Radon Action Guide for Provinces and Territories

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Summary

Radon is a naturally occurring radioactive gas that emanates from the ground and can enter and accumulate in buildings. Radon gas is found in every building in Canada at some level. Radon exposure is the leading cause of lung cancer after smoking, and accounts for an estimated 16 percent of lung cancer deaths in Canada. Radon risk reduction is easy to address through testing and mitigation. Simple tests involve placing a long-term radon detector in the lowest lived-in level of a building for three months during the fall-winter months. Health Canada estimates that ~7% of homes will have a high radon level; this percentage varies significantly across Canada, as indicated by Health Canada's radon map. There are relatively inexpensive and very effective ways to reduce radon exposure in homes and buildings with high radon levels, i.e., over the Canadian Radon Guideline of 200 Bq/m^3.

This Radon Action Guide provides many steps provinces and territories can take to reduce radon exposure. Radon affects all types of buildings, and radon action affects many different areas of law and policy concerned with the built environment, from real estate transactions to workplace standards. In Canada's federal system, the provinces and territories are uniquely situated to make law and policy change. Provinces and territories can become leaders in advancing radon action through individual actions across areas such as education and awareness, supporting community testing, creating databases and maps, and updating worker and tenant protections. This guide describes how provinces and territories can develop more comprehensive radon strategies.

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1. Introduction

Radon gas is a naturally occurring radioactive gas that comes from the breakdown of uranium in the ground. While radon is found in every building in Canada, exposure to higher concentrations has significant health effects. Radon exposure is the leading cause of lung cancer after smoking, and accounts for more than 3,000 lung cancer deaths in Canada.[1] Health Canada estimates that 7% of homes in Canada have high radon levels above the Government of Canada Guidelines of 200 Bq/m^3.[2] Public awareness remains low and a vast majority of Canadian homeowners (>90%) have never tested for radon.[3]

The standard way to test homes in Canada involves placing a small detector in the lowest lived-in level of the home (basement or main floor) for 3 months.[4] Do-it-yourself long-term test kits are available, typically costing 30 to 60 dollars, from a variety of online suppliers and hardware stores. "Real-time" digital monitors and radon measurement services from certified professionals are also available, at a much higher cost than the DIY test kits. If test results are high, mitigation professionals can install a radon mitigation system that will reduce the radon level. Techniques to lower radon levels are effective and can save lives. A radon mitigation system, which can be installed in less than a day, will reduce the radon level by more than 80% in most homes. The cost is about the same as other common home repairs, such as replacing the furnace or air conditioner.[5]

There are good reasons for provinces and territories to take action on radon. Canadians look to their governments to help them reduce risks and lead healthier, safer lives. Radon mitigation is a relatively inexpensive exercise, and well-designed government radon strategies can be a cost-effective way to save lives.[6] In Canada's federal system, provinces and territories have jurisdiction over buildings, public health, and air quality. While Health Canada's National Radon Program (NRP) has made significant strides,

[1] Chen, J., Moir, D. and Whyte, J., 2012. "Canadian population risk of radon induced lung cancer: a re-assessment based on the recent cross-Canada radon survey," *Radiation Protection Dosimetry* 152(1-3), pp. 9-13.
[2] Health Canada, 2012. Cross Canada Survey of Radon Concentrations in Homes, Final Report. Available at https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/radiation/cross-canada-survey-radon-concentrations-homes-final-report-health-canada-2012.html (accessed January 8, 2021).
[3] See Statistics Canada, 2017. Knowledge of radon and testing. Table: 38-10-0086-01.
[4] See Health Canada, 2017. Guide for Radon Measurements in Residential Dwellings (Homes). Available at https://www.canada.ca/en/health-canada/services/publications/health-risks-safety/guide-radon-measurements-residential-dwellings.html (accessed January 8, 2021).
[5] Health Canada, 2018. Residential Radon Mitigation Actions Follow-Up Study: Public Summary. Available at https://www.canada.ca/en/health-canada/services/publications/health-risks-safety/residential-radon-mitigation-actions-follow-up-study.html (accessed January 8, 2021).
[6] Gaskin, J., Coyle, D., Whyte, J., Birkett, N. and Krewksi, D., 2019. "A cost effectiveness analysis of interventions to reduce residential radon exposure in Canada," *Journal of Environmental Management* 247, pp. 449-461. For a broader introduction to health economics analysis of radon, see World Health Organization, 2009. WHO Handbook on Indoor Radon: A Public Health Perspective. Geneva, Chapter 4, Cost Effectiveness of Radon Control. Available at https://www.who.int/ionizing_radiation/env/9789241547673/en/ (accessed January 8, 2021).

provincial and territorial action is needed to ensure radon is fully addressed. Provincial governments need to ensure radon is addressed by provincial public health agencies, and incorporated into relevant laws regulating the indoor environment. Most radon exposure occurs in homes,[7] making Building Codes, New Home Warranty, rental homes and real estate transactions especially important areas for change. That said, workplaces, schools, and care facilities are also important places to reach.

This Radon Action Guide will help guide provincial and territorial governments in developing programs to address radon. It describes broader radon planning and strategy development (Part One). It also includes interventions such as developing public outreach and testing programs, and rules for real estate transactions or residential tenancies law that can be taken on individually or form parts of a broader plan. This guide also includes an Appendix with examples and specific guidance that will help provinces in formulating policies and regulatory change.

This Radon Action Guide builds on comparative research that considers existing actions across Canada, as well as internationally, especially in the United States and European Union.[8] Many US states have specific radon legislation,[9] and in the European Union the Basic Safety Standards Directive requires member states to engage in radon planning, resulting in many country-level legal changes.[10]

Also available are a series of companion documents to justify action and support the guidance in the Radon Action Guide:

- **Justifications and Policy Rationales for Radon Action:** This document provides more detail on why governments should take action, discussing societal values around public health, saving lives, and environmental concern. It outlines how radon action is cost-effective in the long term and reduces the costs that lung cancer imposes on the health care system. It discusses initiatives already in place for which radon action is a natural extension, from Disease Prevention Strategies to Healthy Community Planning.
- **Radon Action Guide for Municipalities:** This details a series of steps that municipalities can take.

[7] Chen, J., 2019. "Risk assessment for radon exposure in various indoor environments," *Radiation Protection Dosimetry* 185(2), pp. 143-150.
[8] Quastel, N., Siersbaek, M., Cooper, K. and Nicol A-M. 2018. Environmental Scan of Radon Law and Policy: Best Practices in Canada and the European Union. Toronto and Burnaby: Canadian Environmental Law Association and CAREX Canada. Available at https://cela.ca/wp-content/uploads/2019/07/Radon-Policy-Scan-Full-Rept-with-Appendices_0.pdf (accessed January 8, 2021).
[9] For US laws, see Environmental Law Institute, 2019. Database of State Indoor Air Quality Laws. Database Excerpt: Radon Laws. Available at https://www.eli.org/sites/default/files/docs/2019_radon_with_cover_bolded.pdf (accessed January 8 2021).
[10] European Union Basic Safety Standards Directive. 96/29/Euratom. Available at http://www.ensreg.eu/nuclear-safety-regulation/eu-instruments/Basic-Safety-Standards-Directive (accessed January 8, 2021).

- **Radon Action in Municipal Law: Understanding the Legal Powers of Cities and Towns in Canada:** Recognizing that municipalities are "creatures of the provinces" and constrained by enabling law, this document looks at the powers that municipalities have to address radon.

2. Planning for Radon

2.1. Introduction to Radon Planning & Strategies

All buildings have some level of radon in them; the only way to know how much is to test. Addressing radon requires ensuring measures across many different areas, from workplace standards to residential tenancies to schools and more. This guide includes many measures that provinces and territories can take as discrete actions or bundled together. Governments can start with small steps such as public awareness campaigns while comfort around the issue grows. Governments could also take a more visionary approach and develop a radon plan, which has an overarching aim to systematically address the issue and outlines a range of interventions to achieve that goal. This can ensure a consistent, integrated, and comprehensive approach. By way of example, the European Union's Basic Safety Standards Directive requires member states to prepare action plans. Appendix, section 1 further expands on the Directive, shows important components of radon planning and how member states such as the United Kingdom have followed it for their own National Radon Plan.[11]

There are important components and general areas of concern that an action plan should address.

Surveillance: A province or territory needs to know where elevated radon is prevalent, and how many homes, workplaces and other indoor environments have high radon.

Guidelines: A province or territory can look to the Government of Canada's Radon Guideline (200 Bq/m^3) as the standard for what counts as unacceptable levels of radon. This will help drive programs for education and awareness, and a system of policy, incentives, and laws for reducing radon in different types of built environments.

Reduction Strategies: Many places (with radon policies) have distinct laws covering different aspects of the built environment. These include specific interventions covering new buildings, older owner-occupied homes (and real estate transactions), workplaces, schools, daycares, and other public spaces.

In a federal system such as Canada's, different aspects of radon planning will fall under the jurisdiction of different orders of government. Health Canada's National Radon

[11] Basic Safety Standards Directive 2013/59/EURATOM Council Directive of 5 December 2013, s. 103.1, together with Annex XVIII. Available at http://www.ensreg.eu/nuclear-safety-regulation/eu-instruments/Basic-Safety-Standards-Directive (accessed January 9, 2021).

Program has taken important steps to begin testing, set a Radon Guideline, developed standards and protocols for testing and mitigation, and developed a framework for radon professionals. However, in Canada, the federal division of powers results in significant gaps that fall on provinces and territories to fill. As this guide discusses, there are many steps remaining for provinces and territories, ranging from learning how much radon there is at the community level, and clarifying (and making into law) guidelines for workplaces and public buildings, to developing policy frameworks for reducing radon in the indoor built environment. Section 1 of the Appendix shows important components of radon planning based on international precedent, and how each order of government in Canada has important roles in the process.

2.2. Adopt Guiding Principles, Goals, and Indicators

Cohesive plans require guiding principles. Health Canada's National Radon Program's overarching goal is the reduction of radon-induced lung cancer. Provinces and territories are encouraged to set a similar goal in the development of their Radon Action plans. Other values are also important, such as health equity and ensuring everyone has access to guidance and resources to maintain and improve good health. When worked into radon planning, health equity can mean adopting policies ensuring lower income homeowners can get subsidies or incentives to remove cost barriers for testing and mitigation. Further steps could include special protections for renters and workers who lack the ability to impose standards in their living and workplaces.

Good planning should build in indicators and targets that are specific, measurable, achievable and give clear timelines. This will allow policy-makers and the general public to be focused on success and transparently assess the results.[12] For instance, a goal of "reducing the number of homes in the province with elevated radon by half within 10 years" is specific, clear and measurable and will more directly drive action compared to a vague promise of future reductions.

It is also important to build a process of learning and evaluation into the Radon Action plan to evaluate what is going right or wrong, learn of unintended consequences, and ensure continuous improvement. Provinces and territories should consider building monitoring and evaluation of programs into the radon policy and planning process. For instance, many provinces have already made changes to their building codes and this could be evaluated with studies to assess whether builders are complying with new building code provisions.

[12]Boyd, D. 2016, Cleaner, greener, healthier: a prescription for stronger Canadian environmental laws and policies. Vancouver: UBC Press, p. 227.

2.3. Linkages to Other Frameworks, Strategies & Plans

Radon action can be incorporated into broader government policies. For instance, some provinces have chronic disease prevention strategies, which often already address lung cancer. Provinces such as Alberta, Manitoba, Ontario, and Newfoundland have dedicated cancer plans which could be extended to include radon action.

A recent focus of city planning has been "Healthy Built Environment" and/or "Healthy Communities Strategies" which promote healthier lifestyles, often including the issue of unhealthy indoor air. These could be extended to include radon action. Ontario's Health Standards target natural and built environments, including indoor pollutants, and in 2018 were updated to particularly mention radon. Ontario also gives specific direction to health boards to work with municipalities to promote healthy built and natural environments to enhance population health and mitigate environmental health risks. This direction in Ontario has already stimulated a number of health units to take on radon-specific work, including health promotion and coordinated testing programs.

Appendix, section 2 includes examples of language that could be added to chronic disease prevention strategies, cancer plans, Healthy Built Environment initiatives and Public Health Standards.

The **Justifications and Policy Rationales for Radon Action** document goes into more detail about existing health and environmental strategies in which radon can be included.

2.4. Collaboration, Partnerships, Engagement

Collaboration, consultation, and partnership are important components of policy development and can help to garner public and political support for new initiatives.[13]

Provincial level radon planning should include outreach and consultation between government departments, municipalities, health authorities as well as relevant professional associations, diverse civil society actors, including lung, cancer and other health-related associations, environmental organizations, renters' advocates, and others.

[13] De Savigny, D. and Adam, T. eds., 2009. Systems thinking for health systems strengthening. World Health Organization. p. 82

Health Boards and Authorities

As previously noted, radon action can be made an important component of Health Standards and directions given to Health boards and authorities. Even without legislative or policy change, provincial and territorial radon planners can work with health boards and authorities to develop and execute a Radon Action Plan. Health Boards and Authorities will be key players in radon action, given they hold personnel trained in public health and preventive health interventions. Health boards/authorities currently have legal authority to advance radon action, investigate complaints (such as by renters), impose conditions on workplaces (such as through health officers in schools), attach conditions to licensing (such as for daycares), and conduct community testing and other initiatives.

Municipalities

Municipalities can play an important role in addressing radon. Municipalities can, for instance, launch their own community testing or incentive programs for testing and mitigation. Municipalities can also help foster coordination between various local authorities such as school boards, libraries and health authorities/boards, each of which can take steps to address radon. Municipalities are the feet on the ground and have a significant role in implementation—ensuring that particular buildings are in fact free of elevated radon levels. Municipalities are responsible for building inspection, health bylaws, standards of maintenance bylaws, bylaws governing public spaces, and business licensing—all important for ensuring low radon in rental accommodations, and places to which the public has regular access.

Provinces and territories can help municipalities with radon action. Provinces and territories can also make clear that radon action is supported by municipal legislation. For instance, municipalities may have broad powers to enact public health bylaws, but when anti-smoking bylaws were being introduced, most provinces clarified municipal law legislation to make it clear that municipalities had the legal power to do so. In some provinces, there are legislative requirements that municipalities consult with provinces when passing bylaws relating to health and the environment. For examples and model language on supporting legislation and provincial approval procedures, see Appendix, section 3.

Provinces can also develop model bylaws, provide planning guidance, and direct staff to liaise with municipalities and help with coordination. This guide discusses working with municipalities to ensure Building Code provisions are implemented and inspected (Section 3.5 and Appendix, section 8.1), and model standards of maintenance bylaws that provincial and territorial governments can promote (Section 3.7, and Appendix, section 10).

Provincial and territorial governments with an interest in supporting Municipal Radon Action Plans can refer to **Radon Action in Municipal Law: Understanding the Legal Powers of Cities and Towns in Canada** and **Radon Action Guide for Municipalities.**

2.5. Finding a Home for Radon Programs

Radon requires a "Whole of Society" approach in the sense that it requires action across many areas of law, policy, and governmental organization that touch on the built environment.[14] This means that any one agency may face significant barriers to solving the problem if left on its own. For instance, public health ministries are an obvious place to lead a Radon Action Plan—and there are important precedents where health officers have interpreted Public Health legislation to take action on radon in Alberta[15] and BC.[16] In Ontario the *Public Health Standards* have triggered important local level testing initiatives and public outreach.[17] However, if radon is treated as the exclusive domain of public health officers, they may find they have no legislative mandate to make important changes, such as might be required to protect renters, update building codes, or ensure elevated radon is covered by home warranty programs.

More comprehensive radon planning can help ensure issues are not siloed and create intergovernmental cooperation. Governments should ensure there is a single agency for administering the Radon Action Plan, that will guide the policy process, program implementation, and develop systems that foster interaction, flows of information, and cooperation between provincial government departments and agencies and key partners, such as municipalities and organizations representing important sectors (including radon professionals, device manufacturers, landlords, tenants, employers, and health organizations).

[14] Kickbusch, I. and Behrendt, T., 2013. Implementing a Health 2020 vision: governance for health in the 21st century. Making it happen. World Health Organization. Regional Office for Europe. Addy, N.A., Poirier, A., Blouin, C., Drager, N. and Dubé, L., 2014. Whole-of-society approach for public health policymaking: a case study of polycentric governance from Quebec, Canada. *Annals of the New York Academy of Sciences* 1331(1), pp. 216-229.

[15] See *Public Health Act*, RSA 2000, c. P-37 s. 59 to 61, and the Nuisance and General Sanitation Regulation, Alta Reg 243/2003, using "Nuisance" defined as "a condition that is or that might become injurious or dangerous to the public health, or that might hinder in any manner the prevention or suppression of disease" (*Public Health Act*, s. 1(ee)). This is further discussed in Quastel et al., ibid. at p. 86.

[16] Using the *Community Care and Assisted Living Act*, S.B.C. 2002, c. 75 which empowers medical health officers to attach terms and conditions to a license (s. 11) and to revoke licenses if there is a risk to persons in the care of such facilities (s. 14). For further discussion see Phipps, E., Nicol, A.M., Giesbrecht, D., Cooper, K., Baytalan, G. and Bush, K., 2017. Call for action on radon in child care settings. *Environmental Health Review* 60(3), pp. 77-81. Quastel, et. al., ibid. at p. 93

[17] See Take Action on Radon, 2020. Ontario. Available at https://takeactionradon.ca/ontario/ (accessed January 8, 2021).

3. Radon Reduction Actions

The following are distinct actions that provinces can take, either as standalone interventions or as part of a broader Radon Action Plan. References are made to sections in the appendix that provide resources and tools, such as examples from other jurisdictions, communication materials, and model Code language.

3.1. Testing, Databases, and Mapping

Importance of Widespread Testing

A key piece in understanding the radon problem is knowing what locations are more prone to elevated radon. Health Canada stresses that all homes have some level of radon and should be tested, but the prevalence of high radon—and the risk that a particular building might have elevated radon—can vary significantly. Studies show that in some places in Canada, such as Regina, Saskatchewan, over half of homes (without radon systems) have radon levels above Canada's Radon Guideline of 200 Bq/m^3.[18]

Identifying high radon areas is important for targeting policy interventions. In British Columbia, radon provisions in the BC Building Code, 2018 are directed at municipalities where there are clear indicators (including from surveys and testing initiatives) that there are radon problems.[19] In Ontario, the Building Code radon provisions apply where "radon gases are known to be a problem".[20] Many initiatives, such as public education, outreach efforts, and subsidies for testing and mitigation will be more efficient and effective if targeted at high radon risk areas.

Health Canada's 2012 Cross-Canada Survey of Radon Concentrations in Homes was an important first step. However, due to the budget and logistics of surveying all of Canada, it has a limited sample size of approximately 100 results per health region.

There are a variety of testing initiatives across the country, including testing of government-owned buildings at the federal level, public buildings such as schools, and community testing of homes. For example British Columbia's RadonAware program's testing for Prince George and Castlegar, the Evict Radon program in Alberta, and the Take Action on Radon program, which enrolls municipalities in the "100 Test Kit Challenge." However, most parts of Canada still do not have sufficient numbers of test results.

[18] Stanley, F.K., Irvine, J. L., Jacques, W.R., Salgia, S.R., Innes, D.G., Winquist, B.D., Torr, D., Brenner, D.R. and Goodarzi, A.A., 2019. "Radon exposure is rising steadily within the modern North American residential environment, and is increasingly uniform across seasons," *Scientific Reports* 9(1), pp. 1-17.
[19] BC Building Code, Division B Section 9.13.4, together with Division B Appendix C, Table C-4.
[20] Ontario Building Code 2012, as amended, 9.13.4.2, and Supplementary Standard SB-9.

Building Awareness, Community Testing and Citizen Science

To date, many agencies in Canada have started programs to hand out test kits free of charge or on a subsidized basis (see Appendix, section 4.1 – 4.3). It is important to distinguish different types of programs and rationales.

- Some initiatives are primarily oriented towards building awareness. They seek to both build awareness of radon and help individuals test.

- Community testing initiatives are oriented towards learning radon prevalence in the community. Here, researchers estimate an appropriate sample size to allow sufficiently precise estimates for a municipality or region. For example, in the communities of Thunder Bay, Windsor-Essex, and Kingston, Frontenac, and Lennox & Addington in Ontario, hundreds of test results per area were completed to help support policy changes related to building codes and public health standards.

- In citizen science projects, individual home occupants are asked to test their homes in exchange for allowing researchers to collect radon readings and survey data. Results are typically held in university or health agency databases and are used to provide evidence-based reporting and guidance to the target area (for a list of initiatives, see Appendix, section 4.3).

In practice, these different testing approaches are compatible and can be combined in a single program. For instance, a community testing initiative can also have a significant public awareness component, and also collect survey data to be shared with researchers.

Databases and Maps

Data collection is important to support the development and implementation of Radon Action plans. A radon database can help build understanding of how radon intersects with local health conditions (such as prevalence of smoking), the links between geological radon and risks in homes, or whether some people have a greater genetic susceptibility to radiation-related illness. Creating a radon map or other visual resource can be an effective way of communicating risk and supporting policy action. For instance, knowledge of local radon risks in the real estate industry can serve to put buyers, sellers, and realtors on alert that radon may be a latent defect in houses for sale. Health Canada's radon data is available at https://open.canada.ca/en.

The government of Nova Scotia and a private sector company (Radon Environmental Management Corp.) have produced maps by using underlying geological and soil information.[21] However, radon concentrations also depend on building structure and design, and collecting indoor tests is considered to be a better way of estimating local radon risks. Health Canada has developed a radon risk map utilizing Nova Scotia and Radon Environmental Management Corp.'s survey data, data from the Cross-Canada Radon Survey (2011), the Radon/Thoron Survey in Canadian Metropolitan Areas (2013), data from radon laboratories, and national geological data. For a list of examples of radon testing approaches and programs, databases and mapping, see Appendix, section 4.4.

In creating maps and databases, efforts can be made to collect test data from diverse sources, such as results of community testing initiatives, government testing of its own buildings, academic research, citizen science projects, and from health associations who have sold or distributed radon test kits. This can be improved through coordination on many issues, ranging from content of survey data to ensuring consent forms facilitate sharing of results. To help with coordination, database managers, researchers and mappers across Canada have formed the Canadian Radon Database and Mapping Working Group.

Collection and Reporting of Test Results

There are possibilities for ensuring that whenever buildings are tested for radon, the results are placed into databases. The Canadian government has compiled radon tests of its own buildings, and provincial governments could require that any in-house testing initiatives make public the results. This Guide discusses certification of radon professionals in Section 3.3. Once radon professionals are certified there can be further requirements that any radon test results they obtain be shared with government agencies. For a list of jurisdictions (and regulations) that require reporting of test results, see Appendix, section 6.2. A provincial or territorial government could couple the creation of databases with requirements for radon professionals and testing laboratories to contribute to it.

3.2. Education and Awareness

A key component of addressing radon is ensuring that people know that it is a health risk and have the tools to act to remedy it. Many countries and sub-national governments around the world have radon education programs.

[21] Nova Scotia Department of Natural Resources. Radon Risk Map for Nova Scotia. Available at https://fletcher.novascotia.ca/DNRViewer/?viewer=Radon (accessed January 8, 2021). Radon Environmental Management Corp. 2012. Radon Potential Map for Canada. Available at http://www.radonaware.ca/database/files/library/Canada_Radon_Potential_Map.pdf (accessed January 8, 2021).

While diverse agencies such as municipalities, health authorities, centres for disease control, and government agencies may have information on web pages, it is helpful to have a centralized Provincial/Territorial information portal which can be kept up to date. This helps people navigate the problem of many different and conflicting information sources through the provision of reliable, government-endorsed, and up-to-date public health information (Appendix, section 5).

Along with web resources, other communication and outreach techniques should be used to effectively reach the target audiences, such as radio, television, social media, print media, public meetings and webinars. It is also important to ensure awareness efforts extend to diverse unilingual language users in your communities who may be more receptive to information presented in a language other than English or French.[22] Appendix, section 5 provides access to Health Canada and Take Action on Radon outreach and communication resources.

Resolutions

Educational programs can be strengthened by broad resolutions, such as a legislature recognizing November as Radon Action Month in Canada. Health Canada's 2019 proclamation is a good example. Appendix, section 5.2 provides information and examples of such resolutions.

Empower Health Authorities

An empowered public health administration will play a key role in advancing radon action. Many health authorities have the legal power to offer education on radon but individual officials may lack a clear mandate. One way to improve the situation is to follow the lead of the Ontario Public Health Standards which establish action on radon as a minimum expectation by the Province for its boards of health (Appendix, section 5).

Target At-Risk Audiences

Some agencies have found ways of particularly targeting persons at high risk of radon. For instance, where homes with exceptionally high radon levels are found, Public Health England provides additional individual practical support to the householders that can include on-site visits, individual advice, assistance in remediating, and periodic radon monitoring.[23]

Community Testing and Citizen-Science Approaches to Engagement

These can create more active ways of engaging publics in radon. As mentioned earlier, testing initiatives can help people learn about radon, but also contribute to community

[22] Statistics Canada, 2011. Linguistic Characteristics of Canadians. Catalogue no. 98-314-X2011001
[23] UK Radon Action Plan (2018), s. 3.1.6 p. 11.

level knowledge and science on the topic.[24] For further resources on awareness, citizen science and community testing see Appendix, section 4 on testing, databases, and mapping.

Tap into Existing Duties

Many people have direct responsibilities relevant to reducing radon. Landlords, employers, school districts, and others in charge of indoor spaces *already* have broad obligations to meet health and safety requirements. What is needed from provincial and territorial authorities is to raise awareness about radon and communicate how radon fits into those obligations. For instance, real estate licensees generally have duties to be knowledgeable about environmental conditions and to take the appropriate steps to alert their clients of known health or environmental concerns. Several real estate councils and associations in Canada have been able to significantly advance radon awareness and action through notifying real estate professionals about the ways that their existing duties extend to radon. (See Section 3.6 below and Appendix, section 9 for further discussion on real estate agents' duties around radon.)

Offer Training to Trades and Professional Groups

A variety of occupational and professional groups do not know enough about radon. Municipal building inspectors, building tradespeople and contractors, family doctors, pharmacists and others would be better equipped and more likely to correctly address radon in their work given the correct capacity-building. Section 5.5 of the Appendix lists known radon courses for professionals.

Guidance and Protocols on Testing and Mitigation

Health Canada and the Canadian General Standards Board have already developed many guidance documents on best practices for testing and mitigating different types of buildings. For examples, see Section 5 of the Appendix. Provinces and territories can reference these materials to help guide the general public and professionals who work with radon.

Support Outreach with Stronger Action

Governments can send the message that an issue is important through having clear policy and law change. This includes many tools discussed in this guide, such as incentives and subsidies for testing and mitigation, and a host of regulatory and legislative changes. Section 5.6 of the Appendix discusses jurisdictions with legal requirements around radon education.

[24] McKinley, Duncan C., et al. "Citizen science can improve conservation science, natural resource management, and environmental protection," *Biological Conservation* 208 (2017), pp. 15-28.

3.3. Recognizing Certified Radon Professionals

Radon measurement in larger buildings, and installing radon reduction systems in any building, can require specialized knowledge. In some cases, such as real estate transactions, parties engaged in arms-length transactions require a reliable third party to provide an assessment. As such, qualified radon professionals are an important part of a societal response to the radon problem.

Licensing and Certification of Professionals

Health Canada recommends radon mitigation and measurement professionals certified through the Canadian National Radon Proficiency Program (C-NRPP). However, certification remains voluntary. While Canadian provinces have jurisdiction for regulating professions, none have acted on this for radon professionals. However, many areas such as plumbing, massage therapists etc. do require certification. Consumers may be faced with advertisements and offers for radon abatement from unqualified providers. Consumers who do not know the details of radon may be drawn to providers who offer services at a low cost, creating a danger that substandard work could drive out better qualified providers and become normalized. Licensing and certification can thus ensure high standards and guarantee quality to consumers. Appendix, section 6 provides model language on regulating radon professionals and gives examples of jurisdictions where this has been done.

Ensuring Professional Standards

In Canada, C-NRPP oversees professional education and training, and imposes its own duties on members, set by the C-NRPP Policy Advisory Board. This includes following guidance documents from the Canadian General Standards Board, Health Canada, the Canadian Association of Radon Scientists and Technologists and C-NRPP's own internal documents.[25] As well, C-NRPP has a system for approving radon measurement devices[26] and analytical laboratories.[27]

In regulating radon professionals, provinces and territories should consider requiring C-NRPP certification as the appropriate standard.

[25] C-NRPP 2021. Resources for Professionals. Available at https://c-nrpp.ca/resources-for-certified-professionals/ (accessed January 8, 2021).
[26] See C-NRPP. 2021. Listed Radon Measurement Devices. Available at https://c-nrpp.ca/approved-radon-measurement-devices/ (accessed January 2021).
[27] C-NRPP's process for certifying laboratories is found on this page: https://c-nrpp.ca/how-to-become-certified/ (accessed January 8, 2021).

Professional Contribution to Radon Databases and Maps

Another advantage of certified professionals is they can be directed to contribute testing results to centralized databases. C-NRPP certified professionals already do this in Canada on a voluntary basis and so help produce C-NRPP's radon map. Twelve US states mandate not only that radon service providers be certified but that they deliver test results to state agencies (Appendix, section 6.2).[28]

Ensuring Services Are Available

Service provision in Canada has been primarily through the private sector. However, governments can have a role, at times, in supporting a still-developing industry. In some locations, there may be a relative absence of C-NRPP professionals, in part because there is not yet customer demand. This creates a potential vicious circle, as consumers who need the services have trouble accessing them. Some provinces have, in the past, taken the approach of directly subsidizing trades workers to take C-NRPP certification (various types of construction, electrical, plumbing, or engineering occupations are obvious entry points).[29] Provinces should also consider regular monitoring of the industry to ensure services are available to consumers.

3.4. Government Buildings and Operations

Governments have broad duties to ensure spaces are safe, whether as employers, landlords (in relation to social housing), or "occupiers." A government might also choose to construct its own buildings to higher standards as a way of acting ethically, leading by example, or to help support local environmental industries. Government testing can also be a way to build databases and maps.

The federal government has conducted extensive testing of federally occupied buildings, and some provinces have also tested their buildings. Some US states have enacted specific legislation requiring testing in government buildings. (Canadian and US examples are provided in Appendix, section 7).

Where widespread mandatory certification of radon professionals is not yet in place, provinces and territories should consider requiring C-NRPP certified professionals be used for any radon work in government owned buildings.

[28] c.f. New Jersey Statutes Title 7, Chapter 28, Subchapters 27. Available at https://www.nj.gov/dep/rpp/radon/download/sub27.pdf accessed January 8, 2021; also Environmental Law Institute 2012, ibid. at p. 6.
[29] Authors' discussion with Dr. Menn Biagtan, British Columbia Lung Association and participant in the RadonAware program.

3.5. Reducing Radon in New Homes

Building Codes

New construction is an excellent place to implement radon provisions, given that Building Codes are often updated, this is an area where health and safety standards are widely accepted, and targeting new construction is particularly cost-effective. There are radon provisions in the (model) National Building Code (with the radon provisions last updated in 2010), and many provinces have incorporated some radon provisions in their Code (Appendix, section 8.1). Provinces and territories without radon provisions, or with older iterations of radon standards, should consider updating their Codes.

To unpack the variety of codes in Canada, it may be useful to analyze different radon reduction strategies, ranging from the most rudimentary to the most effective.

- **Soil gas barriers:** This involves placing a membrane between the slab and the ground below. This remains one option that builders might use in Ontario.[30] **Soil gas barriers are not considered an effective stand-alone radon reduction strategy.**
- **Radon rough-in with stub:** This involves the sealing of radon (and other soil gas) entry points, granular material below the slab, and a radon rough-in "stub"—a short vent pipe which rises from the floor and is capped. This was added to Canada's National Building Code in 2010 and has been adopted into several provincial and territorial Building Codes. There is a significant risk that high radon environments remain untested and unmitigated. Current best practices require more complete systems.
- **Passive sub-slab depressurization:** This involves a pipe installed through the foundation that runs upwards through the inside of the building and vents to the outside at the roofline. British Columbia's Building Code started with the rough-in stub (following the National Building Code) but after studies showed problems with implementation,[31] moved to a modified form of passive depressurization system in radon risk areas. While often effective at reducing radon, these systems can not be relied on to reduce high radon concentrations to below the guideline level. Homes with these systems should still have the radon level tested.
- **Active sub-slab depressurization:** This involves adding a fan to passive sub-slab depressurization systems to further increase the reduction of radon. Québec's Building Code now requires the radon rough in with stub, with the

[30] Ontario Building Code, s. 9.13.4.2. and MMAH Supplementary Standard SB-9, "Requirements for Soil Gas Control."
[31] See Rogoza, D. et al. 2015. A Comparison of Three Radon Systems in British Columbia Homes: Conclusions and Recommendations for the British Columbia Building Code. BC Lung Association. Available at http://www.radonaware.ca/database/files/library/BCLung_Radon_Castlegar_reportG___updated(1).pdf (accessed January 8, 2021).

additional need for radon test results to be submitted to the authority having jurisdiction (generally municipal building officials) and the addition of sub-slab depressurization sufficient to reduce levels to within Health Canada's Guidelines.[32]

Health Canada recommends that all provinces and territories incorporate radon reduction into their building codes. The Canadian General Standard Board's 2019 "Radon control options for new construction in low-rise residential buildings" is the recognized mitigation standard in Canada and should be referenced in building codes. The standard provides detailed technical prescriptions for radon mitigation strategies.

There are significant benefits to targeting radon prone areas and requiring new homes to have operational systems (i.e., at least a passive sub-slab system), ensuring that homes are built with less radon in them and reducing the incidence of radon-induced lung cancer in higher risk regions.

If Building Codes continue to require forms of 'rough-ins' that are incomplete, provinces and territories should consider requiring clear labelling on these systems stating that they are incomplete. Radon levels in a home will normally not be known until after occupancy, and further radon testing is required by homeowners once they occupy the home. Provinces and territories can consider requiring builders to leave radon test kits and informational guides with new home-owners.

In updating Building Codes, provinces and territories should also consider important procedures. It is a good idea to require C-NRPP certified professionals be involved in designing, overseeing, and building radon systems in new construction. Any installed radon systems should be labeled. Post-construction testing is necessary to ascertain whether systems have actually reduced radon levels. As well, Building Codes need to be followed, and provinces should include educational outreach for builders to ensure proper implementation. Provinces should consider research and follow-up surveys to determine the impacts of their building code changes on radon levels in homes and other buildings.[33]

Inspections

A building code is only as good as its implementation. Radon mitigation is often overlooked in whole or in part during post-construction inspections, due to lack of resources, lack of understanding of radon issues, and lack of clarity regarding who is

[32] chapter B-1.1, r. 2, Construction Code, s. 9.13.4.6. available at http://legisquebec.gouv.qc.ca/en/pdf/cr/B-1.1,%20R.%202.pdf accessed March 4, 2021

[33] Arvela H. et al., 2012. "Radon prevention in new construction in Finland: a nationwide sample survey in 2009," *Radiation Protection Dosimetry* 148, 4, pp. 465-474. Manitoba Home Builders Association 2014. Radon Demonstration: Application of Building Code Changes in Winnipeg New Home Construction (accessed December 1, 2020).
Fabio Barazza et al., 2018. A national survey on radon remediation in Switzerland, *Journal of Radiological Protection* 38, pp. 25-33.

responsible for inspecting radon mitigation systems.[34] Building Code legislation should include requirements for education and technical assistance in administering new standards.[35]

Canadian provinces generally delegate Building Code enforcement to municipalities, either by direct requirement[36] or matter of course.[37] Municipalities may also face liability for negligent inspection.[38] Education and training for inspectors concerning radon will therefore be a key component of provincial collaboration with municipalities.

New Home Warranty

Many real estate associations and councils in Canada now treat elevated radon as a latent defect in home sales. This same idea can extend to new homes. Most Canadian provinces have New Home Warranty systems in place which provide for protection from defects in structure, materials, and workmanship. Tarion (Ontario's provider) explicitly recognizes high radon as a defect and provides direction to home buyers on how to address the issue with builders (see Appendix, Section 8.2, for examples of radon reduction policies for new homes).[39] Tarion's policies apply even where the Ontario Building Code radon provisions are not enforced.

Provinces should give explicit direction to make sure that high radon is understood to be a defect in structure or materials in a home. Provinces can consider recommending or requiring that home builders provide information to new homeowners about the risks of radon and the importance of conducting a long-term radon test after moving in. Radon information should also be included in applicable guidance documents, such as Construction Performance Guides for warranty-approved builders and continuing education requirements for building contractors.

3.6. Reducing Radon in Owner-Occupied Homes

While Building Code changes can be an important way to address radon, only 1 to 2% of the housing stock is newly built each year. There are, however, a suite of interventions that can help reach the existing housing stock.

[34] Quastel et. al. 2018 ibid. at p. 37.
[35] Environmental Law Institute, 2012, ibid. at p. 28.
[36] See Saskatchewan The *Uniform Building and Accessibility Standards Act*, SS 1983-84, c U-1.2 s. 4 Manitoba. The *Buildings and Mobile Homes Act*, CCSM c B93 s.4; Ontario, *Building Code Act*, 1992, SO 1992, c 23 s. 3; *New Brunswick Building Code Act*, SNB 2009, c N-3.5, s. 4(1), and 6(1); *Building Codes Act*, RSPEI 1988, c B-5.1 s. 8(3); Nova Scotia, *Building Code Act*, RSNS 1989, c 46, s. 5.
[37] British Columbia, Community Charter 8 (3)(l) and s. 54, Alberta *Safety Codes Act*, RSA 2000, c S-1, s. 26; Yukon *Building Standards Act,* RSY 2002, c 19 s. 4 ; Nunavut, *Building Code Act*, SNu 2012, c 15 s. 21(3).
[38] *Rothfield v. Manolakos* [1989] 2 S.C.R. 1259; *Just v. British Columbia*, 1989 CanLII 16 (SCC), [1989] 2 SCR 1228; *Ingles v. Tutkaluk Construction Ltd.*, 2000 SCC 12 (CanLII), [2000] 1 S.C.R. 298.
[39] Tarion, 2021. Radon and Your Warranty. Available at https://www.tarion.com/homeowners/your-warranty-coverage/radon-and-your-warranty (accessed January 8, 2021).

Real Estate Transactions

Radon should be considered a consumer protection issue for buyers and sellers of homes. There is already significant action in Canada related to addressing radon in the real estate process. Quebec courts have stated that radon could be considered a latent defect.[40] Common law courts would likely make the same finding. A significant number of real estate associations and regulatory councils across Canada have concluded that radon is a latent defect in a home, meaning that sellers have a duty to disclose to buyers known elevated radon levels. In the United States some states have passed laws that enshrine the same principles.[41]

Typically, governance of real estate transactions is a complex mix of government legislation, independent regulatory oversight, and industry self-governance. In some cases, provincial radon planning may proceed through a process of education, coordination, and cooperation with industry and independent regulators. Existing experience in Canada suggests both associations and regulators have shown willingness to act, when informed. That said, radon planning should not lose sight of the ability of provincial governments to introduce new legislation and use this power in negotiating with associations and regulators. Key pieces to consider implementing include:

- **Clarification of agents' duties.** These include proactively discussing radon with their clients (whether sellers or buyers), raising the issue in negotiations, and disclosing known high radon levels as a latent defect. Appendix, section 9.1 on policies for radon reduction in existing homes includes details on the work of Canadian provincial level real estate councils and associations in issuing guidance to buyers, sellers and real estate agents.
- **Radon on the Property Disclosure Statement,** including known radon levels, whether there has been a long-term (91-day) test, the date of any testing, and any mitigation performed. Appendix 9.1 provides some examples of Canadian provinces where radon is specifically mentioned in disclosure forms for real estate transactions.
- **Mandating information for home buyers,** such as having sellers give standard forms, typically produced by public health agencies, to buyers (Appendix 9.1). Some US states require such statements, including Delaware, Florida, Iowa, Illinois, Kansas, Minnesota, Montana, and New Hampshire.[42] An alternative

[40] Quebec Civil Code, art. 1726; *Pouliotc. Leblanc* 2011 QCCQ 7882
[41] 2 DE Code § 2572, § 2572a; Maryland Real Property Code § 10-702; Colorado Revised Statutes § 12-61-804
[42] See Environmental Law Institute, 2020. Database of State Indoor Air Quality Laws, Radon Excerpt. Available at https://www.eli.org/sites/default/files/docs/2020_radon_excerpt_3.3.20_bold.pdf (accessed January 20, 2020). Individual state provisions include: Delaware Code, tit. 6, §§ 2570--2578; Florida Statutes § 404.056; Kansas State Act 58-3078a; Illinois Compiled Statutes Ch. 420, §§ 46/1--25; Iowa Code § 558A.1 et seq.; Minnesota Statutes § 144.496; Montana Code Annotated 2017, Montana Radon Control Act, 75-3-606; New Hampshire NH Rev Stat § 477:4-a (2015).

approach might be to work with trade associations/regulators to streamline information that realtors give to clients as part of their own professional duties

Subsidies and Financing for Homeowners

In many cases, testing and mitigating elevated radon is a cost-effective health intervention. Health economists have found radon interventions on par with or less expensive than other medical and drug expenses governments regularly incur with an eye to improving life-expectancy and quality of life. This is particularly so in high radon potential areas.[43] Subsidies and incentives work to share the costs of a collective good. Equity considerations arise as well. Homeowners with lower incomes will tend to push off into the future radon testing and any needed mitigation.

Appendix, section 9.2 details a range of subsidy and incentive programs for homeowners, ranging from prices as an incentive to test one's home to tax credits for mitigation work.

Subsidies for mitigation should only be made available where mitigation is performed by C-NRPP certified radon professionals.

Strata/Condominium Units

Special attention should be given to the unique situation of people who live in strata properties (in British Columbia) and condominiums (elsewhere in Canada). The enabling legislation for this type of housing arrangement typically allocates to owners the responsibility to maintain and repair their own units and allocates to a common corporation the duty to maintain and repair common areas. Legislation does not spell out particular indoor health standards.[44] Care should be taken to ensure that any rules around real estate transactions (such as mandatory information or latent defects), home warranty, subsidies and incentives, and certifications extend to strata and condominium units. Special education and outreach on radon can be directed at strata councils/condominium boards or specialty organizations, such as the Condominium Authority of Ontario.

[43] Gaskin, J., Coyle, D., Whyte, J., Birkett, N. and Krewksi, D., 2019. "A cost effectiveness analysis of interventions to reduce residential radon exposure in Canada," *Journal of Environmental Management* 247, pp. 449-461. For a broader introduction to health economics analysis of radon see World Health Organization, 2009. WHO Handbook on Indoor Radon: A Public Health Perspective. Geneva, Chapter 4, Cost Effectiveness of Radon Control.

[44] *Strata Property Act*, SBC 1998, c. 43, s. 72; *Condominium Property Act*, RSA 2000, c C-22 s. 37; The *Condominium Property Act*, 1993, SS 1993, c C-26.1 s. 35; The Condominium Act, CCSM c C170 s. 180; Condominium Act, 1998, SO 1998, c 1 s. 90; *Condominium Act*, RSNS 1989, c 85 s.35; *Condominium Act*, RSPEI 1988, c C-16; *Condominium Act*, 2009, SNL 2009, c C-29.1 s. 55; *Condominium Act*, RSY 2002, c 36 s. 18; *Condominium Property Act*, SNB 2009, c C-16.05s. 48; *Condominium Act*, RSNWT 1988, c C-15 s. 23; Quebec Civil Code s. 1039.

3.7. Rented Homes

Over a third of Canadian households rent their homes. Attention to renters and social housing is important for ensuring action on radon follows principles of health equity, and to ensure a healthy home environment for the tenants. Renters do not normally have the legal right nor the funds to conduct major repairs on buildings they do not own.

Testing programs (as described above in section 3.1) should be careful to include rented accommodation, and education and awareness programs (as described above in Section 3.2) can be specifically tailored to renters. As well, there are a number of areas of law, regulation, and policy that can specifically target radon in rented homes.

Residential Tenancies/Landlord Tenant

Each province and territory has legislation, typically named as Residential Tenancy or Landlord-Tenant law, that includes necessary terms in the landlord-tenant contract. Generally, these include broad provisions giving landlords the duty to ensure living spaces are in "good repair." Administrative tribunals in Ontario and Quebec have already held that elevated radon will violate those provisions.[45] It is only a matter of time (and efforts by renters and their advocates) before tribunals in other provinces and territories also identify radon as a problem. One way to ensure such tribunals make findings around radon is to support tenants' advocacy organizations, and housing advocates to bring cases forward. More generally, education should be directed at both landlord and tenant groups. Provinces and territories can also work with tribunals to provide interpretations and guidance documents that indicate residential tenancy law supports radon action.

A further step would be to implement new legislation or regulation that makes clear what counts as a problematic state of disrepair. This makes it much easier for renters (or their advocates) to explain the issue to landlords and avoids the situation where a renter has to go to a tribunal to have their situation taken seriously. For instance, in the United Kingdom, the *Homes (Fitness for Human Habitation) Act 2018* together with regulations take explicit steps to protect tenants through listing out a series of indoor contaminants, air quality issues and health hazards that affect rented accommodation (and so render it unfit for human habitation). This includes radiation from radon.[46] Appendix 10 covers existing legislation and model language suitable at the provincial and territorial level. Renters can also be protected through Public Health Regulations and municipal level

[45] Ontario, CET-67599-17 (Re) 2017 CanLII 60362 (ON LTB); Quebec-- *Vanderwerf v. Dolan*, 2019 QCRDL 37417
[46] United Kingdom Ministry of Housing, Communities & Local Government, 2019. Guide for tenants: *Homes (Fitness for Human Habitation) Act* 2018. Available at https://www.gov.uk/government/publications/homes-fitness-for-human-habitation-act-2018/guide-for-tenants-homes-fitness-for-human-habitation-act-2018 (accessed June 18, 2020).

Standards of Maintenance Bylaws. (Standards of Maintenance Bylaws are further discussed in the *Radon Action Guide for Municipalities*, section 8.)

Provinces and Territories could update their residential tenancies laws to require radon testing in occupied rentals in contact with the ground. Mitigation should be explicitly required if tests show levels above the Canadian Guideline. This would make explicit when landlords test, disclose results to tenants, and mitigate high radon in rental dwellings.[47] In some provinces or territories it may be appropriate to specify this only for known radon-prone areas. This would allow landlords and tenants to understand their rights and obligations by direct reference to legislation or regulation and may help avoid the cumbersome process of applying to administrative tribunals to secure rights. One option could be to allow renters to test and if necessary pay the costs of mitigation and then recoup this from landlords—in the form of reduced rent. In British Columbia this power is already given to tenants in areas of "emergency repairs"[48] which could be clarified to include mitigation of elevated radon. For radon reduction it is recommended that the use of certified mitigation professionals be required. This will ensure the quality of service and an ability to be able to track compliance and report radon results through the accreditation body.

Landlords and their organizations are more likely to support radon measures that do not simply pass on to them the costs for supplying a social good. **Policy makers should consider distribution of subsidized or free radon testing kits, extending tax credits, direct grants and other incentives for radon work in rental accommodation.**

Housing and Maintenance Standards

Some Canadian provinces have explicit housing standards that apply to residential accommodation. Generally, these are regulations to public health acts, and empower health officers to take action once a renter lodges a complaint with them. This can provide renters with access to a sympathetic advocate rather than needing to go through a complex tribunal process. Currently no provincial or territorial standards explicitly include radon in housing and maintenance standards.

It might be possible for health officials with knowledge and understanding around radon to apply very general public health clauses to renters' complaints and work with a landlord to require mitigation. In Alberta a health officer drew on general nuisance clauses in the *Public Health Act* and the *Nuisance and General Sanitation Regulation*.[49]

[47] For Norway see references in Quastel et al. 2018, ibid. Appendix 1, Page 23; Maine, 14 M.R.S.A. Section 6030-D

[48] *Residential Tenancy Act*, SBC 2002, c 78, s. 33.

[49] *Public Health Act* at s. 59 to 61, and the *Nuisance and General Sanitation Regulation*, Alta Reg 243/2003 Reg 243/2003.

A better approach is to ensure that radon and other indoor air quality concerns are explicitly mentioned in these regulations. Appendix, section 10.3 provides examples and model language for health regulations. Ideally there needs to be direction given to health boards and authorities to take action on radon, coupled with supportive policies, such as empowering health officers to spend the time needed to learn about, and take enforcement action concerning, elevated radon.

In many cases provinces have delegated maintenance standards to municipalities. Provinces should then work with municipalities to ensure radon is considered. If provinces have model standards of maintenance bylaws, they should be sure radon is included. Appendix, section 10 provides model language for standards of maintenance bylaws. (See also *Radon Action Guide for Municipalities*, section 8).

Affordable Housing

Canada has a hybrid system of support for non-market housing and care should be taken to tailor radon policies to each type.

Some building sites are **owned directly by provincial governments and their agencies**. In these cases, governments should address radon both as part of their own operations and as part of their responsibilities as landlords. Indeed, a number of provinces and public housing corporations have already conducted radon testing (Appendix, Section 10.6). Beyond testing and mitigation programs, efforts can include updating internal standards, guides and toolkits for housing managers.

Often, affordable housing is provided by **non-profit housing societies**. There are many avenues for addressing radon here, including directed education to providers, updating guides and toolkits, and ensuring radon testing and mitigation requirements are included in required standards and operating and management agreements. Policy makers should consider direct subsidies and incentives for testing and mitigation as well as tying requirements to financial support.

Special consideration should be given to **housing cooperatives**, which make up a sizeable number of social housing units in Canada. While housing cooperative participants typically pay rent on a month-to-month basis, they largely have a membership, rather than tenant status: Most inhabitants are also collective owners of buildings and land. They do not have protection under landlord-tenant laws. Underlying legislation covering cooperative associations does not specify indoor air quality or other health standards. Issues as to indoor health and environment standards are established by bylaws of the cooperative or settled by collective decision making. Unlike strata units, cooperatives often do make collective decisions (and pool money) for some

maintenance issues within individual units. A good approach can be to direct education and outreach to housing cooperatives. Provinces and territories can also offer forms of assistance such as drafting model policies for housing cooperatives, or providing targeted subsidies and incentives for radon testing and mitigation.

Some provinces have moved to providing **portable rent subsidies**—these allow eligible individuals to receive subsidy for rental units (at times provided by co-ops and non-profit housing providers, but also through private market rental units). This may occur for persons in need in locations where no subsidized housing is available. While landlord-tenant laws will apply, housing agencies may also conduct independent checks to ensure basic safety standards are met.[50] A further condition for review of potential units could include radon testing, disclosure of results to agencies and tenants, and, if needed, mitigation.

3.8. Work, Study, and Care Spaces

Workplaces

It is estimated that the majority of exposure to radon in the Canadian population is from time spent at home.[51] Still, it is important to test and reduce radon exposure in work environments, schools, and daycares.

The Canada Labour Code, which governs workplaces under federal jurisdiction, has been updated to reflect the National Radon Guideline of 200 Bq/m^3. As well, the Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM Guidelines) recommends a radon protection framework for all workplaces in Canada. The NORM Guidelines provide a tailored way to ensure workplaces align with the National Radon Guideline of 200 Bq/m^3 and other radiation protection standards.

Provinces and territories should ensure their occupational health and safety regulation provide workers protection against elevated radon. Provincial and territorial workplace legislation does not generally provide specific wording on radon in the normal workplace, although some do have provisions for ionizing radiation or incorporate lists of exposures from organizations such as the American Conference on Government Industrial Hygienists (ACGIH). All provinces, however, have "general duty clauses" that

[50] BC Housing and Province of British Columbia, 2015. Program Guide: Housing Provider Kit. pp. 68-73.
[51] Chen, J., 2019. "Risk assessment for radon exposure in various indoor environments," *Radiation Protection Dosimetry 185*(2), pp. 143-150.

require attention to hazards.[52] One important example that can be followed is Ontario, which has issued guidance for how the NORM Guidelines work together with the general duty clause to apply to workplaces in the province.[53]

Section 11 of the Appendix, provides resources to help provinces and territories update their workplace standards to ensure workers are protected from elevated radon.

Schools, Day-Cares and Long-Term Care Facilities

Exposure to high radon during childhood increases the lifetime risk of developing lung cancer later in life.[54] There is a legal basis for radon action in schools based on the occupational health and safety rights of staff, but also because schools have broad duties to protect the health of students. In addition, schools can share educational information with families to encourage testing at home. Appendix, section 11.2 provides examples of Canadian school testing programs, noting that in many parts of the county only a few schools have been tested.[55]

Many US states, and other countries specifically mandate testing in schools. Specific rules not only help create transparency but can ensure all schools are tested. Appendix, section 11.2 details jurisdictions with requirements for school testing.

Childcare centres and long-term care facilities are another important area for addressing radon. Appendix, section 11.3 lists childcare testing initiatives in Canada. Like schools, childcare settings would ideally be covered by workplace legislation, but may be introduced earlier in the process given the immediacy of concern and public sentiment. Appendix, section 11.3 describes jurisdictions with mandatory childcare testing. In some US states there is specific legislation. In Canada, at least one health authority has ordered radon testing in childcare as part of licensing requirements.

[52] British Columbia, Occupational Health and Safety Regulation, BC Reg 296/97, Part 4 - General Conditions - 296/97 at s. 4.1; Alberta, *Occupational Health and Safety Act*, RSA 2000, c O-2 at s. 2(1); The *Saskatchewan Employment Act*, SS 2013, c S-15.1, at s. 3-8; *Occupational Health and Safety Regulation*, 1996 O-1.1. at section 12; Manitoba, *Workplace Health and Safety Act*, s. 4(1) C.C.S.M. c. W210; Ontario, *Occupational Health and Safety* Act, RSO 1990, c O.1 s. 25(2)(h); Quebec, *Act respecting the occupational health and safety*, CQLR c S-2.1 at s. 51 Nova Scotia, *Occupational Health and Safety Act*, SNS 1996, c 7 at s. 13 (1); New Brunswick, *Occupational Health and Safety Act*, SNB 1983, c O-0.2 at s.9; Prince Edward Island, *Occupational Health and Safety Act*, RSPEI 1988, c O-1.01 s. 12; Newfoundland, *Occupational Health and Safety Regulations*, 2012 under the *Occupational Health and Safety Act* (O.C. 2012-005) at s. 42, Yukon, *Occupational Health and Safety Act*, RSY 2002, c 159 at s. 3(1); Northwest Territories, *Safety Act*, RSNWT 1988, c S-1 at s. 4. (1); Nunavut, *Safety Act*, RSNWT (Nu) 1988, c S-1 at s. 4(1).

[53] Ontario Ministry of Labour, Training and Skills Development, 2016. Radon in the workplace. Available at https://www.labour.gov.on.ca/english/hs/pubs/gl_radon.php. (accessed January 20, 2021).

[54] Chen, J., 2013. "Canadian lung cancer relative risk from radon exposure for short periods in childhood compared to a lifetime," *International Journal of Environmental Research and Public Health* 10(5), pp. 1916-1926.

[55] Saskatchewan, New Brunswick, Nova Scotia, PEI and Yukon have tested all schools for radon while BC, Alberta, Manitoba, Ontario and Newfoundland have tested very few. CAREX Canada, 2017. Radon in schools: A summary of testing efforts across Canada. Available at https://www.carexcanada.ca/radon_in_schools/ (accessed January 20, 2021).

3.9. Energy Efficiency

The limited exchange between indoor and outdoor air in energy efficient homes can prevent radon from escaping into the outdoors.[56] Energy-efficient home insulation practices reduce heat loss but also often suppress air exchange. Indeed, increasing airtightness can elevate mean radon concentrations by over 50%.[57] Tight buildings that control indoor air flow have unique advantages beyond reducing energy use, including ensuring quiet, lack of moisture ingress, and thermal comfort. However, care must be taken to avoid unwanted consequences, of which radon is a major concern.[58] Energy efficiency programs and guides thus need to be coupled with attention to ventilation rates as well as testing and mitigating for radon.[59]

There are clear opportunities and benefits to providing education and outreach to existing energy efficiency initiatives to make clear the importance of radon. Appendix, section 12.1 provides examples of energy efficiency guides and programs that include recommendations for radon.

Radon action should include ensuring that any government (or agency)-linked incentive and financing programs include incentives for radon testing and mitigation along with efficiency and other "green building" improvements. This can extend to home repair loan programs, but also subsidies, loans and financing programs by public utilities. Appendix 12.3 covers financing programs.

3.10. Smoking Cessation

There is a strong synergistic interaction between radon exposures and smoking, given the damage both cause to lungs.[60] Provinces and Territories should consider combining radon awareness and smoking cessation programs. Cessation program outreach workers can be trained in radon awareness and learn about local area risks, and when contacting or counselling smokers in high radon potential zones, explain the radon problem and its relevance. Clinical interventions, such as nicotine prescriptions, can be

[56] United States General Accounting Office, 1986. Indoor Radon Air Pollution. GAO/BCED-S6-170. Available at https://www.gao.gov/assets/150/144501.pdf (accessed January 20, 2021 at page 12).
[57] Stanley, F.K., Zarezadeh, S., Dumais, C.D., Dumais, K., MacQueen, R., Clement, F. and Goodarzi, A.A., 2017. "Comprehensive survey of household radon gas levels and risk factors in southern Alberta," *CMAJ Open* 5(1), pp. E255-E264.
[58] Shrubsole, C., Macmillan, A., Davies, M. and May, N., 2014. 100. *Unintended consequences of policies to improve the energy efficiency of the UK housing stock*," *Indoor and Built Environment* 23(3), pp. 340-352.
[59] Arvela, H., Holmgren, O., Reisbacka, H. and Vinha, J., 2013. "Review of low-energy construction, air tightness, ventilation strategies and indoor radon: results from Finnish houses and apartments," *Radiation Protection Dosimetry* 162(3), pp. 351-363.
[60] Lichtenstein, E., Andrews, J.A., Lee, M.E., Glasgow, R. E. and Hampson, S.E., 2000. "Using radon risk to motivate smoking reduction: evaluation of written materials and brief telephone counselling," *Tobacco Control* 9(3), pp. 320-326; Hampson, S. E., Andrews, J. A., Barckley, M., Lichtenstein, E., & Lee, M. E. (2006). "Personality traits, perceived risk, and risk-reduction behaviors: A further study of smoking and radon," *Health Psychology 25*(4), 530–536; Lichtenstein, E., Boles, S. M., Lee, M.E., Hampson, S.E., Glasgow, R. E. and Fellows, J., 2008. "Using radon risk to motivate smoking reduction II: randomized evaluation of brief telephone counseling and a targeted video," *Health Education Research* 23(2), pp. 191-201.

coupled with free radon test kits and subsidies for mitigation. Because the rates of lung cancer are so high amongst smokers with chronic exposure to high radon, these interventions are likely to be highly cost-effective.[61]

4. Conclusion

This guide will facilitate and support provinces and territories in developing a Radon Action Plan by providing justification and evidence-based links to existing frameworks, strategies and policies where radon can be considered or incorporated. Included in this document and the Appendix are a variety of resources, examples, links, key messages and sample language that can be used in the development of a Radon Action Plan. It includes numerous actions that can be taken individually or together to start to help reduce the incidence of radon-induced lung cancer in your local communities.

The Radon Action Guide is broken down into sections and component parts and includes supporting evidence and examples so that provinces and territories can build a broad and comprehensive plan or take individual, discrete steps. Radon action can be advanced by choosing a few high impact and appealing interventions, such as ensuring daycare centres or government-operated social housing are tested. In some cases, the first step will be to develop more awareness, and provinces and territories can take advantage of the materials developed by Health Canada's National Radon Program materials. Other key actions include increasing testing and collecting data to get a better understanding of the regions with higher radon risk. Provinces and territories can use this data to give direction to public health agencies, and target education to professional groups such as real estate licensees and municipal building officials. In many areas, such as landlord-tenant, occupational health and safety, and real estate licensees there is broad scope for alerting people to existing laws, and having agencies issue interpretive bulletins, rather than more formal legal change. There is also significant scope for governments to work with other organizations and institutions, such as academic researchers who conduct citizen science projects, or provincial lung associations who conduct outreach. Municipalities, other local governments, local health boards, schools and libraries will also be important stakeholder partners.

Significant radon outreach and action have been achieved in Canada since the National Radon Program began. Provinces and territories are encouraged to take advantage of the existing resources and materials from the National Radon Program, Take Action on

[61] Groves-Kirkby, C.J., Timson, K., Shield, G., Denman, A.R., Rogers, S. and Phillips, P.S., 2011. "Lung-cancer reduction from smoking cessation and radon remediation: a preliminary cost-analysis in Northamptonshire, UK," *Environment International* 37(2), pp. 375-382.

Radon Network and many of the already existing initiatives by provinces, territories, regulatory councils and non-profits in Canada. By using this guide and taking action on radon you will help people, improve indoor environments, and save lives.