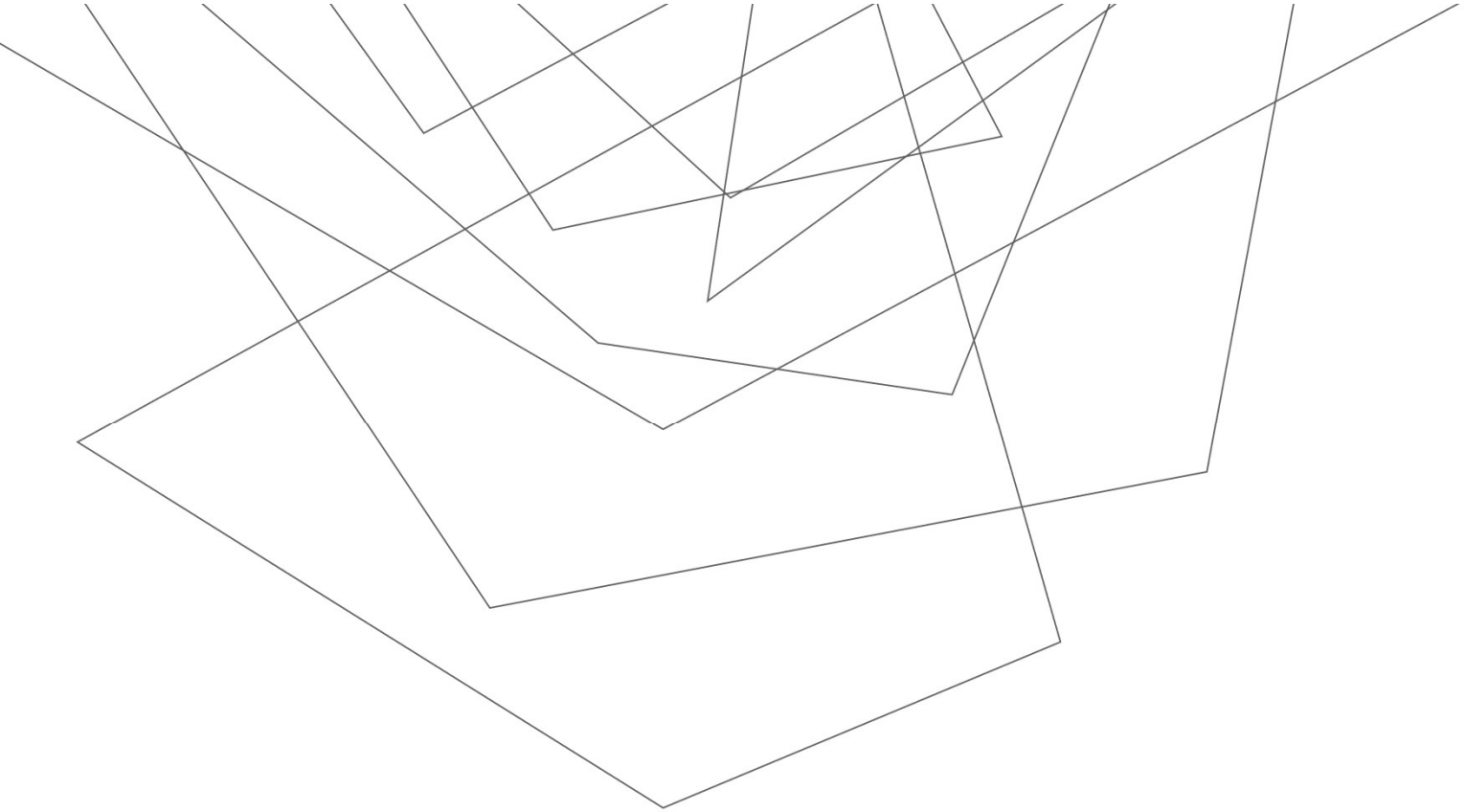


Let's Talk RadonX

Cory Norman, P.Eng.

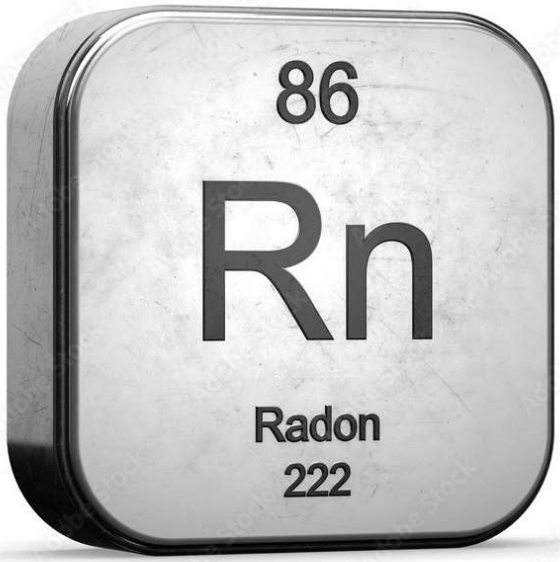
Agenda

Radon 101

Code
“Requirements”

Mitigation Methods

Radon 101



What is Radon?

- Radon, referring to radionuclide (^{222}Rn), is a gas that is undetectable by human senses
  - it is **tasteless**, **colorless** and **odorless**

- Radon is a naturally occurring radioactive gas that is produced by the **radioactive decay** of uranium

- Radon gas is present in **all** soil and rock types
  - Also referred to as a 'soil gas'

Health Effects of Radon

- Radon is radioactive and unstable – it decays and **emits alpha particle** radiation which severely damages DNA

- Radon has been classified as a **Category 1 Class A Carcinogen**

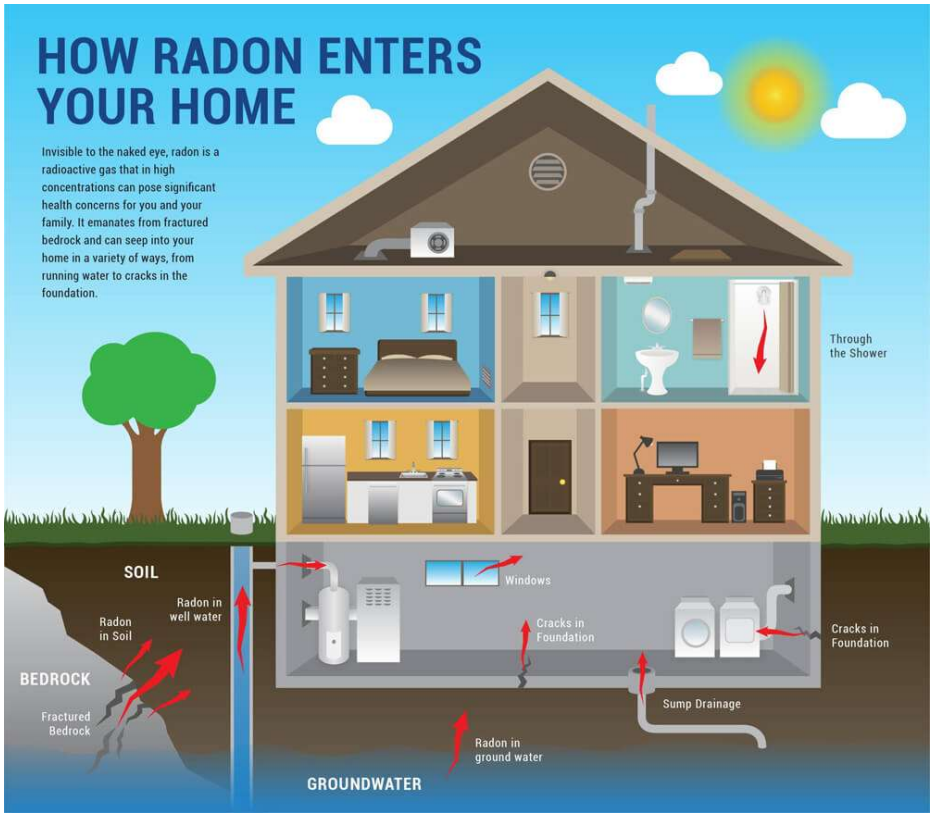
- Radon is the **second leading** cause of lung cancer after *smoking*, accounting for **16%** of lung cancer diagnosis
    - More than 3,000 people die annually from radon-induced lung cancer in Canada

Reference: Radon Reduction Guide for Canadians, Health Canada

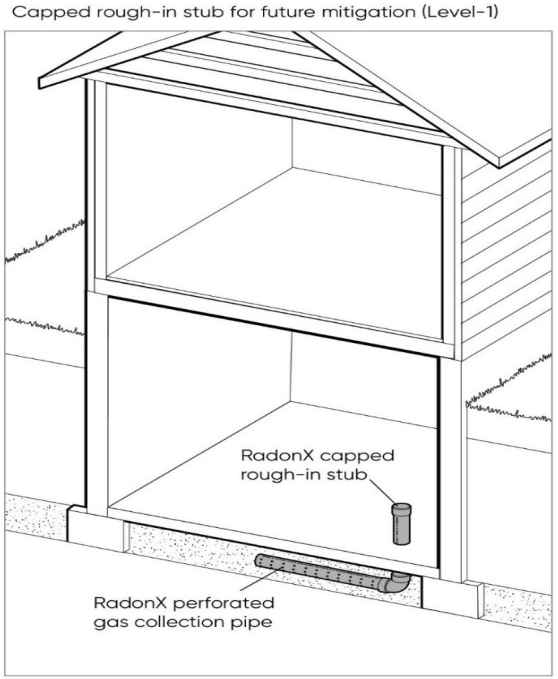
Radon Entryways in a Dwelling

- Radon can move through the soil and enter the dwelling through various openings:
  - Basement windows
  - Floor drains/sump pits
  - Cracks in foundation walls and floor slabs
  - Construction joints
  - Foundation wall to floor slab joint
  - Gaps around service pipes and/or support posts
  - Well water supply (where applicable)

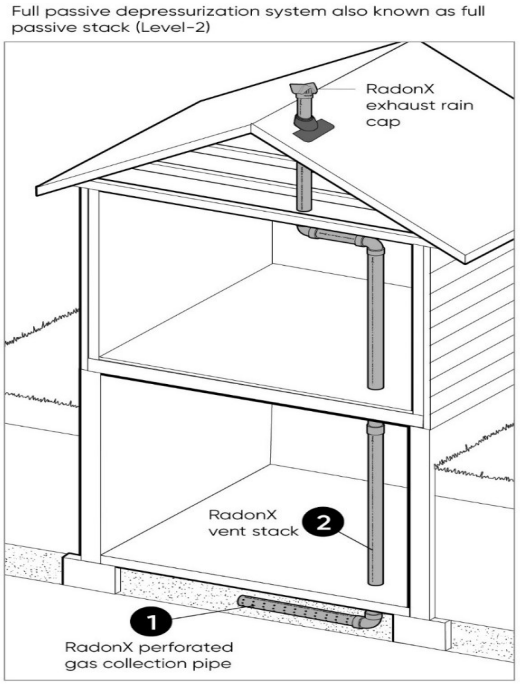
- The air pressure inside a dwelling is generally lower than the surrounding air and soil, especially in lower foundational levels in contact with the ground
  - This **ΔP** causes the dwelling to act like a **vacuum**, pulling in soil gases through any existing openings



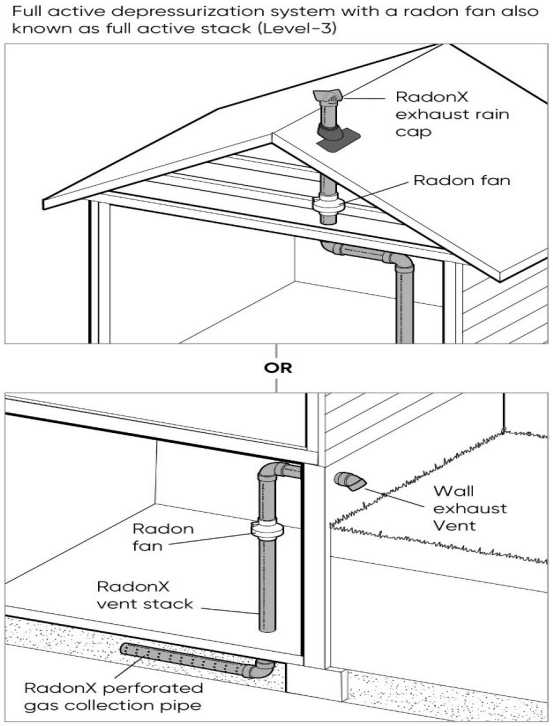
Levels of Mitigation



Level 1 – Capped Rough-In



Level 2 – Full Passive Stack



Level 3 – Active Stack

Measuring Radon Levels

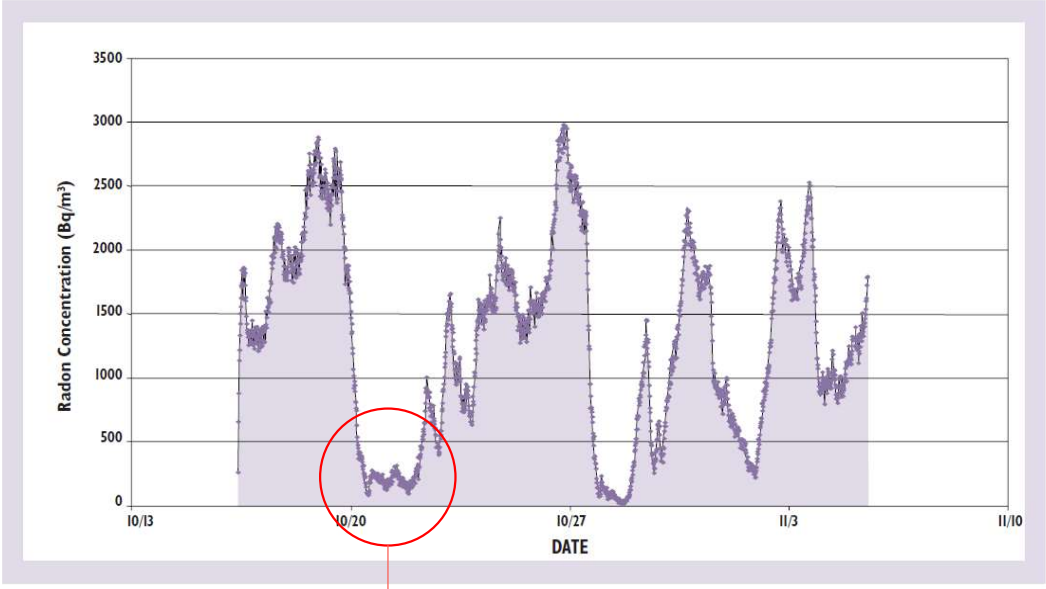
- There is no way to identify the expected radon levels in a home or building prior to construction, **radon testing after occupation** is the only way to quantify radon levels

- Radon test kits come in various forms:
  - Available at most home improvements stores, municipalities, or non-profit organizations
  - Short term (3-7 days) or long term (3-12 months)
  - Health Canada recommends continuous measurements taken over a 3-month interval – normally done in the winter months (doors/windows mainly closed) using a certified device

Quantifying Radon - Units of Measure

- Radon gas concentration is measured in units of Becquerels per cubic metre – **Bq/m³**
  - 1 Bq/m³ is equivalent to *1 alpha particle* being released per cubic meter of air

- Several factors influence radon concentration, including:
  - Severe weather (high winds, heavy rainfall etc.)
  - Home's air exhaust devices (bathroom fans, heaters, furnaces etc.)
  - Pressure differences between interior/exterior of home



Acceptable Indoor Levels of Radon

- No amount of radon gas concentration is recommended in homes or buildings – **unrealistic**

- Health Canada has developed a guideline for **radon in indoor** air for dwellings to be a maximum of **200 Bq/m³**
  - Before 2007, this guideline was 800 Bq/m³ but was reduced after new scientific information was released at the time
  - As a reference, the average outdoor concentration of radon in Canada is **10 Bq/m³**

World Health Organization

100 Bq/m³

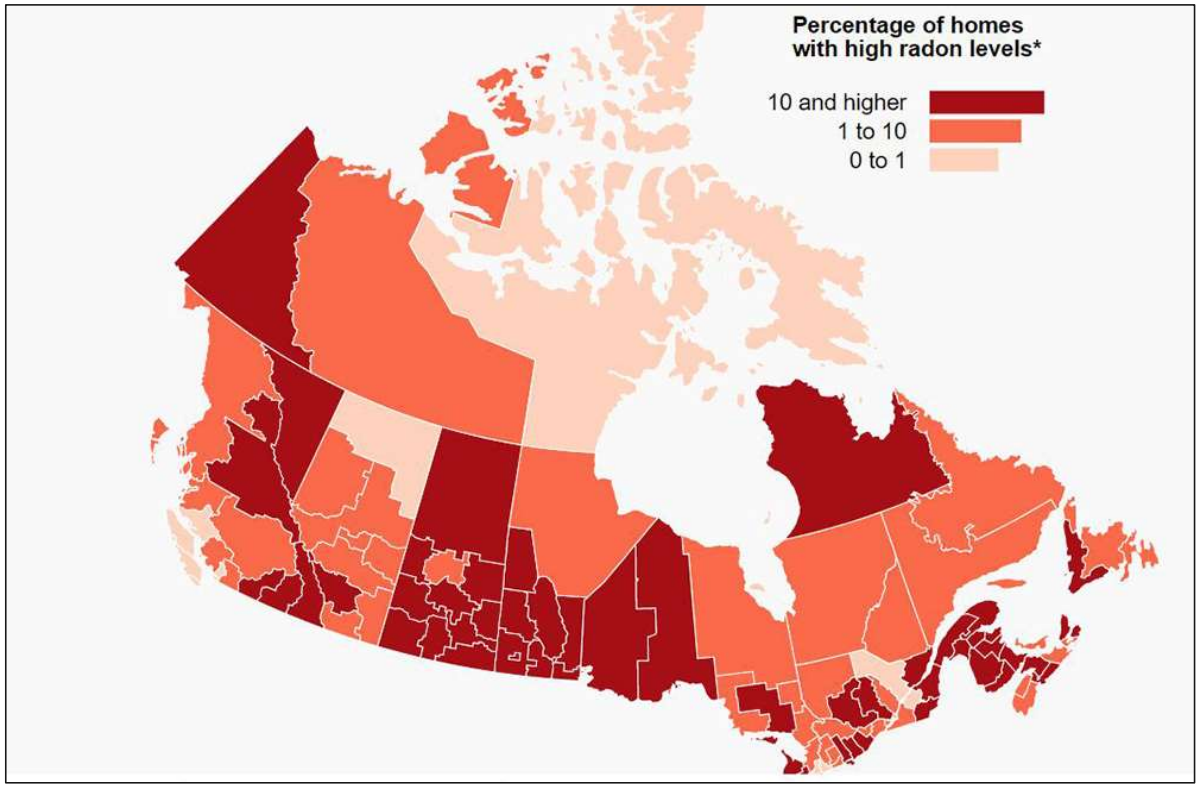
200 Bq/m³

150 Bq/m³

200 Bq/m³

Nationwide Perspective

All homes in Canada have some amount of radon gas.



Map produced by Radiation Protection Bureau, Health Canada, 2019.

Provincial Perspective

British Columbia:

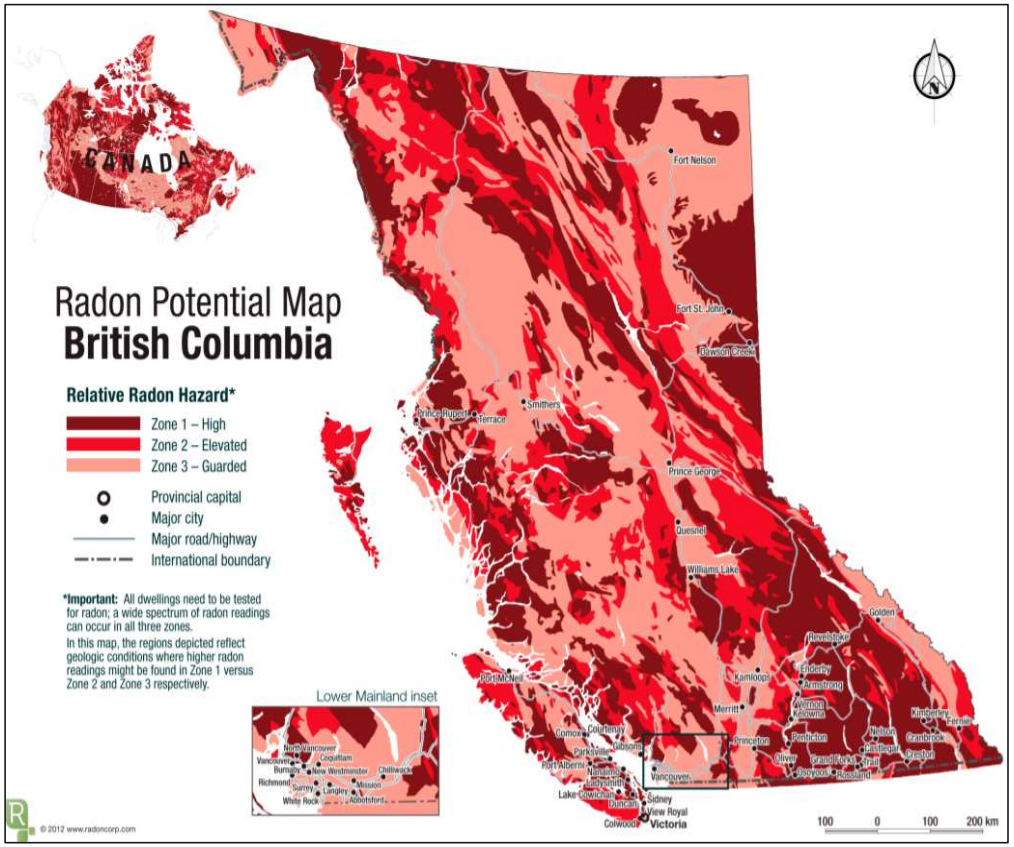
BCBC 2018

- Regional map dictates where mitigation systems are exempt.

BCBC 2024

- Proposal to remove BC map and harmonize with NBC.
- Open to public comment until July.

*Provincial Building Codes (BC, ON, and QC) could differ from National Building Codes



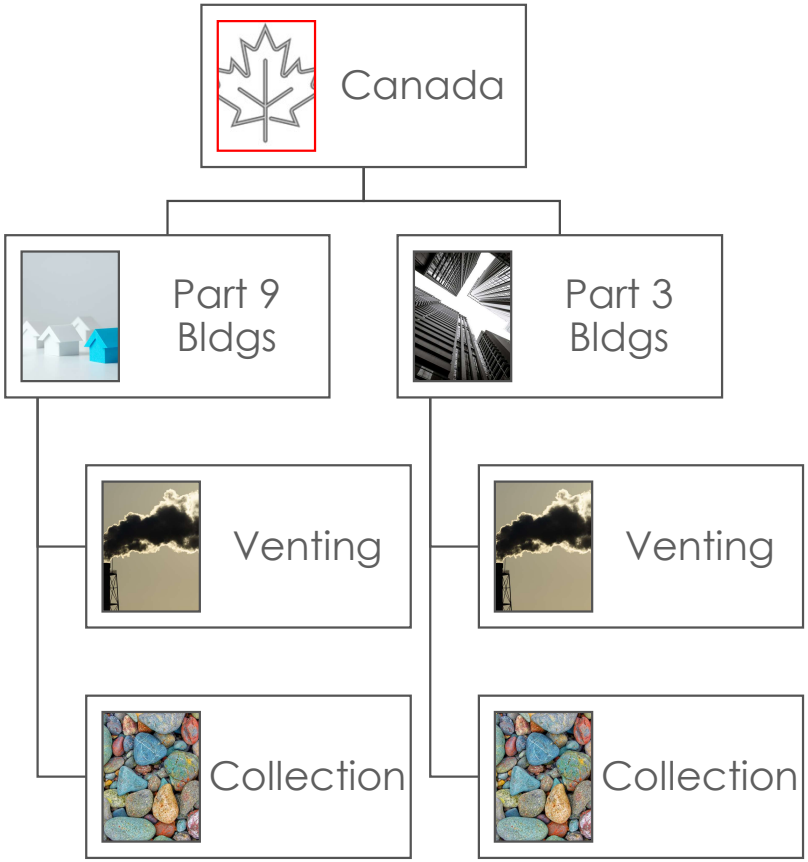
*Source:*http://www.radonaware.ca/database/files/library/British_Columbia_Radon_Potential_Map.pdf / Note / Reference doc*

Radon Mitigation
New & Existing Construction

- The most common and effective radon reduction method is called **sub-slab depressurization.**
- A sub-slab depressurization system is designed to achieve a lower sub-slab air pressure relative to indoor air pressure, either through a passive or active (fan-powered) system.

Code Requirements

Radon Application Roadmap



2024 BCBC: What Does it Say

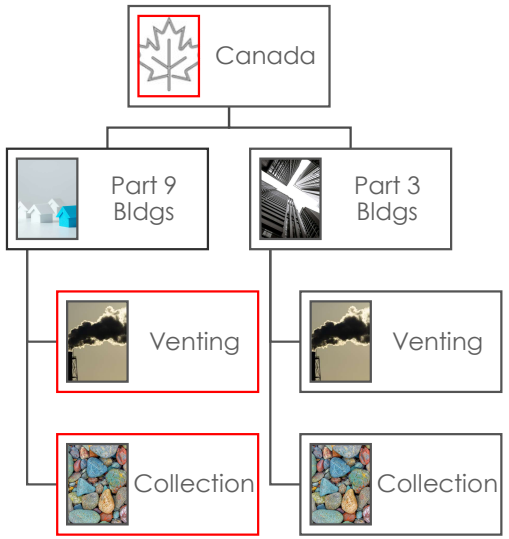
9.13.4.2. Protection from Soil Gas Ingress

1) All wall, roof and floor assemblies, or parts thereof, separating *conditioned space* from the ground shall be protected by an *air barrier system* conforming to Subsection 9.25.3.

2) Unless the space between the *air barrier system* and the ground is designed to be accessible for the future installation of a subfloor depressurization system, *buildings* shall

a) be provided with the rough-in for a radon extraction system conforming to Article 9.13.4.3., or

b) conform to Parts 5 and 6 for the protection from radon ingress and the means to address high radon concentrations in the future (see Articles 5.4.1.1. and 6.2.1.1.).



2024 BCBC: What Does it Say

5.4.1.1. and 6.2.1.1.).

5.4.1.1. Required Resistance to Air Leakage

(See Note A-5.4.1.1.)

1) Where a *building* component or assembly separates interior *conditioned space* from exterior space, interior space from the ground, or environmentally dissimilar interior spaces, the properties and position of the materials and components in those components or assemblies shall be such that they control air leakage or permit venting to the exterior so as to

a) provide acceptable conditions for the *building* occupants,

b) maintain appropriate conditions for the intended use of the *building*,

c) minimize the accumulation of condensation in and the penetration of precipitation into the *building* component or assembly,

d) control heat transfer to roofs where ice damming can occur,

e) minimize the ingress of airborne radon from the ground with an aim to controlling the indoor radon concentration to an acceptable level, and

f) not compromise the operation of *building* services.

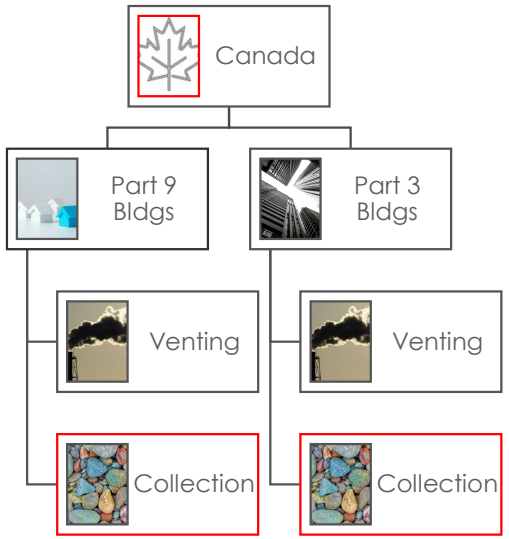
2) Except as provided in Sentence (3), an *air barrier system* shall be installed to provide the principal resistance to air leakage.

3) An *air barrier system* is not required where it can be shown that uncontrolled air leakage will not adversely affect any of

a) the health or safety of *building* users,

b) the intended use of the *building*, or

c) the operation of *building* services.



2024 BCBC: What Does it Say

5.4.1.1. and 6.2.1.1.).

6.2.1.1. Good Engineering Practice

(See Note A-6.2.1.1.)

1) Heating, ventilating and air-conditioning systems, including mechanical refrigeration equipment, shall be designed, constructed and installed in conformance with good engineering practice such as that described in, but not limited to,

a) the ASHRAE Handbooks and Standards,

b) the HRAI Digest,

c) the Hydronics Institute Manuals,

d) the NFPA Standards,

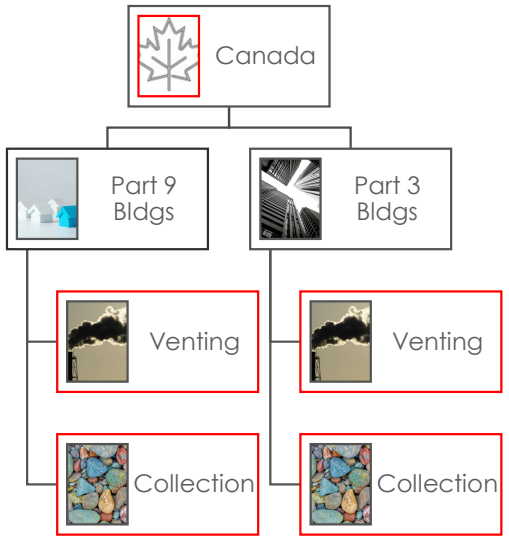
e) the SMACNA Manuals,

f) the Industrial Ventilation Manual published by the ACGIH,

g) CSA B214, "Installation Code for Hydronic Heating Systems,"

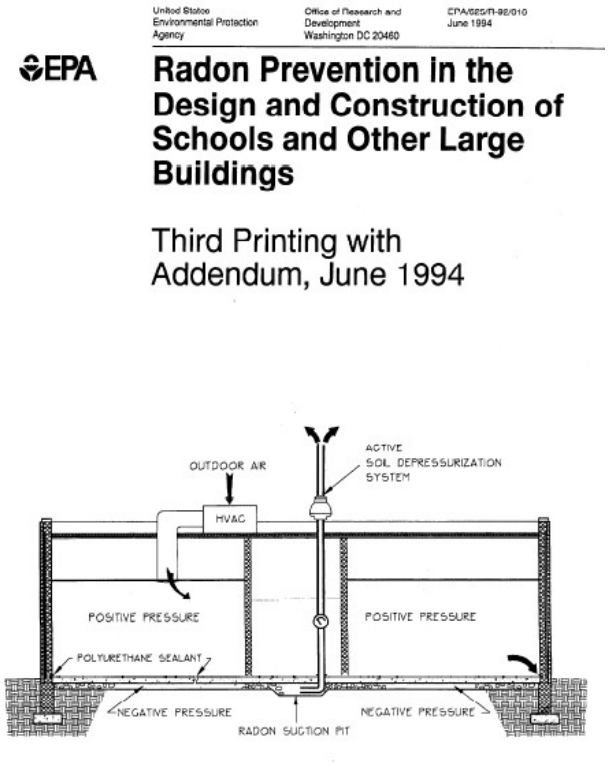
h) CAN/CSA-Z317.2, "Special Requirements for Heating, Ventilation, and Air-Conditioning (HVAC) Systems in Health Care Facilities," and

i) EPA 625/R-92/016, "Radon Prevention in the Design and Construction of Schools and Other Large Buildings."



EPA 625-Radon Prevention in the Design and Construction of Schools and Other Large Buildings

- Level 2 passive systems and building pressurization are NOT recommended in large buildings.
- Air barriers are effective and recommended to be used with other mitigation methods.
- Promotes 4”-6” gas permeable aggregate layer with a centrally located 4’x4’x8” suction pit and 6” dia vent pipe.
- Insulation of vent pipe to prevent condensation helps avoid condensation problems.



2024 BCBC: What Does it Say

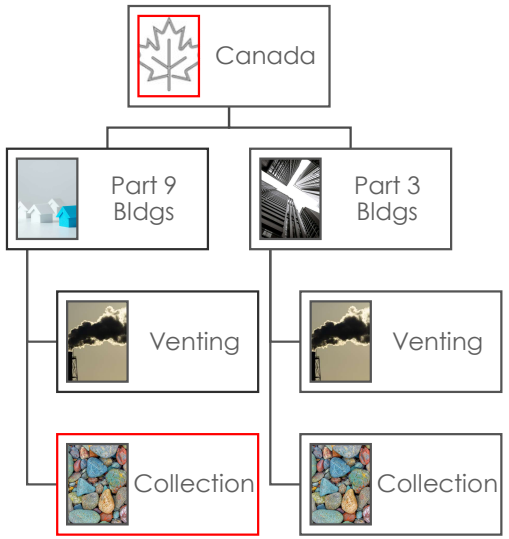
9.13.4.3. Rough-in for a Subfloor Depressurization System

(See Note A-9.13.4.3.)

1) Floors-on-ground shall accommodate the future installation of a subfloor depressurization system by installing a radon vent pipe, and a contiguous gas-permeable layer between the *air barrier system* and the ground consisting of

a) a material or materials that allow effective depressurization of that space (see Sentence 9.16.2.1.(1)), or

b) not less than 100 mm of coarse clean granular material containing not more than 10% of material that would pass a 4 mm sieve.



2024 BCBC: What Does it Say

9.13.4.3. Rough-in for a Subfloor Depressurization System

(See Note A-9.13.4.3.)

2) The radon vent pipe required by Sentence(1) shall

a) be sealed to maintain the integrity of the *air barrier system*, with no perforations along the pipe above the *air barrier system*,"

b) have one or more inlets that allow for the effective depressurization of the gas-permeable layer (See Note A-9.13.4.3.(2)(b) and (3)(b)), and

c) permit connection to depressurization equipment,

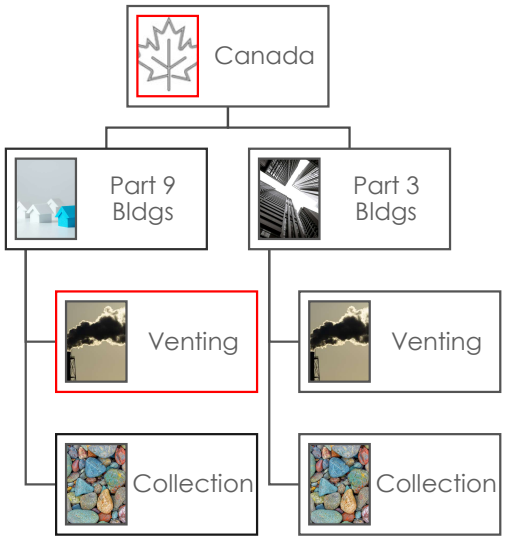
d) where it passes through *conditioned space*, wholly located in the *conditioned space*,

e) consist of pipe and fittings in accordance with 7.1.3 of CAN/CGSB-149.11, "Radon control options for new construction in low-rise residential buildings,"

f) terminate outside the *building* in a manner that does not constitute a hazard,

g) be installed to prevent the accumulation of moisture and away from locations where snow and ice accumulate, and

h) be clearly labeled every 1.8 m and at every change in direction to indicate that it is intended only for the removal of radon from below the floor-on-ground.



CAN/CGSB 149.11-2019

Section 7.1.3. – Pipe & Fittings

- Pipes must be certified to one of the following:
  - ASTM F628 (cellular core ABS)
  - ASTM F891 (cellular core PVC)
  - CSA B181.1 (solid wall ABS)
  - CSA B182.1 and be SDR35 (BDS/Drain tile PVC)
  - ULC S636 (flue gas venting)
- Nominal ID not less than 4".
- PVC vent pipes must comply with Schedule 40 specs.
- Radon pipe should have a different color or identifying markings than DWV piping.

2024 BCBC: What Does it Say

9.13.4.3. Rough-in for a Subfloor Depressurization System

(See Note A-9.13.4.3.)

2) The radon vent pipe required by Sentence(1) shall

a) be sealed to maintain the integrity of the *air barrier system*, with no perforations along the pipe above the *air barrier system*,"

b) have one or more inlets that allow for the effective depressurization of the gas-permeable layer (See Note A-9.13.4.3.(2)(b) and (3)(b)), and

c) permit connection to depressurization equipment,

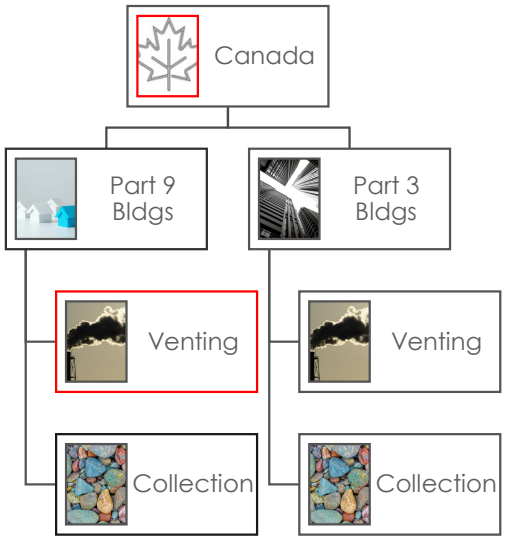
d) where it passes through *conditioned space*, wholly located in the *conditioned space*,

e) consist of pipe and fittings in accordance with 7.1.3 of CAN/CGSB-149.11, "Radon control options for new construction in low-rise residential buildings,"

f) terminate outside the *building* in a manner that does not constitute a hazard,

g) be installed to prevent the accumulation of moisture and away from locations where snow and ice accumulate, and

h) be clearly labeled every 1.8 m and at every change in direction to indicate that it is intended only for the removal of radon from below the floor-on-ground.



2024 BCBC: What Does it Say

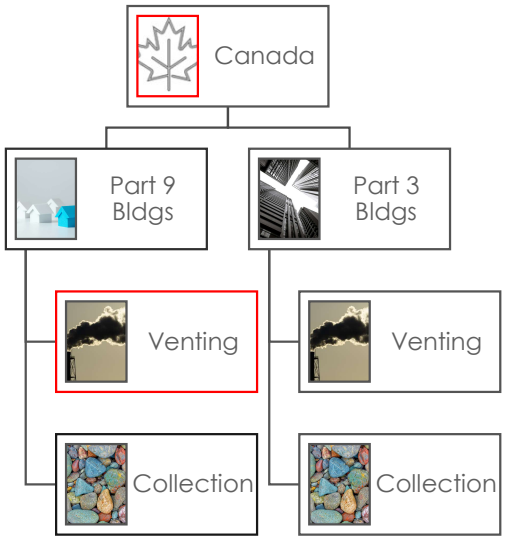
9.13.4.3. Rough-in for a Subfloor Depressurization System

(See Note A-9.13.4.3.)

3) A radon vent pipe shall be deemed to comply with

a) Clause (2)(b) where its inlet or inlets below the *air barrier system* are located at or near the centre of the floor-on-ground with gas-permeable material extending not less than 100 mm beyond any inlet, and, and

b) Clause (2)(f) where it terminates outside the *building*, not less than 1.8 m from a property line, and located in accordance with either 7.2.4.6 or 7.3.4 of CAN/CGSB-149.11, "Radon control options for new construction in low-rise residential buildings ," with the opening of the pipe fitted with a corrosion-resistant screen or grille with a mesh opening size of 10 mm to 12.5 mm or a product of equivalent air flow performance.



Code Challenges

- Building codes do not apply post-occupancy, thus testing for radon after occupancy cannot be a code requirement.
- Radon sub slab piping systems are not considered in the Plumbing Code, which tends to put them in a similar category as drain tile and in the architectural scope.
- Above slab radon vent piping may be considered part of the plumbing scope.
- No code requirements to test a Level 2 passive stack or Level 3 active stack.
- Radon systems would fall under the building inspectors' scope rather than the plumbing inspectors, which may cause confusion.

Mitigation Options

Feedback from Stakeholders Across Canada

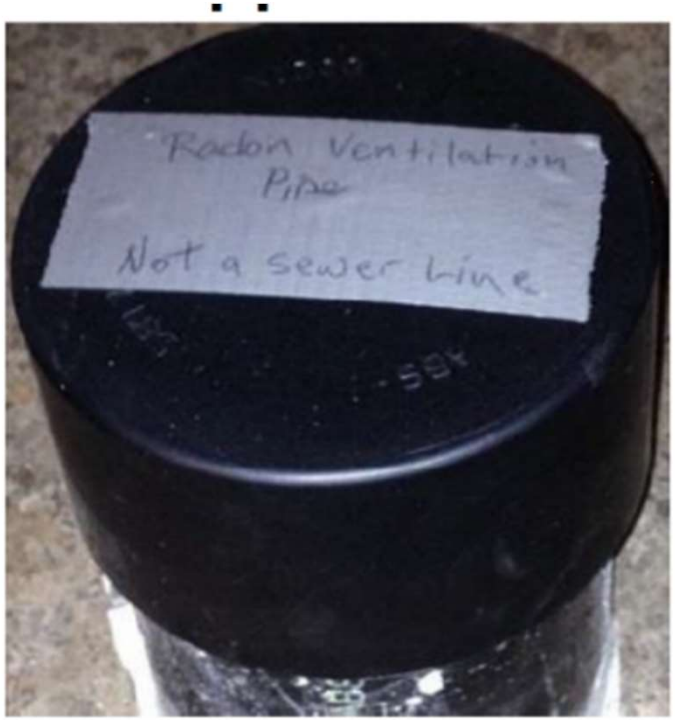
1. No description of the sub-slab pipe properties
   - BDS, Sch.40 or HDPE pipe
   - Solid or perforated
   - Loop design or one length

2. Potential condensation formation, ‘pipe sweating’ within walls.

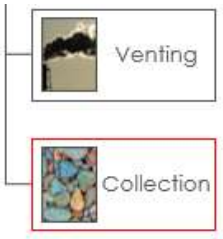
Feedback from Stakeholders Across Canada

3. Pipe identification and labelling is inadequate
   - Rough-in stubs have been misidentified as plumbing connections
4. Roof termination options are limited
   - Not protected enough, allows for debris and rodents to cause blockages
   - Ice build-up

Customer Insight Findings Examples



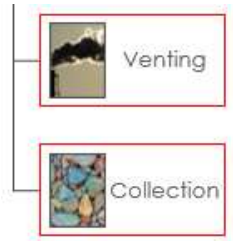
Piping Products: Sub-Slab Depressurization (Level 2 & 3)



- Generic DWV products being used for radon venting from other competitors, including IPEX (System 15) – primarily ABS
- Sewer pipe (perforated & non-perforated) used in the sub-slab region
- Big 'O' underground drainage pipe being used as a soil gas collector – flexible product

Challenge is lack of test data proving radon reduction performance of active vs passive systems

RadonX™



- RadonX™ Soil Gas Venting, is the **first,** complete engineering PVC piping solution specifically tested and labelled to vent soil gases from a building.

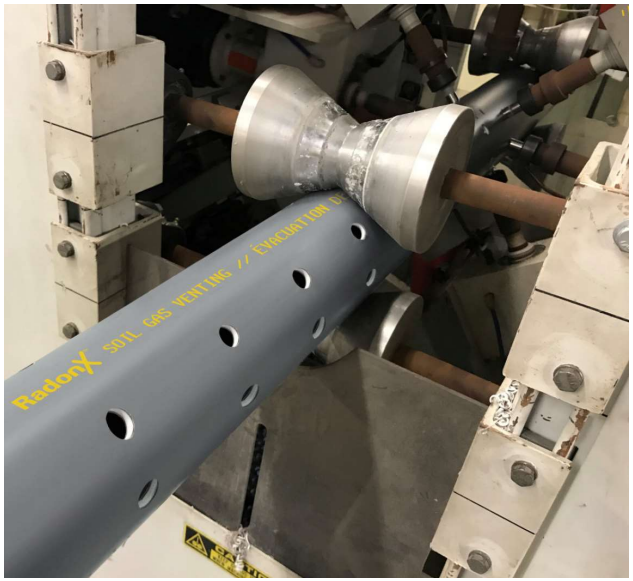
Material Property	RadonX
Flame Spread ≤ 25	Yes
Smoke Development ≤50	No
High-Rise & Plenum Suitability	No
Diameter	4”
Pipe Print Line Colour	Yellow
Fitting Labels	Black and Yellow

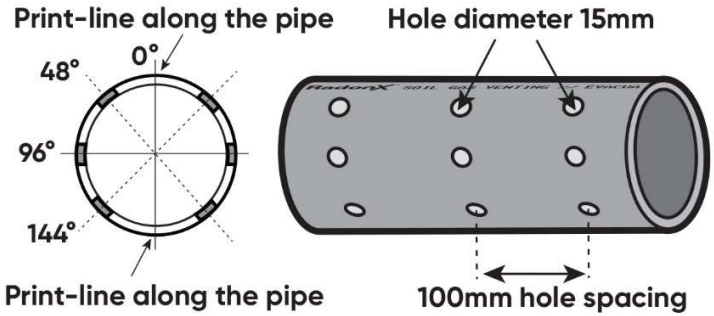
RadonX
Meeting Standards

Description	Standards	RadonX™
Tolerances and dimensions	CSA B181.2; ASTM D2665	✓
All material and testing requirements	CSA B181.2; ASTM D2665	✓
Gas venting system performance tests -Gas leakage -Pull-out -Torque -Combustibility	ULC S636	✓
Solvent cement	ASTM D2564	✓
Product markings	CGSB/CAN 149.11; CGSB/CAN 149.12	✓
Flame Spread Rating not exceeding 25	CAN/ULC S102.2	✓

RadonX™
Soil Gas Collection Pipe

- RadonX soil gas collection pipe is specifically designed to collect soil gas in the sub-slab area:
  - Smooth interior surface and the unique perforation pattern enables improved air movement in the sub-slab area, resulting in **higher airflow** rates in vent stack
  - The **6-row perforation pattern** creates a total area of perforation of ~100cm² per metre of pipe
  - Increased perforation and clean-cut circular holes **reduce** the risk of clogging during installation and over its service area





RadonX™
Fittings & Terminations

- RadonX fittings:
  - Schedule40 thickness
  - DWV molds were utilized, with SGV engravings
  - Coupling rings and plates were modified
  - Markings include:
    - SGV for "Soil Gas Venting"
  - Warning label
    - Warning message (not required by CGSB 149.11)
    - "CSA B181.2" is printed (no logo)
    - Barcode
    - Date
    - Product number

Putting RadonX to the Test
Rain Cap Studies at National Research Center (NRC):

- **Passive stack** tests were conducted, over a one-month period, in the winter using the perforated RadonX pipe sub-slab
  - Radon levels were reduced by **93%** using the **RadonX** system with RadonX rain cap*
- In **ASD**, the **RadonX stack** with **rain cap** had:
  - **Higher CFM values** with no air restriction
  - **No ice/snow build up** due to condensation

Description	Standard mesh type termination	New RadonX Rain Cap
Active Depressurization System field tests		
	Measured airflow in the stack (cfm)	
i) high fan speed	94.63	**98.04**
ii) low fan speed	19.38	**23.48**

*Source: NRC Report No.: A1-015955.02, October 28, 2019

Putting RadonX to the Test

Field Studies at the National Research Council of Canada (NRC)

Sub-slab Depressurization Field Tests*:	Parameter	No sub-slab pipe	Non-perforated Open-Ended Schedule 40 pipe	Perforated BDS DR35 sewer pipe (CSA B182.1)	**RadonX™ gas collection pipe**
	Nominal Pipe Size	-	4" -100mm	4" -100mm	**4" -100mm**
	Total Open Area (cm²/m)	-	-	32	**100**
Active depressurization system (Radon fan – high speed)	Average Airflow (cfm)	79.49	80.18		**98.40**
	Average Delta P (Pa)	-11.58	-11.96		**-15.08**
Active depressurization system (Radon fan – low speed)	Average Airflow (cfm)	7.82	16.91	17.56	**20.48**
	Average Delta P (Pa)	-0.59	-0.51	-1.29	**-1.15**
Passive depressurization system (No Radon fan)	Average Airflow (cfm)	3.2	4.2		**6.4**
	Average Delta P (Pa)	0.6	0.7		**0.02**

+23%

+52%

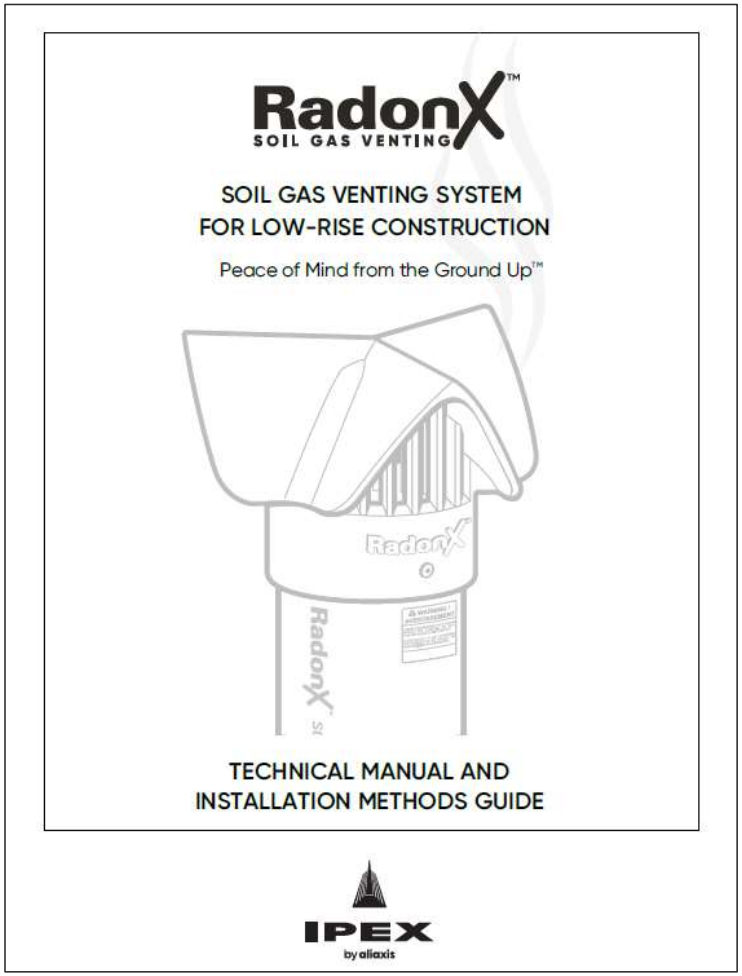
- The **ASD stack** with the **RadonX gas collection pipe** resulted in the **highest flow rate** in the stack and the **greatest depressurization** in the sub-slab area – in comparison to the other scenarios.
- In **Passive stacks**, the **RadonX gas collection pipe** resulted in the **highest airflow** and the **greatest depressurization** in the sub-slab region – provided **all other variables** are **equal**
- Overall, radon levels in the test house were reduced from 264 Bq/m^3 to 17.9 Bq/m^3 using the complete RadonX system

RadonX™ Technical Manual

Installation Guide

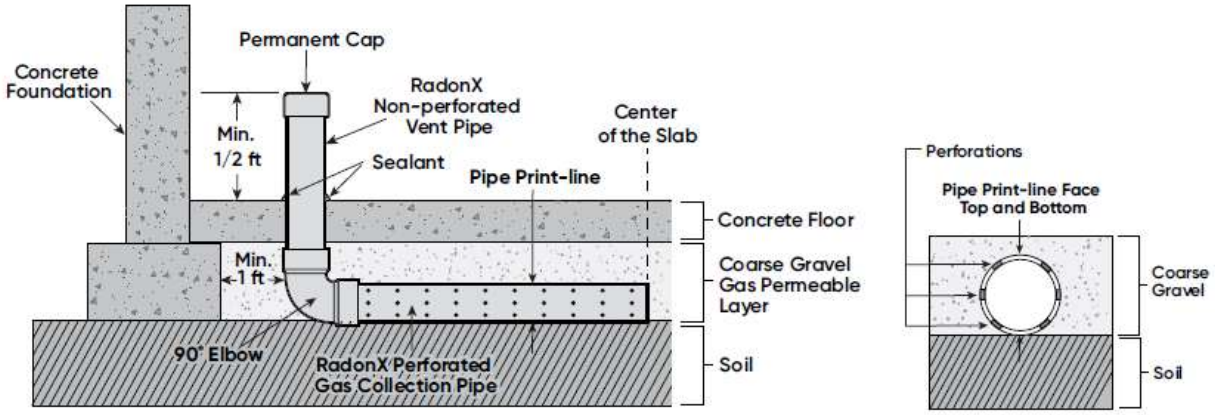
- The RadonX Technical Manual and Installation Methods can be found on the RadonX landing page at **www.ipexna.com**
  - The installation manual covers everything related to venting, including pipe supports and best practises

- To ensure safest installation, use this installation manual in collaboration with your local IPEX Sales Representative



RadonX Below Grade (Sub-slab) Piping System
New Construction

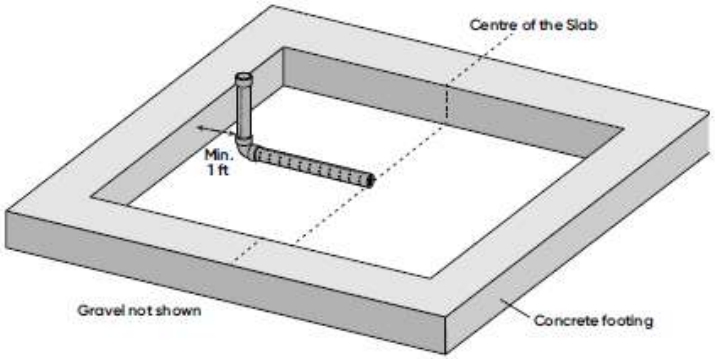
- RadonX perforated soil gas collection pipe shall extend into the gas-permeable layer and be located near or be oriented in the direction of the centre of the dwelling
  - Clean granular material must be used as a gas permeable layer on the undisturbed soil to a depth not less than 100mm (4")
  - The final depth of the has permeable layer should be determined as per *local building code*
- For every **46m² (500ft²)** of the building footprint, a **minimum of 3m (10')** of RadonX perforated gas collection pipe shall be used in the sub-slab area



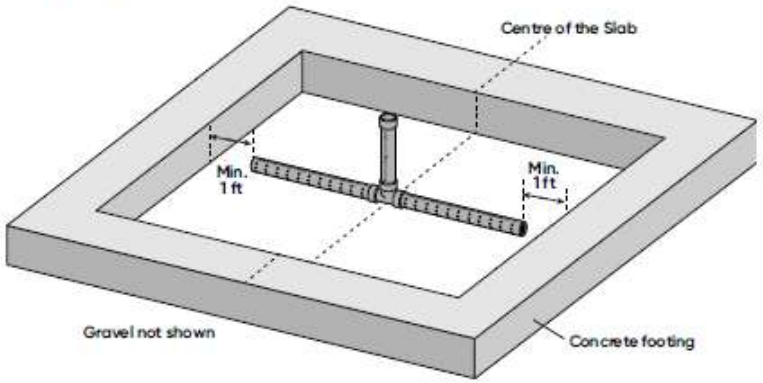
Typical installation of RadonX Level 1 – Rough-In.

Additional Below Grade (Sub-slab) Piping System Designs
New Construction

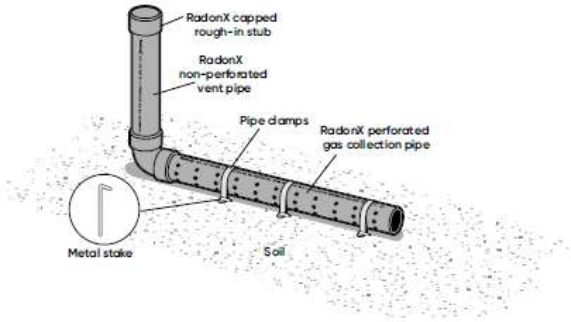
RadonX sub-slab piping when the riser is not at the centre



Acceptable RadonX sub-slab piping when the riser is at the centre

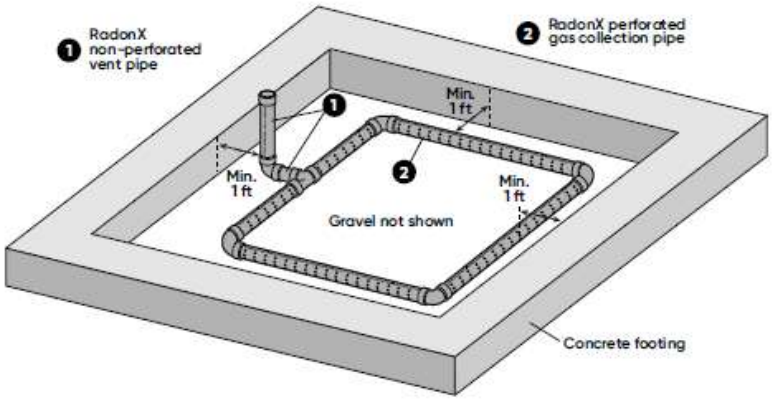


Typical pipe clamp installation

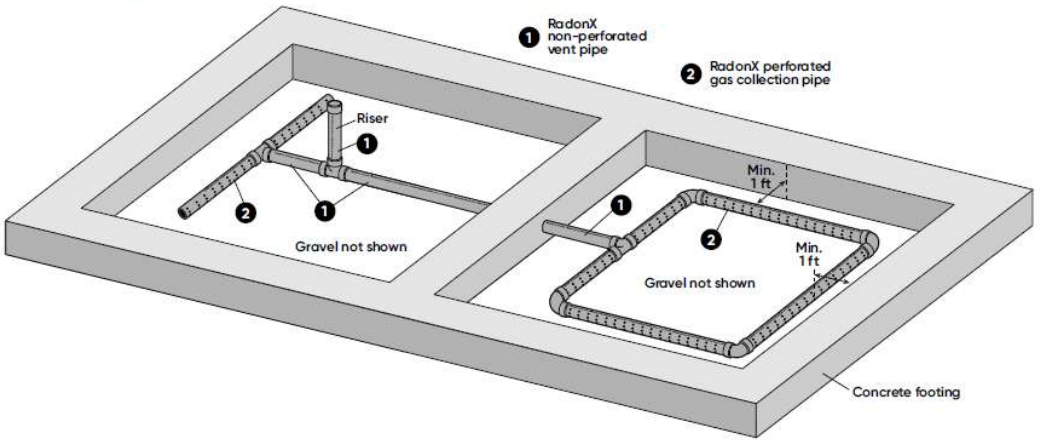


Alternative Below Grade (Sub-slab) Designs
New Construction

Alternative RadonX gas collection pipe loop in the sub-slab area



Connecting two gas permeable layers



Additional Resources

BC Lung Foundation

- Download their Recommendation for a BC Action Plan.
- Order test kits.
- Radon Map

Health Canada

- Radon Reduction Guide for Canadians
- Health Effects of Radon report
- Additional resources

Take Action on Radon

- Campaign resources
- DIY Test Kits
- Additional resources for homeowners, contractors, school, various stakeholders

Additional Resources

Canadian Cancer Society

- Radon and cancer awareness
- Canadian Cancer Society Recommendations

Evict Radon

- National study involving university based research from across Canada
- Provide radon test kits
- Radon research resources

Canadian – National Radon Proficiency Program (C-NRPP)

- Certification program that establishes guidelines, training and resources for the provision of radon services by professionals

Summary

- All homes in BC require a passive stack with vent pipe running out the roof now.
- **Enforce labelling** so the owner has a hope of activating the rough-in in the future.
- RadonX is the only above and below slab radon system with quantified performance off the shefl.
- The RadonX rain cap is 2024 BCBC compliant.