Radon Control Options for New And Existing Construction in Low Rise Residential Buildings

Presented by: Jeff Whyte, Health Canada
Co-chair, CGSB Working Group 1 (149.11) and Chair CGSB 149 Technical Committee
and
Mathieu Brossard, Health Canada
Chair Working Group 2 (149.12)
In August 2013, the Canadian General Standards Board (CGSB) established Working Groups to develop 2 national standards on radon mitigation, one on new construction and one for existing construction.

The CGSB requires Technical Committees to be comprised of balanced representation from 4 main categories, namely Regulators, Users, Producers, and General Interest.

Working Group and Technical Committee members were comprised of public (government) and private organizations and comprised stakeholders representing regulators (federal, provincial & municipal), radon professionals (test & mitigation), engineers, architects, scientists, and manufacturers.

WG-1 (new construction) held 2-hour teleconferences every 2\textsuperscript{nd} week over the course of the standard’s development; and held two 2-day Technical Committee meetings in the National Capital Region (Ottawa).
• WG-1 reviewed “best practices” from other jurisdictions and standards bodies and built on those methodologies deemed compatible with Canadian requirements.

• The work culminated in the draft national standard, CAN CGSB-149.11.

• Among the features of the new standard were proposed consistent and progressive requirements for a 3-level approach to radon reduction, ranging from a rough-in through to a full active soil depressurization system.
Aims & Goals

• Provide design criteria, design tools, methods and techniques, and sample construction specifications based on a 3-tiered system to minimize radon entry into new homes prior to initial occupancy and to prepare for future mitigation measures if deemed necessary after occupancy (149.12) has occurred.

• Possible cross-referencing of CGSB-149.11 by the Canadian National Building Code depending on content. The NBC is a minimum and standards may go beyond this as a best practice.

• In reference to language, “shall” is a mandatory requirement, “should” is a recommendation and “may” is used to express an option or that which is permissible within the limits of this Standard. Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.
Terminology

**New Construction** - residential building construction initiated from the ground up.

**Low-Rise Residential** - buildings 3 storeys or less in height and having a footprint that does not exceed 6,500 ft$^2$ [600 m$^2$].
CGSB Working Group I (149.11) – New Construction Standard

**Terminology**

Detached →

Semi-Detached →
CGSB Working Group I (149.11) – New Construction Standard

**Terminology**

- Townhouse
- Link Homes

[Images of construction and townhouse houses]
CGSB Working Group I (149.11) – New Construction Standard

CGSB - General

• Proposed -11 sections:

  1. Scope – small buildings
  2. Normative References – various standards that are referenced
  3. Terms/Definitions
  4. Abbreviations
  5. Classification – 3 Levels
  6. General Requirements – some brief detail on each Level
  7. Detailed Requirements -
  8. Labelling – how to label the components of the 3 Levels
  9. Inspection – Annex C-inspection checklist
  10. Testing – refers to Annexes on LT radon testing and communication testing
  11. Informative Annexes – general radon information, inspection checklist, radon in water/construction materials, homeowner information, radon reductions, radon testing devices, communication testing, radon risk, other construction considerations.
CGSB Working Group I (149.11) – New Construction Standard

3 Levels

• Level 1 – gas permeable layer, sealed sub-slab membrane, and capped rough-in pipe stub to allow conversion to an active system if required later.

• Level 2 - Level 1 is extended/built-upon to add a full passive vertical stack that terminates above the roof

• Level 3 – full active (fan-driven) soil depressurization system with a number of fan location and discharge location choices
Local Radon Risk

• The classification of areas of radon risk was beyond the scope of this standard.

• Indoor radon levels cannot be predicted prior to the construction and occupancy of a new home, therefore every new home needs to be tested.

• The results of the nation-wide, 2-year cross-Canada residential radon survey by Health Canada, based on test information for 13,814 homes tested from all Canadian Provinces & Territories, was provided as an Appendix to the standard which could be used by authorities. This data has been and is being used by provinces and municipalities.
CGSB Working Group I (149.11) – New Construction Standard

Radon Risk
Related Work

• In fall 2014, it was recognized that a Rn fan specification should be developed to support the developing standard. WG-3 was created for this purpose.

• Fans were obtained from a number of manufacturers and tested at the National Research Council laboratories with our partners.

• Radon fans shall meet the product safety requirements in accordance with CAN CSA-C22.2 No. 113 and the motor shall comply with the applicable requirements of CAN CSA-C22.2 No. 100 for motors having 100% duty cycle.

• Fans requiring bubble leak testing or fans installed outdoors shall meet the requirements of CAN CSA 22.2 No. 113 for outdoor use.
Proposed - Fan Leakage

- Rn fan seams and enclosure openings shall be sealed so that the combined area of all gaps or openings of the fan housing does not exceed a total area of a single [3.17 mm] 0.125” diameter hole which would result in a maximum [0.425 m3/h] 0.25 cubic foot per minute (cfm) leakage at [375 Pa] 1.5” WC pressure.

- Installer shall check each connection, fan joint and system component subject to fan-induced positive pressure while under normal operating pressure with either a liquid bubble solution or a leak-detection device to locate any source of a leak. Exception: Does not apply to Rn fans mounted outdoors, in attics or attached garages, or to fans with all critical seams under negative pressure or housed in a negative pressure enclosure. Leaks shall be sealed in a manner recommended by the fan manufacturer and retested.
Proposed - Common Elements

• All pipe and fittings shall comply with ASTM Schedule 40 specification for 4” diameter pipe. Sub-slab soil gas collector piping can be SDR 35.

• Sub-slab aggregate consisting of coarse, clean granular material shall be provided on the undisturbed soil to a depth ≥ 4” [10 cm].

• Aggregate shall contain no more than 10% of material that will pass a 5/32” [4 mm] sieve.

• There is provision for other material to be used under the slab (geotextile drainage matting, sub-slab ventilation panels, etc) as a substitute for aggregate.
Proposed - Common Elements

- Soil gas barrier material used under a concrete slab or in exposed dirt crawlspaces.

- Currently the thickness of the membrane is one of the items requiring resolution after the public review.

- This aspect of the standard may have a shall and a should component, but this remains to be seen pending feedback from the Technical Committee.

- The NBC references 6 mil and TC members need to decide whether they want a thicker membrane (10-12 mil) thickness. Hence this is one of the situations where the standard may go above and beyond the NBC and become a best practice document.
Level 1

- Provides minimum protection and provides provisions for a radon rough-in stub.
- Provides provisions for sealing soil gas entry points.
- Level 1 is **NOT** a complete radon reduction system, but allows for easier conversion to one in the future, should it become necessary.
- Most provinces and territories have adopted the Level 1 requirements described in this Canadian National Standard.
Level 2

- Provides moderate protection and includes all provisions of Level 1, with the addition of extending the pipe stub to create a full, vertical passive (without a fan) radon stack system that runs upwards through the inside of the building shell and vents above the roof.
- Level 2 is a complete passive soil depressurization radon reduction system.
- A Level 2 system will typically reduce radon levels by 50%.
- In areas where significant proportions of homes are likely to test above the 200 Bq/m$^3$ Canadian radon guideline, authorities may find it prudent to adopt either a Level 2 or Level 3 protection requirement in new construction.
- The Level 2 solution since 2015 is now used in the BC building code in radon-prone areas.
Level 3

• Provides maximum protection and includes all provisions from Levels 1 and 2, with the addition of a radon fan to create an active soil depressurization system (ASD).
• Level 3 is a complete radon reduction system.
• A Level 3 system will typically reduce high radon levels in a home by more than 90%, but requires a fan to be operating continuously.
• In areas where significant proportions of homes are likely to test above the 200 Bq/m$^3$ Canadian radon guideline, authorities may find it prudent to adopt either a Level 2 or Level 3 protection requirement in new construction.
Public Review

- 120+ comments were received during the public review and the TC Chair was able to address the majority of them.

- There were 19 points where the Chair felt he needed input from the TC members since this is a National consensus standard.

- Currently awaiting TC guidance on these points.
CGSB Working Group I (149.11) – New Construction Standard

**Status**

- As of this date, the draft national standard, CAN CGSB-149.11 has completed the main public review and dozens of small changes were made.

- Once the consensus has been reached on the 19 items, the draft will undergo a short public review and then would be ready for a committee ballot.

- Draft would then be submitted to SCC for ratification

- It is anticipated that the standard will be completed late this spring.
Status

• Once the standard is published, CGSB has a requirement to revisit/update standards at 5 year intervals

• As we learn more from new build research over the next 5 years in Canada there will be opportunity to revise and improve these standards.

• Stay tuned.
Aims & Goals

• Provide methods and techniques to minimize radon entry into existing homes or into newer homes after occupancy has occurred.

• Provide a National standard that could be used by the radon mitigation industry in Canada

• The Health Canada publication entitled “Reducing Radon Levels in Existing Homes: A Canadian Guide for Professional Contractors” was to be used as the basis for this standard.
Proposed Normative Provisions

- Sub slab-depressurisation
  - Above roof discharge /gable discharge with fan in the attic,
  - Horizontal discharge with indoor fan,
  - Above roof discharge with outdoor fan and pipes in heating zone 5

- Sub membrane depressurisation

- Sump & drainage system depressurisation

- Completion or retrofitting of preventive measures
  - Rough-in completion
  - Passive vertical stack
  - Activate ASD system

- Dilution through ventilation using ERV of HRV
Proposed Informative Provisions

- Crawl space / sub floor exhaust ventilation

- Outdoor Soil depressurization
  - Above roof discharge other than climate zone 5
  - Downdraft fan with enclosed box

- Drainage tubing/ weeping tile depressurisation with underground fan
Multifamily/Semi-Detached Dwelling Challenges – Proposed Informative

• Buildings are to be considered as systems

• Consider buildings as a whole for initial radon testing

• Accessibility to all basement levels of the building to perform diagnostics

• Challenges to install, operate and maintain costs of a radon mitigation system – Beyond the scope of this standard.
Diagnostics - Proposed

Mandatory in two scenarios:

• Fan Sizing
  ➢ To effectively reverse flow of soil gas from inside to outside of the house
  ➢ Minimizes chances for natural draft combustion appliance back drafting

• Suction point selection:
  ➢ To maximize pressure field extension (PFE) across the slab
  ➢ Ensures proper sizing of ASD system to have effective draw
Proposed - Fan Characteristics

- In-line centrifugal fans designed / designated by manufacturer for radon mitigation
- Maximal acceptable leak rate: 0.12 L/s [0.432 m³/hr] 0.25 cfm leakage at [375 Pa] 1.5” water column (WC) pressure
- Leak test requirement for indoor (basement or attic) fan – Same as new construction standard
Proposed Exhaust Clearances for ASD Systems

Adapted from CSA-B149.1 Natural Gas and Propane Installation Code 2005 and 2010.

Two exhaust discharge clearances:
- Minimal required clearance distance (normative)
- Recommended clearance distance
Proposed - Selection of Horizontal Sidewall Discharge

- Recommended circumstances for side wall discharge:
  - Cold temperature (Heating Zones).
  - Soil moisture: Elevated soil moisture is more likely to increase system icing issues.
  - Low exhaust flowrates.
  - Frequent electric power interruption.
Proposed - Selection of Pipe Size

- 100 mm (4 inch) diameter shall be the first choice.

- 75 mm (3 inch) diameter pipe is acceptable in two situations:
  - In low flow situations
  - Or only partially for routing purposes

- PVC pipe with Schedule 40 specifications

- Consider protecting the soil depressurisation pipe against physical damage or puncture.
Proposed - Mandatory Post-Mitigation Testing

• Short term post mitigation radon measurement within first month of mitigation.
  ➢ Duration no shorter than 48 hours using approved radon testing device.
  ➢ Monitoring no sooner than 24 hours after activation to assess system effectiveness.

• Conduct long-term test using an approved radon testing device.

• Re-test to be performed every 2 years with a long-term radon testing device.

• Radon testing device shall be approved by Canadian National Radon Proficiency Program (C-NRPP), National Radon Proficiency Program (U.S -NRPP) or equivalent.
Proposed - Radon in Water and Building Materials

• Radon outgassing is a very small contributor to indoor radon levels.

• Rule of thumb: Requires radon in water concentrations of 10,000 Bq/m³ to add 1 Bq/m³ of radon to the air of a typical residential home.

• Municipally treated water systems are usually extremely low due to water treatment methods.

• Radon levels in well water can be significant depending on the source.

• Construction materials such as concrete, drywall, tiles, or granite countertops emanate some radon depending on the radium-226 levels.

• Contribution to indoor radon from construction materials in Canada is generally very small.
Status

• Red line draft is being prepared for final review by the Technical Committee

• The next stage will be a committee ballot shortly

• Draft would then be submitted to SCC for their ratification

• Publishing anticipated later in the spring
Acknowledgements

As Chair of the overall Technical Committee I wish to acknowledge the work of WG-1, WG-2, and WG-3 members, the WG chairs, the Technical Committee, Deepti Bijlani for her overall management of this CGSB standards project, and to Cosmina Panu-Anghel of CGSB as well.
Thank-you

Questions?