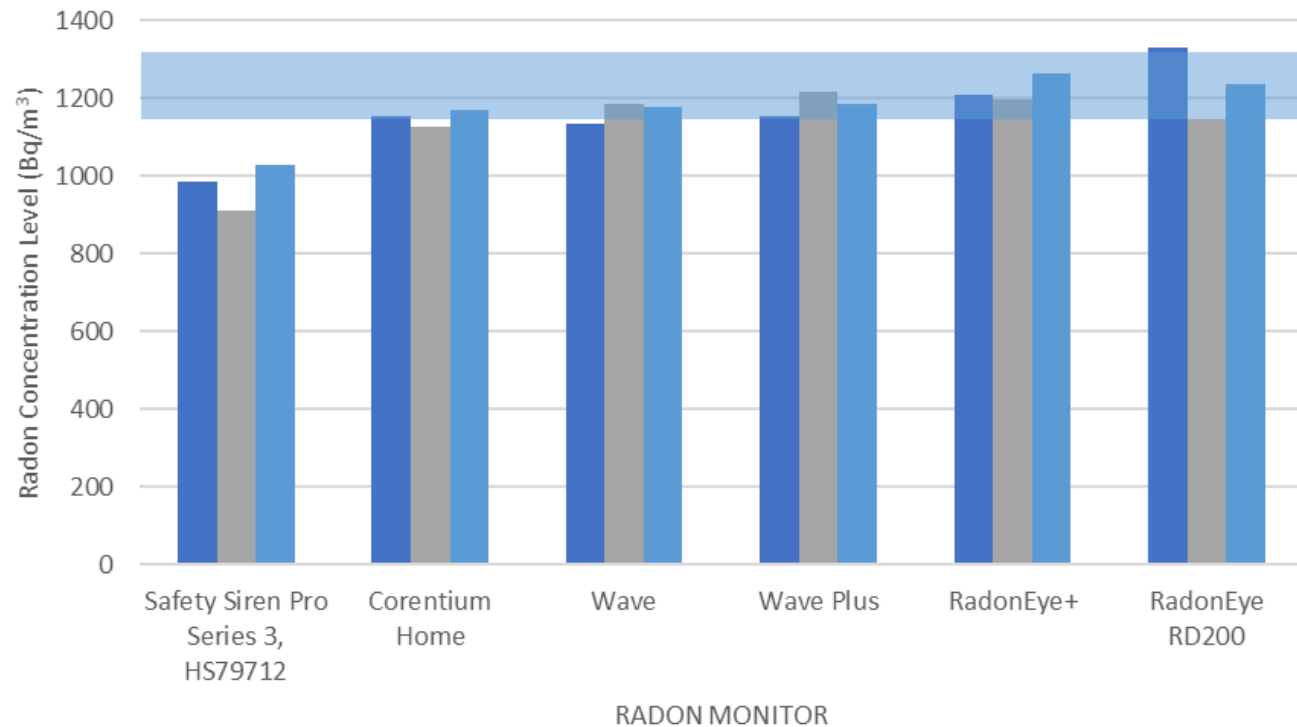
Digital Radon Monitors



Manufacturer's Name	Device Name	Accuracy Grade for Round 3
Safety Siren	Pro Series 3	B
Airthings	Corentium Home	A
Airthings AS	2900 Wave	B
Airthings	Wave Plus	C
Radon Eye	Radon Eye Plus	B
Radon Eye	Radon Eye RD200	B

Round 4:

Radon level of 1000 Bq/m³, temperature of 18 to 22 degrees C, humidity of 20 to 50 %

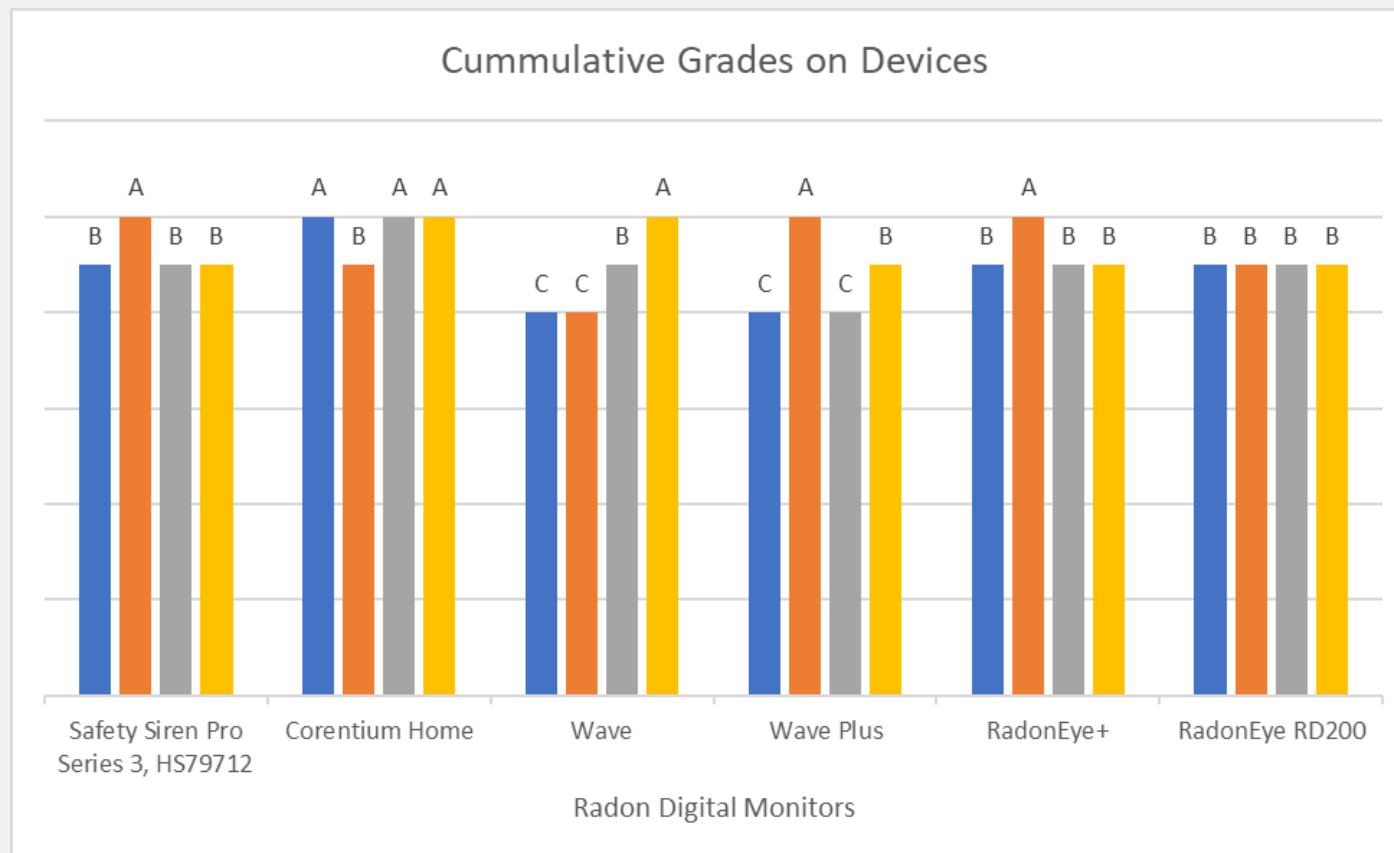


Digital Radon Monitors

Manufacturer's Name	Device Name	Accuracy Grade for Round 4
Safety Siren	Pro Series 3	B
Airthings	Corentium Home	A
Airthings	2900 Wave	A
Airthings	Wave Plus	B
Radon Eye	Radon Eye Plus	B
Radon Eye	Radon Eye RD200	B



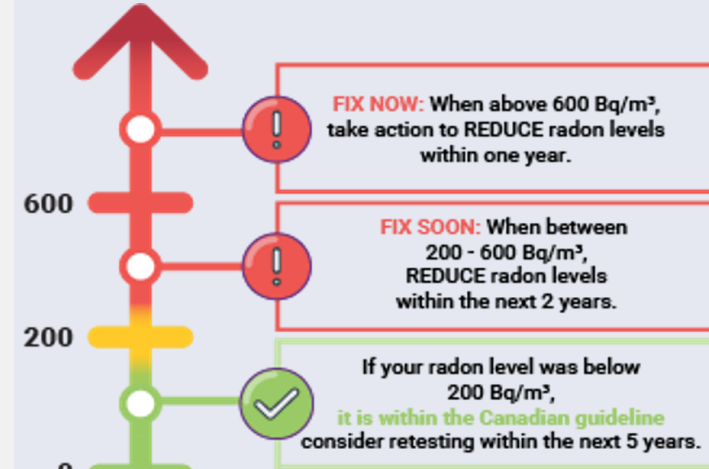
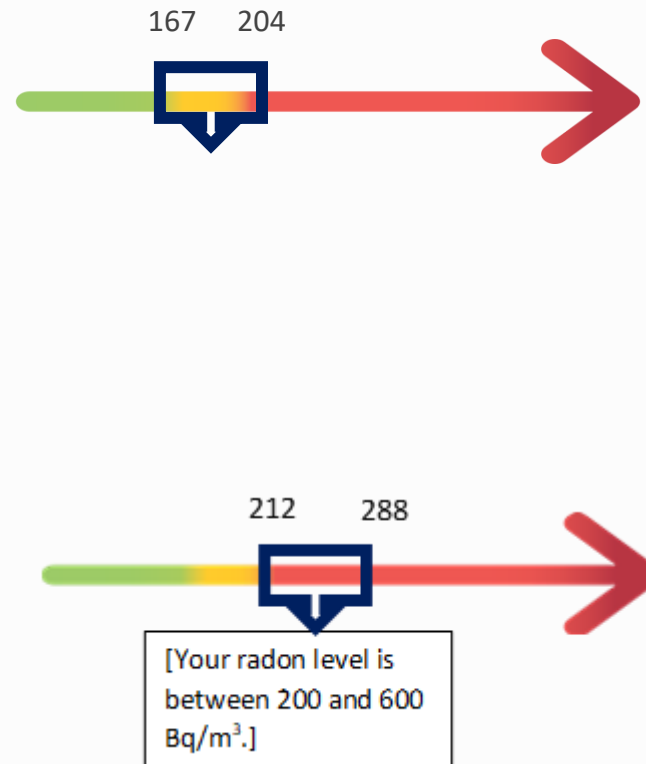
Digital Radon Monitors



Limitations of Digital Radon Monitors

Margin of Error

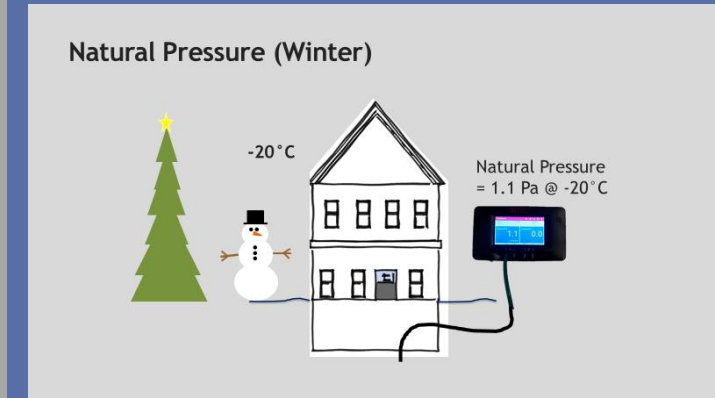
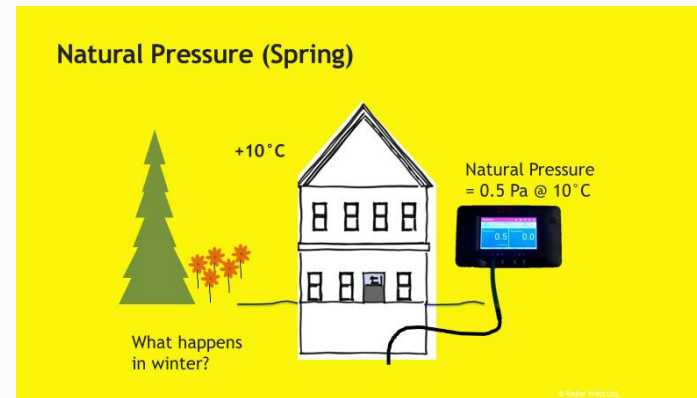
- passive device labs produce a radon report which include a statements on the report to disclose the degree of variance; radon monitors provide an instant read out but no indication of variance
- For example: 185 Bq/m³
 - Grade of A, radon level is between 166.5 Bq/m³ and 203.5 Bq/m³.



Limitations of Digital Radon Monitors

Fluctuation of Radon Levels

- it is the average annual exposure level that is a concern.
- Health Canada recommends basing a decision to mitigate a home on a long-term radon level which is determined by testing for 91-days or more and it is this level that should be considered and compared to Canada's Radon Guideline level when making decisions.



Thank you....Questions?

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