

Proposed Change 2160

Code Reference(s):	NBC25 Div.B 9.13.4. (first printing)
Subject:	Radon and Soil Gas Mitigation
Title:	Active Side-Wall Radon Stack
Description:	This proposed change adds the option of an active side-wall radon stack as a means of meeting the requirements for radon mitigation in dwelling units and home-type care occupancies that have a floor assembly in contact with the ground.

This change could potentially affect the following topic areas:

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| ☐ Division A | ☒ Division B |
| ☐ Division C | ☐ Design and Construction |
| ☐ Building operations | ☒ Housing |
| ☒ Small Buildings | ☐ Large Buildings |
| ☐ Fire Protection | ☒ Occupant safety in use |
| ☐ Accessibility | ☐ Structural Requirements |
| ☐ Building Envelope | ☐ Energy Efficiency |
| ☐ Heating, Ventilating and Air Conditioning | ☐ Plumbing |
| | ☐ Construction and Demolition Sites |

Problem

Radon is a colourless, odourless, radioactive gas that occurs naturally as a result of the decay of radium. It is found in varying concentrations as a component of soil gas in all regions of Canada. It is known to enter dwelling units by infiltration into basements and crawl spaces.

The 2025 edition of the National Building Code of Canada (NBC) mandates the installation of a passive vertical radon stack during construction for certain occupancies. However, use of a vertical stack may not be practical for specific dwelling unit designs, such as open-concept construction.

Justification

This proposed change introduces the option of an active side-wall vented subfloor depressurization system with a radon fan, and specifies the minimum and maximum airflow at the exhaust. This option would provide an alternative to the requirement for a passive vertical stack where the vertical stack is not practical for specific dwelling unit designs.

The minimum requirement for the active side-wall radon stack is only intended to provide an equivalent performance to the passive system, not to reduce radon levels to a certain value.

PROPOSED CHANGE

[9.13.4.] 9.13.4. Soil Gas Control

(See Note A-9.13.4.)

[9.13.4.1.] 9.13.4.1. Application and Scope

- [1] 1)** This Subsection applies to
- [a] a) a *conditioned space* that has a wall, roof or floor assembly that is in contact with the ground,
 - [b] b) the rough-in of a *conditioned space* that has a wall, roof or floor assembly that is in contact with the ground, and
 - [c] c) a ~~passive-vertical~~ radon stack for a *conditioned space* that has a wall, roof or floor assembly that is in contact with the ground.
- [2] 2)** This Subsection addresses the leakage of *soil* gas from the ground into the *building*.

[9.13.4.2.] 9.13.4.2. Protection from Soil Gas Ingress

- [1] 1)** All wall, roof and floor assemblies separating a *conditioned space* from the ground shall be provided with an *air barrier system* conforming to Subsection 9.25.3. that provides a level of radon gas diffusion protection equivalent to that provided by 0.15 mm polyethylene sheet conforming to CAN/CGSB-51.34, "Polyethylene sheet for use in building construction – Material specification".
- [2] 2)** Except as provided in Sentence (4), *dwelling units* and *home-type care occupancies* where a floor assembly separates a *conditioned space* from the ground shall be provided with a passive vertical radon stack, conforming to Article 9.13.4.4., or an active side-wall radon stack, conforming to Article 9.13.4.5., that is made of components that are compatible with adjoining materials described in Article 9.13.4.3.
- [3] 3)** Where *buildings* are used for *occupancies* other than those described in Sentence (2), protection from radon ingress and the means to address

high radon concentrations in the future shall conform to

[a] a) Article 9.13.4.3., or

[b] b) Parts 5 and 6 (see Articles 5.4.1.1. and 6.2.1.1.).

(See Note A-9.13.4.2.(3).)

- [4] 4)** Where an entrance at *grade* contains a floor assembly separating a *conditioned space* from the ground and provides direct access to a stairway leading up to a *dwelling unit* or *home-type care occupancy* located above another *dwelling unit* or *home-type care occupancy*, the entrance and space under the stairway need not comply with Sentence (2).

[9.13.4.3.] 9.13.4.3. Rough-in for a Subfloor Depressurization System
(See Note A-9.13.4.3.)

- [1] 1)** Floors-on-ground shall be provided with a rough-in for subfloor depressurization consisting of
- [a] a) a gas-permeable layer, an inlet and an outlet as described in Sentence (2), or
 - [b] b) clean granular material and a pipe as described in Sentence (3).
- [2] 2)** The rough-in referred to in Clause (1)(a) shall include
- [a] a) a gas-permeable layer installed in the space between the air barrier and the ground to allow the depressurization of that space,
 - [b] b) an inlet that allows for the effective depressurization of the gas-permeable layer (see Note A-9.13.4.3.(2)(b) and (3)(b)(i)), and
 - [c] c) an outlet in the *conditioned space* that
 - [i] i) permits connection to depressurization equipment,
 - [ii] ii) is sealed to maintain the integrity of the *air barrier system*, and
 - [iii] iii) is clearly labeled to indicate that it is intended only for the removal of radon from below the floor-on-ground.
- [3] 3)** The rough-in referred to in Clause (1)(b) shall include
- [a] a) clean granular material installed below the floor-on-ground in accordance with Sentence 9.16.2.1.(1), and
 - [b] b) a pipe not less than 100 mm in diameter installed through the floor, such that
 - [i] i) its bottom opening is located in the granular layer required in Clause (a) at or near the centre of the floor and not less than 100 mm of granular material projects beyond the bottom opening of the pipe measured along its axis (see Note A-9.13.4.3.(2)(b) and (3)(b)(i)),
 - [ii] ii) its bottom opening is protected by a low-pressure-drop stainless steel mesh with 10 mm to 12.5 mm openings or by a product and fitting system that provide an equivalent level of air-flow performance and corrosion resistance,
 - [iii] iii) its top opening permits connection to depressurization

equipment and is provided with an airtight cap, unless a ~~passive vertical~~ radon stack conforming to Article 9.13.4.4. ~~or~~ 9.13.4.5. is connected to the rough-in, and

- [iv] iv) the pipe is clearly labeled near the cap and, if applicable, at 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.

[9.13.4.4.] 9.13.4.4. Passive Vertical Radon Stack

(See Note A-9.13.4.4.)

- [1] 1)** The passive vertical radon stack ~~required by~~ referred to in Sentence 9.13.4.2.(2) shall be installed
 - [a] a) in a *conditioned space* in accordance with Clauses 7.2.2.3 and 7.2.3.2 to 7.2.4.2 of CAN/CGSB-149.11, "Radon control options for new construction in low-rise residential buildings",
 - [b] b) except as provided in Sentence (2), in the vertical direction, and
 - [c] c) such that its rooftop termination conforms to Table 9.13.4.4.-A.

Table [9.13.4.4.-A] 9.13.4.4.-A
Minimum Clearances for Rooftop Termination of Passive Vertical Radon Stacks
Forming Part of Clause 9.13.4.4.(1)(c)

Description	Minimum Clearance, m
Vertical clearance above the roof at the point of penetration	0.15
Vertical clearance above windows and doors	0.6
Vertical clearance above mechanical air intakes	0.9
Horizontal clearance from windows, doors and mechanical air intakes	3
Clearance horizontally from vertical walls that extend above the penetrated roof	3

- [2] 2)** Where it is not possible to install a passive vertical radon stack entirely in the vertical direction, the stack is permitted to include a horizontal offset on each *storey*, including the *basement*, provided each offset
 - [a] a) is not more than 3.6 m long,
 - [b] b) is connected using 22.5° to 90° fittings, and
 - [c] c) has a slope not less than 1 in 50.
 (See Note A-9.13.4.4.(2).)

- [3] 3)** Piping and connections for the passive vertical radon stack

[a] a) shall conform to Clauses 7.1.3.1.1 to 7.1.3.1.3 and 7.1.3.1.5 to 7.1.3.2.6 of CAN/CGSB-149.11, "Radon control options for new construction in low-rise residential buildings", and

[b] b) shall not be perforated above the level of the air barrier system.

[4] 4) Piping runs for the passive vertical radon stack that are located inside hollow walls or partitions within 43 mm of the wall or partition surface shall be protected against physical damage and puncture at the intersections of joists, studs, plates and other framing members by the use of steel plates or sleeves not less than 1.59 mm thick.

[5] 5) Except as provided in Sentence (6), the portion of the passive vertical radon stack that passes through the unconditioned *attic or roof space* shall be

[a] a) located within a cylindrical space not less than 500 mm in diameter and not less than 1 000 mm high, and

[b] b) insulated in accordance with Table 9.13.4.4.-B.

(See Note A-9.13.4.4.(5) and (6).)

Table [9.13.4.4.-B] 9.13.4.4.-B
Insulation of Passive Vertical Radon Stack in Unconditioned Space
Forming Part of Clause 9.13.4.4.(5)(b)

2.5% January Design Temperature, °C	Maximum Stack Height Above Roof, m	Insulation, RSI					
		0.70	1.41	2.11	2.82	3.52	4.23
		Maximum Length of Stack in Unconditioned Space, m					
–5 or warmer	0.30	4.71	6.86	7.92	9.45	10.48	11.70
–6 to –11	0.30	2.59	3.91	4.83	5.53	6.29	6.86
–12 to –17	0.30	1.28	2.59	3.08	3.43	3.78	4.11
–18 to –24	0.15	1.25	1.94	2.47	2.93	3.32	3.63
	0.30	0.64	0.98	1.28	1.52	1.68	1.86
	0.30 ⁽¹⁾	1.51	2.32	2.93	3.47	3.90	4.30
–25 to –29	0.15	1.16	1.52	1.95	2.32	2.62	2.90
	0.30	0.40	0.61	0.76	0.91	1.04	1.16
	0.30 ⁽¹⁾	1.34	1.92	2.47	2.90	3.26	3.60
–30 to –34	0.15	0.94	1.22	1.58	1.83	2.07	2.32
	0.30	0.21	0.30	0.40	0.46	0.52	0.58

2.5% January Design Temperature, °C	Maximum Stack Height Above Roof, m	Insulation, RSI					
		0.70	1.41	2.11	2.82	3.52	4.23
		Maximum Length of Stack in Unconditioned Space, m					
	0.30 ⁽¹⁾	1.25	1.65	2.10	2.47	2.77	3.05
–35 or colder	0.15	0.76	0.98	1.25	1.52	1.71	2.59
	0.15 ⁽¹⁾	1.22	1.65	2.07	2.44	2.77	3.05
	0.30 ⁽¹⁾	1.05	1.28	1.74	2.01	2.29	2.53

Note to Table [9.13.4.4.-B] 9.13.4.4.-B:

- (1) The portion of the passive vertical radon stack that extends above the roof shall be insulated to RSI 0.704 and protected from physical damage.

[6] 6) Where it is not possible to provide the cylindrical space described in Clause (5)(a) within an unconditioned *attic or roof space* or where the passive vertical radon stack passes through a *dwelling unit* above, the cylindrical space shall be provided within the *conditioned space*. (See Note A-9.13.4.4.(5) and (6).)

[7] 7) The ~~exhaust~~^{top} opening at the top of the passive vertical radon stack shall be ~~fitted with a stainless steel mesh with 10 mm to 12.5 mm openings or by a product and fitting system that provide an equivalent level of air-flow performance and corrosion resistance~~protected in accordance with Article 9.13.4.6.

[9.13.4.5.] --- Active Side-Wall Radon Stack

[1] --) The active side-wall radon stack referred to in Sentence 9.13.4.2.(2) shall

[a] --) be installed in a *conditioned space*,

[b] --) conform to Clauses 7.1.3 and 7.3.4.3 of CAN/CGSB 149.11, “Radon control options for new construction in low-rise residential buildings”,

[c] --) have a radon pipe that

[i] --) penetrates to an exterior wall at a right angle,

[ii] --) is watertight at the penetration,

[iii] --) has an exhaust end that extends not less than 150 mm measured from the exterior surface of the *building* at the penetration, and

[iv] --) has a clearance of not less than 200 mm from all interior walls, and

[d] --) be connected to a radon fan in continuous operation.

[2] --) The radon fan described in Clause (1)(d) shall

- [a] --) meet the requirements of CSA C22.2 No. 113, "Fans and Ventilators",
 - [b] --) provide an airflow rate of not less than 14 L/s and not more than 28 L/s measured at the exhaust opening to the outdoors,
 - [c] --) be installed according to the manufacturer's instructions,
 - [d] --) be installed with flexible couplers, and
 - [e] --) have all seams and enclosures, other than the inlet and outlet ports of the fan housing, sealed.
- [3] --)** The exhaust opening of the active side-wall radon stack to the outdoors shall be protected in accordance with Article 9.13.4.6.
- [4] --)** The active side-wall radon stack shall be tested for air leakage, with the radon fan in operation, using the soap test method.
- [5] --)** With the radon fan operating at its normal exhaust capacity, the airflow at the exhaust opening of the discharge pipe shall be measured and the fan airflow adjusted and permanently fixed so that the airflow at the exhaust opening of the discharge pipe is within $\pm 10\%$ of the exhaust capacity required in Clause (2)(a).
- [6] --)** The airflow measurements required by Sentence (5) shall be taken using a method accurate to within $\pm 15\%$ of the flow rate being measured.

[9.13.4.6.] --- Protection of Exhaust Opening of Radon Stack

- [1] --)** The exhaust opening to the outdoors of the radon discharge pipe and fitting system shall be fitted with a stainless steel mesh with 10 mm to 12.5 mm openings or by a product and fitting system that provide an equivalent level of air-flow performance and corrosion resistance.

Note A-9.13.4. Soil Gas Control.

Outdoor air entering a dwelling through above-grade leaks in the building envelope normally improves the indoor air quality in the dwelling by reducing the concentrations of pollutants and water vapour. It is only undesirable because it cannot be controlled. On the other hand, air entering a dwelling through below-grade leaks in the envelope may increase the water vapour content of the indoor air and may also bring in a number of pollutants picked up from the soil. This mixture of air, water vapour and pollutants is sometimes referred to as "soil gas." One pollutant often found in soil gas is radon.

Sentence 9.13.4.2.(1), which requires the installation of an air barrier system, addresses the protection from all common naturally occurring soil gases, including nitrogen, carbon dioxide, oxygen, methane and radon, while the remainder of Article 9.13.4.2. along with Articles 9.13.4.3. and 9.13.4.4. to 9.13.4.6., which require the provision of the means to depressurize the space between the air barrier and the ground, specifically address the capability to mitigate high radon concentrations in the future, should this become necessary.

Radon is a colourless, odourless, radioactive gas that occurs naturally as a result of the decay of radium. It is found to varying degrees as a component of soil gas in all regions

of Canada and is known to enter dwelling units by infiltration into basements and crawl spaces. The presence of radon in sufficient quantity can lead to an increased risk of lung cancer.

The potential for high levels of radon infiltration is very difficult to evaluate prior to construction and thus a radon problem may only become apparent once the building is completed and occupied. Therefore various sections of Part 9 require the application of certain measures that will minimize radon infiltration in all dwellings. These measures are

- low in cost,
- difficult to retrofit, and
- desirable for other benefits they provide.

The principal method of resisting the ingress of all soil gases, a resistance which is required for all buildings (see Sentence 9.13.4.2.(1)), is to seal the interface between the soil and the occupied space, so far as is reasonably practicable. Sections 9.18. and 9.25. contain requirements for air and soil gas barriers in assemblies in contact with ground, including those in crawl spaces. Providing control joints to reduce cracking of foundation walls and airtight covers for sump pits (see Section 9.14.) are other measures that can help achieve this objective. The requirements provided in Subsection 9.25.3. are explained in Notes A-9.25.3.4. and 9.25.3.6. and Note A-9.25.3.6.(2)(a).

The principal method of minimizing radon infiltration into a building is to ensure that the pressure difference across the ground/space interface is positive (i.e., towards the outside) so that the inward flow of radon through any remaining leaks will be minimized. The requirements provided in Article 9.13.4.3. are explained in Note A-9.13.4.3.

Impact analysis

Requirements for the installation of a passive vertical radon stack in dwelling units and home-type care occupancies that have a wall, roof or floor assembly in contact with the ground were introduced in the NBC 2025.

The national average construction cost for the installation of a passive vertical radon stack in a three-storey house with basement had been determined to be \$1 273. The passive vertical radon stack is expected to function without maintenance, inspection or replacement over a 75-year service life [1]. The construction and installation cost of an active side-wall radon stack (comprising radon fan, piping and connections) is determined to be \$1 585 nationally. The maintenance cost for the system is \$3 500 to \$4 500 over a 75-year service life. Therefore, choosing to install an active side-wall radon stack in accordance with this proposed change would represent an increased cost of \$3 812 to \$4 812 over its 75-year service life compared to the current Code requirement. This estimate does not account for the cost of operating the fan.

The benefits of this proposed change are identical to those for the passive vertical radon stack. The impact analysis for the requirement to install a passive vertical radon stack in Part 9 residential occupancies demonstrated that the main benefit would be

preventing 10 000 to 16 000 radon-associated lung cancer deaths in Canada over 100 years. The cumulative number of lung cancer deaths prevented over 100 years was estimated to be 10 356 (8 601–12 208) for the lower residential radon exposure and 16 132 (14 402–17 586) for the upper estimate of current residential radon exposure [1]. Although the costs incurred for installing radon stacks (either passive vertical or active side-wall) in new housing construction always exceeds the savings from lung cancer treatment for cases prevented, the cumulative cost per lung cancer death prevented decreases steeply after implementation and drops below the Treasury Board of Canada Secretariat reference value after 30 to 40 years [1].

Reference

[1] "Impact Analysis of Installing Passive Radon Stacks in Part 9 Residential Occupancies," National Research Council Canada, Ottawa, May 2022.

Enforcement implications

The proposed changes related to the active side-wall stack (depressurization) option would require the inspection of the subfloor depressurization system from the subfloor connection to the exterior termination and verification that the fan is operating. Airflow measurements would need to be either collected by the authority having jurisdiction or supplied by the contractor prior to occupancy.

Who is affected

Designers may need to change their designs to better facilitate the termination of the active side-wall radon stack to the exterior when using this option. If the design includes a finished basement, certain elements may need to be moved to accommodate the active stack. For example, walls may need to be moved to conceal the stack or, where walls are not able to be moved, the location where the sub-slab collection pipe penetrates the slab may need to be moved. Further, windows and air intakes near the radon exhaust opening may need to be moved where minimum clearances cannot be met in a current design.

Contractors may be required to add the active subfloor depressurization system to their construction procedures. As a result, further changes to their designs may be required to better facilitate the termination of the active side-wall radon stack at the rim joist. This option may also require moving walls or the location where the sub-slab collection pipe penetrates the slab.

Occupants would benefit from the reduction of exposure to radon gas. This option may require changes to designs to better facilitate the termination of the active side-wall radon stack at the rim joist. It may also require moving walls or the location where the sub-slab collection pipe penetrates the slab.

OBJECTIVE-BASED ANALYSIS OF NEW OR CHANGED PROVISIONS

[9.13.4.1.] 9.13.4.1. ([1] 1) no attributions

[9.13.4.1.] 9.13.4.1. ([2] 2) no attributions

[9.13.4.2.] 9.13.4.2. ([1] 1) no attributions

[9.13.4.2.] 9.13.4.2. ([1] 1) [F40-OH1.1]

[9.13.4.2.] 9.13.4.2. ([2] 2) no attributions

[9.13.4.2.] 9.13.4.2. ([2] 2) [F40-OH1.1]

[9.13.4.2.] 9.13.4.2. ([3] 3) [F40-OH1.1]

[9.13.4.2.] 9.13.4.2. ([4] 4) no attributions

[9.13.4.3.] 9.13.4.3. ([1] 1) [F40-OH1.1]

[9.13.4.3.] 9.13.4.3. ([2] 2) [F40-OH1.1]

[9.13.4.3.] 9.13.4.3. ([3] 3) no attributions

[9.13.4.3.] 9.13.4.3. ([3] 3) [F40-OH1.1]

[9.13.4.4.] 9.13.4.4. ([1] 1) [F40-OH1.1]

[9.13.4.4.] 9.13.4.4. ([2] 2) [F40-OH1.1]

[9.13.4.4.] 9.13.4.4. ([3] 3) [F40-OH1.1]

[9.13.4.4.] 9.13.4.4. ([4] 4) [F40-OH1.1]

[9.13.4.4.] 9.13.4.4. ([5] 5) [F40-OH1.1]

[9.13.4.4.] 9.13.4.4. ([5] 5) [F51-OH1.1]

[9.13.4.4.] 9.13.4.4. ([6] 6) [F40-OH1.1]

[9.13.4.4.] 9.13.4.4. ([7] 7) [F42-OH2.5]

[9.13.4.5.] -- ([1] --) [F40-OH1.1]

[9.13.4.5.] -- ([2] --) [F40-OH1.1]

[9.13.4.5.] -- ([3] --) [F42-OH2.5]

[9.13.4.5.] -- ([4] --) [F40-OH1.1]

[9.13.4.5.] -- ([5] --) [F53-OH1.1]

[9.13.4.5.] -- ([5] --) [F43,F50,F53-OS3.4]

[9.13.4.5.] -- ([6] --) [F53-OH1.1]

[9.13.4.6.] -- ([1] --) [F42-OH2.5]