Environmental Law Clinic
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Regulating Exposure to Radon Gas in BC Homes: A Four Pillar Approach

A Report for the Canadian Cancer Society, BC and Yukon Division

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Introduction: A proposed four pillar approach

This report describes the necessary elements of an effective regulatory regime to reduce radon gas in British Columbia's residential buildings. The framework was adapted from the *WHO Handbook on Indoor Radon*, published as part of the World Health Organization's International Radon Project.[1] It reflects the broad areas of regulation that the organization recognizes as being effective in mitigating exposure to radon. The framework has four pillars:

1) Proactive prevention of radon gas incursion into the interior of residential structures
2) Testing for radon gas in existing structures
3) Remediation of indoor radon concentrations in excess of prescribed threshold
4) Public education

Within each of these four elements, consideration will be given to the regulatory arenas, approaches, and tools that may be deployed to facilitate the mitigation of radon exposure in homes. The substance of these considerations will be shaped by existing regulatory structures in other jurisdictions and best-practices research drawn from academic, government, and non-profit sources. Regulatory regimes concerning other environmental subject matter will also be evaluated as potential models for regulating radon. Recommendations will be advanced that locates this research in the provincial legal context.

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[1] World Health Organization, International Radon Project. *WHO Handbook on Indoor Radon: A Public Health Perspective*. 2009. P x.

1) The First Pillar: Preventing radon exposure in the first place

Effectiveness of prevention

WHO recognizes radon *prevention* measures as the most cost-effective and efficient way to reduce radon exposure in homes.[2] This approach is less expensive than responding to high radon concentrations with remedial measures, and leads to a greater reduction of radon exposure over time. Therefore, a comprehensive prevention program is an essential element of an overall strategy to reduce radon exposure in homes.

Prevention measures can be subdivided into two categories, Applied and Informational:

- Applied Measures are practical measures used in the construction of new buildings to reduce incursions of radon gas. These can be instigated by provisions of the Building Code.
- Informational Measures encompass a range of information provided to stakeholders so that they can consider the relative risk of radon exposure and take preventative steps. This includes information derived from public registries of areas affected by high soil radon concentrations and maps delineating its concentration over a given area.

Mechanisms

BC Building Code

The BC Building Code was updated in 2006 to reflect best-practices for the prevention of radon incursions into residential structures. It draws from recommendations put forth by WHO and mirrors many of the provisions of radon-resistant building codes adopted by jurisdictions in the United States and endorsed by the U.S. Environmental Protection Agency (EPA).[3] Specifically, provision 9.13.4.6 of the BC Building Code provides comprehensive guidelines to prevent radon leakage in new structures. It is comprised of the following important elements:

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[2] WHO, *supra* note 1 at p 86.
[3] See: Environmental Protection Agency, Office of Air and Radiation. *Building Radon Out: A Step-By-Step Guide on how to Build Radon-Resistance Homes*. EPA/402-k-01-002. April 2001.

- The mandatory integration of soil depressurization infrastructure into the foundations of new buildings, to be completed with the addition of exhaust piping if radon levels are found to exceed those prescribed in HC H46-2/90-156E, "Exposure Guidelines for Residential Indoor Air Quality" (sentences 1-5, 9). Note that this guideline, which stipulates an annual average radon concentration of 800 Bq/m^3 as the threshold limit, was replaced by the Government of Canada Radon Guideline of 200 Bq/m^3 in May 2009.[4]

- The mandatory testing of new buildings for radon in accordance with EPA 402-R-93-003, "Protocols for Radon and Radon Decay Product Measurements in Homes," with results being reported to the relevant authorities (sentence 6). As per the EPA guideline, testing should occur over at least 3 months and should be done in the basement of the building. Testing should also occur post-installation to ensure effectiveness.

- The mandatory remediation, by way of the completion of the soil depressurization system, in the event that radon levels in the new building exceed the levels prescribed in the aforementioned HC guideline (sentence 9).

The BC Building Code is a provincial regulation under the *Local Government Act* (s. 692 and BC Building Code Regulation 9/2011) "and has the same force and effect as a validly enacted bylaw of the municipality or regional district, as applicable." Therefore, it is binding on municipalities throughout the province.

While the BC Building Code provides a robust preventative framework in its current configuration, it falls short on two fronts.

The first is in regard to the absence of prescribed protocols for foundation membranes. WHO's International Radon Project recommended the installation of a membrane into the foundation of a new construction to complement soil depressurization systems such as that advised by the Code.[5] These membranes create an airtight barrier against

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[4] http://www.hc-sc.gc.ca/ewh-semt/radiation/radon/guidelines_lignes_directrice-eng.php
[5] WHO, *supra note 1* at P 47.

incursions of radon gas that may not otherwise be captured by the depressurization system.

The second is in terms of remediation protocols. Although most building codes do not provide protocols for remediation, and are instead provided for in specific certification regimes administered by the state, building codes are useful locations to articulate standards that can be flexibly applied by municipalities. Because of the dynamic nature of the construction industry and uncertainty over the extent of radon deposits in the province, having remediation protocols embedded in the Code instead of legislation would facilitate greater adaptability.

Preconstruction site assessments

In addition to a robust building code, preconstruction site assessments are another Applied Measure that can forestall radon exposure. They are not used extensively in North America, but are deployed in areas of Europe, such as the Czech Republic where the soil of potential construction sites are tested for radon.[6] The type of preventative measure to be applied is contingent on this reading.

A likely reason why this approach has not been applied widely is that it is difficult to assess how localized radon deposits will be affected by a building once it has been constructed. Another reason is that this testing would delay construction by up to one year, which could negatively affect the ability of developers to flexibly exploit market cycles.

WHO advises that the most cost-effective technique is to implement radon control measures in all new homes, with occasional exceptions for areas of negligible or significantly high concentrations.[7]

Radon Registry

In addition to Applied approaches to preventing radon exposure, Informational measures are also useful in facilitating medium and long term planning to reduce such exposure. While public education merits its own separate discussion (see the final section), it is particularly relevant to preventative measures. For the purposes of the

[6] WHO, *supra note 1* at p 45.
[7] WHO, *supra note 1* at p 45.

current section, the development of a radon registry and a radon map will be emphasized as a critical component of an effective regulatory regime to prevent radon exposure.

The first such element, a radon registry, serves as a centralized and publically available government-operated database of locations where radon has been identified. The purpose of developing a registry is twofold:

- First, it is an element of effective decision-making by stakeholders with interests in real property, such as home-owners, home-buyers, developers, and rental tenants. Being complemented by individualized testing for greater accuracy, the information contained in the database can influence decisions of where to build and the exercise of discretion in inspecting and remediating.

- Second, it informs development of public policy and the creation and verification of best-practices. The registry assists public health policy by gauging the average exposure of the population to indoor radon and the distribution of the exposures occurring. It also allows for the verification of testing and remediation techniques and provides diverse data that can be studied for novel correlations.

In order to be a practical informational tool, WHO recommends that the registry collect data on the following aspects of testing and remediation:[8]

- Radon levels before and after remediation
- Type of measuring device used
- Name and address of inspection company, laboratory, and remediation firm
- Building characteristics
- Type of remediation measures
- Installation costs
- Effects of installation on structure

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[8] WHO, *supra note 1* at p 86.

To enhance its utility as a public health policy resource, the registry could also be populated with relevant public health data, such as lung cancer rates. This would enable the identification of trends between radon concentrations and instances of the disease.

The collection of data for the registries is typically done through certified radon inspectors and is compulsory. Though self-reporting by residents is possible, it would be limited to detected radon levels and basic location information because the resident likely would not have the competency to assess the other database fields.

Most jurisdictions that regulate radon testing and remediation have established registries to collect specific data. In Pennsylvania, for example, the *Radon Certification Act* makes mandatory the reporting of results by certified radon inspectors to the state. Penalties for non-compliance are also stipulated. Payments from penalties are placed in a fund to support the Department's public education initiatives and the registry. In Iowa, s. 136B.2 of the Iowa Code also makes it compulsory to report remediation measures, though the state's approach to the collection of the information is to keep it confidential. Assurances of privacy are important in generating broad compliance with a registry provision, so it is recommended that any information collected for the purpose of the registry be held in confidence and that the data contained in the registry be made available only in aggregate form with specific identifiers removed.

In Canada, proposed legislation in Ontario calls for the creation of a provincial registry. Under section 3 of the *Radon Awareness and Prevention Act*, radon measurement specialists and labs are required to provide the registry with the following information (s. 3):[9]

- The name and address of the laboratory or radon measurement specialist
- The name and address of the building or place at which the sample was taken.
- The radon level indicated by the sample.
- Any other information prescribed by the regulations.

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[9] When this paper was drafted, this Act was not yet law. As of July 25, 2012, it had passed readings and was awaiting Royal Assent, as per July 25, 2012 telephone interview with Ontario MPP Reza Moridi. See: http://www.ontla.on.ca/web/bills/bills_detail.do?locale=en&Intranet=&BillID=2580

Because the associated regulations have not yet been developed, the framework is only skeletal at present. For instance, it lacks criteria for radon specialists, and its data fields are limited. Nonetheless, it serves as an example of what similar legislation could look like in BC. More will be written on the *Act* below.

Radon Map

Supplementing the registry is the radon map. It is a map generated using the data present in the registry and typically serves as the presentation of the data that is most readily available to the public. The visually striking radon map advances the two main purposes of the radon registry discussed above. It is typically supplemented by geological data to provide accurate representations of the distribution of radon deposits throughout the region. It is typically administered by the same agency that controls the registry.[10]

In the majority of jurisdictions with radon registries, radon maps have been generated using the available data. The maps vary in scope and resolution, but the most common practice is the production of maps of a regional scale. This provides the public with sufficient information to make decisions on testing and remediation, but sufficiently protects the privacy interests of individual property holders. Because radon deposits are variably distributed and fluctuate even over small areas, these maps do have the drawback of being imprecise on a local scale. Therefore, it is common practice for regulators to emphasize that these maps are not adequate substitutes for appropriate radon testing if the presence of radon is a concern.

To address concerns of the misinterpretation of the maps, some jurisdictions have limited access to the maps by imposing fees or restricting access to those with relevant interests, such as home-buyers and stakeholders. In the UK, for example, regional maps are freely available on the regulator's website while more localized maps are available for a fee.[11] Ontario's *Radon Awareness and Prevention Act* restricts disclosure of that

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[10] WHO, *supra note 1* at p 87.

[11] See: http://www.ukradon.org/article.php?key=measureradon

province's map to those who have first made a request.[12] Because the regulations have not yet been developed, the criteria used to judge these requests are unknown.

[12] S. 2(4).

2) The Second Pillar: Testing for radon gas in existing structures

Purpose

The second element of the four pillar regulatory model to reduce radon exposure is the creation of an effective and reliable framework for measuring concentrations in existing homes. This element serves two purposes. The first is the protection of the health of residents through providing them with actionable information on radon levels affecting them and their families. The second purpose is to generate information for the radon registry and map to facilitate medium and long term planning.

Sites of regulation

The creation of a comprehensive framework for the measurement of radon gas levels in residential dwellings requires consideration of the legal mechanisms and constraints that relate to the predominant classes of dwellings. These will be analyzed in this section.

- *Private homes*

Imposing ongoing testing protocols on owners of private homes would be difficult. The lack of intersecting legal obligations, such as the presence of a rental tenant, means that the ability of the province to enforce mandatory testing would be limited during the course of ownership. However, as the subsequent section, Modes of Regulation, will discuss, an opportunity for such testing arises when the property is transferred.

The research for this report yielded no examples of jurisdictions where testing was made compulsory for private homes during the course of ownership.

- *Rented homes*

There is currently no framework in Canada for requiring radon measurements in rented dwellings. However, the intersection of current regulations in the area of tenancy law with such dwellings represents an avenue through which a testing framework could be applied and enforced.

It is practice in other jurisdictions with radon regulations to employ disclosure or mandatory testing frameworks for radon in rental units.

In Illinois, for instance, the *Radon Awareness Act* requires that a lessor disclose to the lessee the existence of elevated radon levels in the dwelling unit. If a lessee finds radon levels in excess of the reference level, the lessor must disclose this level to any subsequent occupant. However, if the lessor conducts their own approved test and finds otherwise, there is no need to disclose. Likewise, if remedial action is taken and its success is verified, then there is no disclosure obligation.

In Maine, the *Act to Reduce Lung Cancer Rates in Maine* articulates a more robust framework. It requires that rental suites be tested for radon at least once every 10 years. Measurements must be taken by designated inspectors. All measurements must be disclosed to the tenants and the landlord must provide general information on the risks of radon exposure. The Act also prescribes a mandatory disclosure form for all new tenancies.

In BC, the *Residential Tenancy Act* could be amended to require radon testing and disclosure to tenants.

- *Provincially owned homes*

Provincially-owned dwellings, such as social housing units, can be subject to more robust standards as they are owned, directly or indirectly, by the provincial government. In Ontario, the *Radon Awareness and Prevention Act* requires that all provincially-owned dwellings be tested by the end of 2012 and with a frequency thereafter to be specified by regulations.[13] Other publicly-owned buildings such as universities, hospitals, and schools must also be tested.

Ways to ensure testing of existing homes

There are multiple mechanisms available to the province to encourage the testing of properties for radon. Three of the most common ones are discussed in the following subsections.

[13] S. 5(1)

Property transfer agreements

The transfer of private property represents a moment when public regulatory structures intersect with the private nature of the property. In many jurisdictions, this interface of regulations creates a suitable circumstance for the imposition of:

- disclosure,
- testing, and
- remediation

obligations on the property owner. The degree to which testing and disclosure are required varies depending on jurisdiction.

At the extreme end of regulatory intervention is mandatory disclosure and testing. While WHO recommends this approach, few jurisdictions have adopted it and the ones that have have been mainly individual municipalities where soil radon concentrations are exceptionally high, such as Port Hope, Ontario. Generally, regulators have found mandatory testing to be politically and socially unpalatable and possibly redundant due to a strong existing impetus arising from personal health concerns. Moreover, mandatory testing at the time of property transfer has been opposed by real estate associations due to the length of time required to obtain an accurate reading by conventional radon detectors. In Canada, for instance, the Canadian Real Estate Association (CREA) opposed mandatory testing during real estate transactions proposed by Health Canada in the late 1990's because it would significantly delay the process of transfer.[14]

The most common method requires the disclosure of radon levels but not mandatory testing. Under this model, public education serves to fill the role of encouraging the population to undertake optional testing using prescribed methodology (to be discussed in the Standards section). For example, this has been legislated in Kansas, where sellers are required to disclose any information known to that seller which shows elevated levels of radon gas on the Property.[15] In Illinois, the implementation of this disclosure

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[14] CREA. (2007). Radon Exposure and Canadian Homes: Information for Realtors.
[15] Kansas Law HB2772. See http://www.kdheks.gov/radiation/radon.htm#laws

obligation is more comprehensive, with the *Illinois Radon Awareness Act* requiring sellers to provide to the purchaser all available records and reports pertaining to elevated radon levels on the property. S. 35 of the *Illinois Residential Real Property Disclosure Act* provides a mandatory disclosure form that must be completed by the seller on real estate transactions which encompasses knowledge of high radon levels and other defects.

A widely used provision concerning property transfers is the mandatory provision on transfer agreements of language articulating the risk of radon exposure and strong encouragement for testing and remediation. An example of this can be found in Kansas State Act 58-3078a:

> "Every buyer of residential real property is notified that the property may present exposure to dangerous concentrations of indoor radon gas that may place occupants at risk of developing radon-induced lung cancer. Radon, a class-A human carcinogen, the leading cause of lung cancer in non-smokers and the second leading cause overall. Kansas law requires sellers to disclose any information known to the seller that shows elevated concentrations of radon gas in residential real property. The Kansas department of health and environment recommends all home-buyers have an indoor radon test performed prior to purchasing or taking occupancy of residential real property. All testing for radon should be conducted by a radon measurement technician. Elevated radon concentrations can be easily reduced by a radon mitigation technician. For additional information go to www.kansasradonprogram.org."

While BC does not have a legislated mandatory disclosure process for property transfers, an optional binding document is provided by the BC Real Estate Association for the reporting of known defects in the property. The Property Disclosure Statement (PDS) does not currently provide for reporting of radon measurements, but could be adjusted accordingly in consultation with the administering organization.

As mentioned previously, mandatory testing could significantly delay a real estate transaction. While short term testing minimally impacts the timeline of sale, it is less accurate than the longer term tests that real estate associations, such as the CREA, cite as an efficiency obstacle to a mandatory testing regime. Indeed, seasonal variations and varying densities of radon gas deposits necessitate long term tests for reliable results. As a compromise, WHO recommends that long term measurements be undertaken

simultaneous to short terms ones in order to yield a viable assessment.[16] This balances the economic considerations of the transaction while ensuring accurate readings for the protection of human health and for contributing to the provincial registry.

To protect the legal interests of the seller, a waiver excluding it from further liability if short-term tests do not yield high levels may be advisable. However, this may induce sellers to delay the test as long as possible to reduce risk. Regulation stipulating a mandatory duration should therefore be considered.[17] Alternatively, a charge could be added to the cost of the transaction to fund remediation if long term testing revealed excessive radon levels. This amount would be refunded if the testing reveals otherwise. This has been proposed in the UK.[18]

Jurisdictions in Europe have adopted mandatory durations for optional, pre-transfer radon tests. Examples are as follows:[19]

- Finland and Sweden: Recommend measurements during the "heating season" – October to April – when homes are fully enclosed
- UK and Ireland: Measurements taken over 3 month period with seasonal correction factors applied
- Italy: Measurements are taken over the course of a whole year to eliminate seasonal variations

Tax credits

Tax credits could be used to encourage testing. For instance, they could be granted to offset the purchase price of testing equipment or services. But because the cost of these items is likely small, the effect of tax credits would be insufficient to motivate large portions of the population to participate.

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[16] WHO, *supra note 1* at p 29.
[17] WHO, *supra note 1* at p 29.
[18] See: http://www.ukradon.org/article.php?key=radonhouse
[19] WHO, *supra note 1* at p 29.

Direct subsidies

The cost of testing equipment and services is low enough that direct subsidies for their purchase could be viably provided by the province. A direct subsidy would entail either the outright provision of testing devices to residents or the compensation, either in full or part, for the purchase price of inspection devices and services. This would have the advantage of encouraging broad compliance and enhancing the ability of the state to ensure compliance with protocols and standards. The flexibility of subsidies allows them to be applied in a way that maximizes economic incentive and has the most meaningful impact on public health. For instance, Illinois and Maine direct subsidies to areas of excessive soil radon concentrations. In the UK, areas such as Cornwall that have high levels of radon are eligible for free radon detection kits. In total, one million testing units have been distributed as part of the UK program.[20] Also, subsidies could be specifically targeted to those whose incomes do not allow them to readily afford the devices or services.

Funding for such a model need not detract from government revenue. Illinois and Maine have designed selective subsidy programs that are cost neutral for the state. Funding comes from a fund created by the payment of certification fees and penalties for noncompliance with testing and remediation protocols. In New Jersey, the state subsidizes 50% of the cost of inspections. These payments are derived from similar funds.[21] Canada has a long history of subsidizing energy audits of homes, and the subsidization of radon inspections could operate similarly. (See below.)

Standards

The substance of radon testing regulations would largely be found in the standards and protocols that would govern activities and personnel surrounding the measurement of radon. The value of standardization is that it ensures the consistency and quality of results.

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[20] See: http://www.ukradon.org/article.php?key=radonhouse
[21] *Radiation Protection Act*, s. 26:2D-80

Designated personnel

In many jurisdictions, the law restricts the measurement of radon levels to personnel who are certified by the government. In Illinois, for instance, individuals are able to purchase and deploy self-testing kits for use on their own property, but measurements used to fulfill transaction requirements or satisfy insurance or mortgage criteria must be done by a designated radon inspector.[22]

WHO notes that there is a potential conflict in the model deployed by some jurisdictions, whereby the designated inspectors are also certified remediation contractors.[23] This is common practice in the US as well as in analogous regulatory programs in Canada dealing with other forms of inspection and remediation. In Canada, the federal Home Renovation Tax Credit energy efficiency program certifies remediation contractors as inspectors as well. The benefit of this approach is that it leverages the existing expertise and infrastructure of contractors. But as WHO notes, the disadvantage is that an inherent conflict exists between the economic interests of the business and the acquisition of objective radon readings.[24]

European regulators have addressed this in varying ways, with Switzerland and Norway each serving as models of the predominant models employed. In Switzerland, inspections are conducted entirely by government employees. In Norway, regulations prevent a company from being certified for both inspection and remediation functions.[25]

Complementing the certification process is the development of a directory of certified personnel and companies. This is common practice in all jurisdictions with a radon certification system.

Certification of inspection companies

Whereas mandatory testing regulations are uncommon, almost all jurisdictions with radon regulations have a certification program for inspection companies. Pennsylvania's

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[22] Illinois Radon Awareness Act. See: http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=2913&ChapterID=37
[23] WHO, *supra note 1* at p 49.
[24] WHO, *supra note 1* at p 29.
[25] WHO, *supra note 1* at p 29.

Radon Certification Act 1987 provides a model for successful legislation in this regard. It empowers the cabinet with the ability to formulate specific regulations, but creates a guiding framework. It defines the scope of certification and prescribes penalties for non-compliance.

Qualifications

The qualifications for certification as a radon testing company are diverse, but typically include the following:

- Requisite financial status
- Requisite education and training, including ongoing training
- Payment of licensing fees
- Adherence to inspection and disclosure protocols stipulated by regulations

A central difficulty in implementing such a qualification regime in BC would be the absence of a private organizational structure for operators in this field. In most US states, for example, regulations require that a firm first be qualified by a professional association for radon inspectors. These professional associations often are often state-based and provide a flexible base of knowledge and experience for the continued evolution of regulations in this field. While the state government dictates the general structure of the certification requirements, the substance, based on evolving best-practices, is best managed by an organization with a high level of specialization in the field. Inducing the development of a private governance body for radon inspectors in BC would greatly facilitate the creation of an effective certification system.

Measurement protocols

While the specific aspects of procedure would likely be governed by private industry associations, the regulations would articulate a general framework. In most certification systems, such as Pennsylvania's, general requirements for the type of equipment to be used, its placement, and the duration of measurements are put forth. In addition,

disclosure obligations for inspectors are outlined as well as the appropriate directions to be offered to clients if radon levels exceed the reference level.

Enforcement

To ensure compliance with regulations, certification regimes also have enforcement mechanisms. These typically complement those managed by private governance bodies and serve two general functions: The protection of public health and the maintenance of an effective system of radon inspection firms.

Enforcement tools are diverse. In Iowa, for example, s. 136B.3 of the Iowa Code provides for spot-checks by state employees to ensure quality and consistency and to evaluate licensing credentials. In Maine, persons are prohibited from testing for radon in the state unless they are registered with the state or are the building owner or tenant. If this is breached, fines are issues that are then paid into a radon testing fund which subsidizes the cost of inspections for select groups.

Certification of measurement technologies

Throughout the US, states have adopted the EPA's guidelines for criteria to guide the certification of appropriate radon detection devices. These guidelines, embodied in EPA documents 402-R-93-003, "Protocols for Radon and Radon Decay Product Measurements in Homes", is also cited by the BC Building Code as the relevant authority for radon testing post-mitigation. Since detection technologies are not region-specific, this guideline could also be viably adopted to direct the certification of devices used in BC.

Certification of laboratories

In jurisdictions with radon regulations, the government often restricts the analysis of radon measurements to certified laboratories. While some technologies may yield results directly to the homeowner or inspector, some rudimentary measurement devices may require analysis by laboratory technicians to provide useful results. To ensure consistency and quality, laboratories are certified in the same way as inspection firms are, with regulations establishing a framework to complement industry best-practices.

Radon reference level

The radon reference level refers to the maximum acceptable radon concentration in a confined space. Health Canada's most recent guidelines set this amount at 200 Bq/m³. While this is significantly lower than the former standard of 800 Bq/m³ which was in place until 2009, it is still above the 100 Bq/m³ range that is recommended by WHO.[26] Changing this standard would require negotiation with HC, but would not be *ultra vires* since public health is allocated by the Constitution to the provinces.

It should be noted that there is no scientific evidence for a definitive threshold level for radon gas, below which human health is not adversely affected. The reference level should therefore not be regarded as absolute when making decisions as to remediation and about testing in one's home in an area where the average is in the range of the reference level.

The application of a threshold level is clearly not absolute. For example, the reference level differs in the Czech Republic for new and existing homes. This ensures the minimization of costs associated with remediation while acknowledging that the threshold, itself, is not definitive.

3) The third pillar: Remediation of high indoor radon gas concentrations

Purpose

Where high levels of radon gas are detected in homes, most jurisdictions specify requirements for remediation. While mandatory remediation regulations are uncommon in national or provincial/state jurisdictions, a range of incentives are created by regulation to encourage property owners to undertake repairs. This section will outline the range of regulatory possibilities to enhance the likelihood of remediation when excessive radon levels are identified.

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[26] WHO, *supra note 1* at p 90.

Sites of Regulation

As with regulations concerning the testing of premises, each type of property has unique considerations when considering remediation.

Legislation rarely mandates remediation *across all types of dwellings* when radon levels exceed reference levels. However, laws in the Czech Republic, Sweden, and Switzerland do make remediation compulsory when such levels are identified in all types of dwellings.[27] In these countries, reference levels are compulsory and regulations prescribe mandatory repairs that the owner must undertake to reduce concentrations to safe levels.[28] Mandatory remediation is required where the results come from certified tests.

This system is problematic as it may discourage the use of certified inspectors and cause homeowners to test privately and conduct remediation to the extent that they are able to afford it. It may also discourage testing altogether. A modification to this approach would be to allow homeowners to undertake remediation over an adjustable period of time -- and provide assurances of either a cap to remediation costs or subsidies, as will be discussed later.

- *Private homes*

Imposing mandatory remediation protocols on owners of private homes would be difficult. The lack of intersecting legal obligations, such as the presence of a rental tenant, means that the ability of the province to enforce mandatory remediation would be limited during the course of ownership. However, as discussed below, an opportunity for such remediation arises when the property is transferred.

The research for this report yielded no examples of jurisdictions where remediation was made compulsory for private homes during the course of ownership.

- *Rented homes*

As with private homes, there are no apparent systems in place in other jurisdictions to enforce mandatory remediation. However, the aforementioned regulations for

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[27] WHO, *supra note 1* at p 92.
[28] European Radon Research and Industry Action Collaboration Concerted Action. *An Evaluation of Radon Reference Levels and Radon Measurement Techniques and Protocols in European Countries*. March 2005, p 24.

mandatory disclosure and testing in rental suites in Illinois and Maine provide the foundation on which a remediation framework could be deployed. This framework would be a natural extension particularly of the Maine framework that requires rented units to be tested every ten years and imposes an obligation on the owner to disclose all measurements to tenants. Owners could be required to reduce radon to a safe level.

In BC, the laws surrounding residential tenants provide a legal infrastructure over which remediation regulation could be implemented. Unlike private homes, rented units are subject to ongoing regulatory requirements that could be extended to encompass a form of mandatory remediation.

- *Provincially owned homes*

As with testing, remediation in these types of homes would be considerably easier as ownership is either directly or indirectly exercised by the provincial government. An example of the exercise of this authority being leveraged is in s. 5(2) of Ontario's *Radon Awareness and Prevention Act*. This section empowers the Minister to ensure that elevated radon levels in provincially-owned residential structures are corrected. Because the regulations for this act have yet to be developed, the mechanisms by which this will be enforced are uncertain. Nonetheless, this does serve as an example of how regulations can be articulated on this in Canada.

Modes of regulation

There are multiple mechanisms available to the province through which to encourage the remediation of existing properties. Three of the most popular ones will be discussed in the following subsections.

Property transfer agreements

As with radon testing requirements, property transfer agreements represent an opportunity where several regulatory processes interact with private property to enable an opportunity for remediation regulations to be exerted.

While the predominant model used throughout the US and Europe is voluntary remediation on the transfer of property, WHO has advised that remediation be made mandatory prior to the resale of a home with verifiably high concentrations of indoor

radon. This model has not yet been implemented according to the WHO report and personal research.[29]

However, the US has regulation which uses mortgages to incentivize radon remediation. The mechanism is in s. 203(k) of the *Federal Housing Administration Act*. Mortgages issued under this section include costs required to rehabilitate a home that does not meet federal standards. These mortgages are widely available and can be applied for if the home meets criteria specified in the regulations, one of which being radon levels in excess of the designated reference level. It would be possible to translate this model to Canada. However, the Canadian Mortgage and Housing Corporation, a federal agency, would likely be responsible as it fills a similar insurance and regulatory role in Canada as the FHA does in the US. This would require engagement with the federal government by either the provincial government or stakeholder groups.

BC Building Code

Another element of regulating radon remediation is to bring remediation practices in line with the BC Building Code. At present, the requirements outlined in the Code for preventing radon exposure do not apply to remediation work. To the extent that they are considered industry best-practices, they are used by remediation contractors. But there is no standardized system of enforcement of these protocols in BC.

In order to achieve this regulatory synchronization, the regulatory framework used in the Czech Republic provides a helpful example. In that country, remediation contractors are required to abide by building code provisions when conducting remediation work. Within the Czech Code, the extent of remediation is contingent on the radon index of the building site, as indicated by Czech Radon Registry.[30]

Tax credits

To incentivize remediation, tax credits could be used to offset the cost in full or in part. In Canada, the federal Home Renovation Tax Credit energy efficiency program provides an example of how such an approach may work. This program has been successful in

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[29] WHO, *supra note 1* at p 29.
[30] European Union Radon Prevention and Remediaton. *Assessment of Radon Control Technologies: Assessment of Current Techniques Used for Reduction of Indorr Radon Concentration in Existing and New Houses*. p 13.

encouraging homeowners to make their homes more energy efficient by providing tax credits for the amount spent on renovations up to a specific cap. Similarly, the provincial government could implement a program in BC to award tax credits for remediation renovations done by certified contractors and in the manner specified by regulations.

Another benefit of a tax credit initiative for radon remediation is that it promotes standardization and provides a feedback mechanism to ensure the effectiveness of repairs. Since eligibility for the credits is contingent on using designated contractors and prescribed methods, the instrument enforces a particular standard of remediation. Also, the awarding of the credits may be contingent on post-remediation inspections validating the reduction of radon concentrations. In this way the tax credit also ensures that the remediation work has achieved the policy outcome of the regulations.

Direct subsidy

The direct subsidization of remediation work is the most effective way to incentivize remediation work that is compliant with regulations. Full subsidies are uncommon, but many jurisdictions offer partial subsidies of remediation work done by certified contractors and in accordance with standards. In some jurisdictions, such as Maine, subsidies are targeted at specific groups, such as low income homeowners, and may be adjusted to encompass the entire or partial cost of remediation. Maine supports the payment of these subsidies through the Radon Relief Fund, which is comprised of monies paid for license fees and administrative penalties for certification violations.[31] The direct subsidy is subject to a verification inspection post-remediation to ensure that concentrations have been reduced below the reference level. In terms of verification for the work, itself, this is entrusted to the remediation contractor.

Eligibility for subsidies can also be contingent on the radon concentrations that need to be remediated. In the Czech Republic, for example, where certified radon readings exceed 1000 Bq/m3, the property may be eligible for a grant of up to 5600 EUR for remediation.[32]

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[31] *Radon Registration Act*, s. 784.
[32] European Union Radon Prevention and Remediaton. *Assessment of Radon Control Technologies: Assessment of Current Techniques Used for Reduction of Indorr Radon Concentration in Existing and New Houses*. p 12.

Subsidies may also be subject to a cap. A proposed model would be to guarantee compensation for homeowners who retain certified remediation contractors up to a certain level. Where the costs of remediation exceed this upper level, a secondary system of subsidies would be activated which would be contingent on the income of the homeowner and the severity of the radon concentration present.

Standards

Standardization

As mentioned above, the BC Building Code represents an existing compendium of standards that is considered to be industry-best practice for preventing radon encroachment. WHO also recommends these standards for the remediation of buildings with high radon concentrations.[33] In particular, WHO advises that soil depressurization, of the type prescribed by the Code, is the most effective means of reducing indoor radon levels. While the piping infrastructure required by these systems can be difficult to integrate into existing structures, the potential costs are justified by the effectiveness of the remediation method. It is the most widely used approach to remediation in the US as well as the following countries: Austria, Belgium, Finland, Germany, Norway, Slovenia, Sweden, and the UK. It reduces up to 99% of indoor radon and often costs less than CAD2000.00.

In applying the Code to remediation, a flexible approach would ensure affordability and effectiveness. For example, in the Czech Republic remediation standards are adjustable depending on radon concentrations.[34]

Certification of remediation companies

Qualifications

The same considerations would apply here as for inspection companies, as discussed previously.

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[33] WHO, *supra note 1* at p 52.
[34] European Union Radon Prevention and Remediaton. *Assessment of Radon Control Technologies: Assessment of Current Techniques Used for Reduction of Indorr Radon Concentration in Existing and New Houses*. p 12.

In addition to these criteria, it is recommended that these companies have personnel experienced in remediation renovations, generally. Remediation renovations for such problems as infestations or hazardous substances differ from other types of renovations. The skills and knowledge cultivated through this experience would be invaluable in assisting the launch of a viable radon remediation industry in BC, where little prior specific expertise exists.

Pennsylvania's Radon Certification Regulations provide an overview of the qualifications generally required by remediation contractors.

Remediation protocols

The role of a remediation contractor is twofold: To adequately reduce indoor concentrations of radon gas and to effectively communicate risk to the homeowner.

On the first point, this role is addressed by adhering to regulated and industry standards. The most widely recognized compendium for radon remediation is ASTM's "Standard Practice for Installing Radon Mitigation Systems in Low-Rise Residential Buildings".[35] ASTM is an international standards organization and this guide is widely used in most jurisdictions, including throughout the US where it is referenced by the EPA.[36]

Also, as part of an effective remediation strategy, follow-up testing should be conducted. This has the purpose of validating the effectiveness of the repair and assisting in the evolution of best-practices for the industry.

On the second point, the remediation contractor is the primary point of contact for home owners on the issue of radon management. Since no solution is necessarily permanent, it is necessary for the contractor to educate the individual on the continued risks of radon infiltration and the ongoing measures they can take to maintain the remediation systems. In addition, WHO recommends that all components of the installed radon remediation system be labelled as such to avoid inadvertent tampering.[37]

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[35] See: ASTM International. *Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings*. Designation: E 2121-03, 2003.
[36] *Supra* note 3.
[37] WHO, *supra note 1* at p 91.

Enforcement

To ensure compliance, post-remediation inspections should be conducted. In Maine, for instance, the state provides free inspections of remedial measures installed by certified companies to ensure quality and consistency. Infractions of standards are penalized and the penalties are paid into a fund to support the subsidization of remediation work.

4) The fourth pillar: Public education

Purpose

Studies have indicated that convincing policy makers to take action through regulatory means has been more effective than direct public education.[38] However, public education nonetheless remains an important strategy to ensure compliance with regulations and allowing individuals to appropriately adapt remedies to their distinct circumstances. It also complements the regulatory system by providing an avenue that is more readily adaptable to changing standards and concerns.

In all jurisdictions, public education is a key aspect of the overall strategy to reduce radon exposure. Because compliance with standards is often voluntary, public education is an essential tool to inform the public of the severity of the issue and what instruments they have at their disposal to address it.

Stakeholders

A successful public education platform involves engagement with all significant stakeholders. Engagement must be bidirectional. During the initial stages of the policy cycle, the stakeholders should be actively engaged for feedback and direction on the evolution of the regulations. At the operational stage of the policy, the task then transforms into one of balancing this engagement with outreach communications to the stakeholders so that they can be educated on the aspects of the policy of importance to them.

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[38] WHO, *supra note 1* at p 75.

In this case, there are four main stakeholder groups: Residents (both owners and tenants), builders, real estate professionals, and health professionals. Each of these groups has different interests and these should dictate the approach toward communicating with them. Public education should be broad, but it should also be selective, addressing the unique requirements of each of the major stakeholders.

Approach

In communicating to the general public, direct and indirect means can be used. Direct communication may be through broadcast media, social media, and the internet. Messaging can be centralized through community engagements and Radon Days. Indirect communication can be undertaken through intermediate groups of repute such as health professionals, builders, and real estate agents.

The Characterization of regulations should be to "reduce lung cancer". A 2007 IRP Survey found that while awareness of radon was high in US, there was a lack of understanding as to its health implications.[39] A characterization of this type would increase public buy-in.

In communicating to more specialized stakeholder groups, direct communication would likely suffice as it would be more technical and highly targeted. Examples of appropriate media would be publications, online learning tools, and opportunities that would allow these stakeholders to engage directly with experts.

Models

Ontario's *Radon Awareness and Prevention Act* provides the most timely and relevant example of how a public education platform can be facilitated by legislation. In the absence of mandatory testing and remediation provisions, the Act provides an outline of what a public education platform could look like. The key sections are as follows:

- S. 4(1) commits the Minister to conduct public education programs and communicate information on risk of radon exposure to the public and ways to reduce it

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[39] World Health Organization, International Radon Project. *Survey on Radon Guidelines, Prgrammes and Activities: Final Report*. 2007. p 37.

- S. 4(2) encourage homeowners to undertake self-measurements or retain a professional to conduct radon measurements and to reduce radon levels to reference level.
- S. 4(3) outlines tools:
    - Use any type of media.
    - Implement a public awareness campaign.
    - Partner with not-for-profit organizations.
    - Include information in the school curriculum.
    - Any other thing that the Minister considers appropriate

As has been mentioned previously, the absence of fully formed regulations for this Act limits our capacity to forsee how this piece of legislation will translate into practice.

Conclusion

This report has advanced a four pillar approach to the regulation of radon exposure in British Columbia homes:

1) Prevention
2) Testing
3) Remediation
4) Public education

For each of these pillars, an array of regulatory options exists that have been pursued in other jurisdictions. This report has sought to present those options which may be most effectively pursued in BC's legal framework and that will yield the most desirable results for the client. As with any policy process, however, novel considerations will emerge over the course of its lifespan that may impact the relevance of these considerations. This

report provides a foundation that, going forward, will facilitate the development of a comprehensive approach to protecting the public from radon.