Environmental Scan of Radon Law and Policy: Best Practices in Canada and the European Union

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About CELA - The Canadian Environmental Law Association (CELA) is a non-profit, public interest organization established in 1970 to use existing laws to protect the environment and to advocate environmental law reforms. CELA works toward protecting public health and the environment by seeking justice for those harmed by pollution or poor decision-making and by changing policies to prevent problems in the first place. Since 1970, CELA has used legal tools, undertaken ground-breaking research and advocated for increased environmental protection and to safeguard communities. As a specialty clinic funded by Legal Aid Ontario, our primary focus is on assisting low-income people and disadvantaged communities. www.cela.ca

About CAREX Canada - CAREX (CARcinogen EXposure) is a multi-institution research project that combines academic expertise and government resources to generate an evidence-based carcinogen surveillance program for Canada. CAREX Canada has examined the Canadian context to identify what, where, and how many carcinogens people are exposed to and, where data are available, has generated estimates of exposure levels. Activities also include knowledge mobilization to make CAREX information available and accessible to Canada's cancer prevention and policy arena. Since 2007 CAREX has been funded by the Canadian Partnership Against Cancer, an independent organization funded by Health Canada to accelerate action on cancer control. CAREX Canada has been hosted at Simon Fraser University's Faculty of Health Sciences since 2013. www.carexcanada.ca

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Part 1 – Introduction, Summary, and Recommendations

Health Canada has asked for an environmental scan of existing radon policy initiatives at the domestic and international level to assist in understanding barriers and strategic opportunities to more effectively deliver the National Radon Program.

In this report we analyze the current state of law and policy in Canada and recommend both immediate and longer term policy options, identifying the strengths, limitations, and implementation considerations of each. We engaged in extensive reviews of statutes and case law, canvassed any secondary academic literature on radon with a policy focus, and conducted interviews with Health Canada officials, public health officers, academics, radon mitigation professionals, and public interest advocates.

From the outset we assumed this work would, in part, provide an update to CELA's 2014 report entitled *Radon in Indoor Air: A Review of Policy and Law in Canada*. [1] (Multiple references are made herein to this prior report as Dunn and Cooper, 2014.) We described jurisdictional responsibilities and scanned law and policy at the federal and provincial/territorial level. Within limited time and resources, we also included profiles of progressive action at the municipal level. In addition, we scanned radon regulations, policies and initiatives in Europe but focused on best practices given the very broad scope of the task.

Our initial scope included, at the federal level, addressing testing and mapping efforts in federal buildings and private homes, Canada's national certification program for radon testing and mitigation, the National Building Code, and limited consideration of other federal departments and mandates. In the course of our research we found, especially when comparing jurisdictions, that understanding of how radon is or may be addressed also required touching on occupational health and safety, tax and other incentives, and federal spending.

For the review of provincial/territorial policy, we set out to address Building Codes, occupational health and safety, real estate transactions and home warranty programs, occupier's liability, residential tenancies, education/schools, child care, and long-term care facilities, public health, and incentive programs for mitigation. We stayed within our original scope (except for long-term care facilities due to difficulty finding sources). We added considerably more detail to the discussion of occupational health and safety than originally anticipated.

The geographical scope for the international scan was initially very broad and open. Given time and resource constraints we chose to focus on European Union radon policy and details of radon policy in six countries in the region: Denmark, Finland, Sweden, the UK, (all currently in the EU) and two other countries, Norway and Switzerland. These countries were selected in part due to their similarity to Canada's geological and meteorological conditions, but we recognize that they do not represent an exhaustive list of the initiatives being undertaken in Europe.

[1] Dunn, B. and K. Cooper. "Radon in Indoor Air - A Review of Policy and Law in Canada," November 2014, Canadian Environmental Law Association. Online at: https://www.cela.ca/publications/radon-indoor-air-review-policy-and-law-canada

The scope of this work remains very large with considerable detail provided in appendices including the scan of radon policies in Europe. Hence, we have used a very detailed and navigable table of contents and also prepared the following detailed summary. In particular, the summary contains comparisons between European and Canadian practices that we use to inform our recommendations.

1.1 Shared federal-provincial jurisdiction and often indirect coverage in law and policy

Radon is an important contaminant in indoor air arising from natural sources and capable of infiltrating any building. Like most indoor contaminants, law and policy tools at both the federal and provincial/territorial level are often silent on this issue. Given the breadth of buildings where people live, work, and visit, a wide range of laws and policies directly or indirectly apply. In Canada's federal system, law and policy may issue from each of federal, provincial/territorial, and municipal governments. Whether these laws or policy specifically refer to radon, or indirectly affect radon, the division of law-making powers set out in Canada's Constitution situates radon as a matter of shared jurisdiction.

1.2 Federal action on radon

1.2.1 The National Radon Program

Under the National Radon Program, Health Canada has led a multi-pronged effort to create, update and modernize the national guidance level for radon, advisory documents, testing and mapping, training and certification, public education and outreach, (including polling public opinion), and the advisory measures contained in the National Building Code.

In comparison, the European Union enacted the Basic Safety Standards Directive in 2013. The Directive *requires* Member States to address radon in workplaces, in public and private buildings, to develop a Radon Action Plan, and a system of enforcement. While the Canadian government does not have the same ability to require provincial/territorial action, scope remains for Canada's federal government to provide comprehensive policy direction and encouragement to enable a coordinated response by the provinces and territories.

1.2.2 Canada Labour Code radon provisions still excessively out of date

The only area where federal action on radon has any legal force is in the *Canada Labour Code*, applicable to federal employees and federally-regulated workplaces. However, the radon limit of 800 Becquerels per cubic metre (Bq/m^3) is exceptionally out of date. Repeated statements have been made since at least 2013 about plans to revise the reference level with the latest prediction being the fall of 2018.

1.2.3 Testing and mapping efforts in federal buildings and private homes

The Cross-Canada Survey of Radon Concentrations in Homes (2012) provided an extensive testing and mapping effort across the country and was used by some provinces to support further radon policy development and planning. Similarly extensive testing has occurred in federal workplaces. In comparison, the EU Directive requires Member States to conduct testing and mapping as part of developing their Radon Action Plans. Among the European countries we surveyed, all had either legal requirements or strong incentives for residential and/or occupational testing, often conducted at the municipal level or focused on radon-prone regions.

1.2.4 Evaluation of the C-NRPP

Among the federal government's research and advisory/educational activities is the Canadian National Radon Proficiency Program (C-NRPP), widely praised by radon professionals. However, these professionals and others we interviewed note two areas where inadequate legal obligations undermine efforts to address radon in Canada. These include: 1) that the services of C-NRPP trained and certified professionals are not mandatory when radon mitigation is required; and 2) there is no requirement for post-construction radon measurement under any building codes in Canada. For the latter, a related issue raised by key informants during this research is a lack of training for the building industry and building inspectors to ensure building code measures for radon mitigation are properly installed during construction (and indeed during home inspections of existing housing stock as well). Notably, the means for making any such measures mandatory rests under provincial/territorial jurisdiction.

1.2.5 Federal spending or taxation powers to assist with radon mitigation

Despite many years of federal efforts to increase radon awareness, emphasizing the strong scientific evidence linking radon to lung cancer and creating tools to support the mitigation industry, too often Canadians greet the radon issue with indifference. Or, they avoid radon testing in light of worries that the problem once identified will be too expensive to fix. Unlike Norway, Sweden, Switzerland and the UK, Canada does not use either spending or taxation powers to assist Canadians with the cost of radon mitigation. It has long been identified as a logical next step for the federal government to expand the National Radon Program to provide financial assistance for the costs of radon mitigation. Doing so would send a powerful signal that the problem should be taken more seriously as well as assist with what can be a significant cost barrier particularly for those with modest to low incomes.

1.2.6 First Nations and housing

The supply and conditions of on-reserve housing remain central concerns in relations between First Nations and the federal government. Radon should be addressed in this context. While we generally outline the law and issues to consider, additional specialized legal research is warranted.

1.2.7 Federal-Provincial-Territorial Radiation Protection Committee could do more

Despite a stated mandate to advance harmonization of radiation protection practices and standards across Canada, the Federal-Provincial-Territorial Radiation Protection Committee could do more to effectively address radon risks. Key areas where this committee's mandate could be applied include the oversight and/or promotion of radon training for relevant inspectors, such as those responsible for the enforcement of building codes and laws addressing occupational health and safety, and public health.

1.3 Provincial action on radon

Most jurisdictional authority over radon exists at the provincial/territorial level in Canada insofar as law-making powers relevant to multiple aspects of the indoor environment rest at this level of government. For example, the National Building Code is advisory and only has legal effect once it is incorporated into provincial/territorial building codes. We addressed other indoor environments subject to provincial/territorial law including owner-occupied homes (real estate transactions and home warranty programs), workplaces (occupational health and safety law), residential rental units (occupier's liability, residential tenancies), schools and child care facilities (public health). We also considered any broad policy initiatives and incentive programs for mitigation.

1.3.1 Provincial/Territorial building codes

This research aimed to update Dunn and Cooper, 2014 to determine the status of provincial/territorial building codes including whether they match or exceed radon provisions in the national code or have in place any associated radon testing initiatives. Overall, key informants echoed comments noted by C-NRPP certified professionals, namely the insufficient knowledge, expertise and/or inspection of radon mitigation systems across the building industry (builders, home inspectors, building inspectors). Although anectdotal, these findings point to the need for more systematic examination of how building code changes are translated into practice and if the building codes are sufficient to reduce radon.

In the European scan, we found that Sweden, Switzerland, Finland, and Denmark have conducted research and follow-up surveys to determine the impacts of their building code changes on radon levels in homes and other buildings. These data have been used to determine where further action on their building codes is necessary.

1.3.1.1 Atlantic provinces

New Brunswick and Nova Scotia have fully adopted the most recent radon provisions in the National Building Code and have done extensive testing and mitigation in public buildings. In Newfoundland and Labrador and Prince Edward Island a similar approach is applied of empowering municipalities to adopt the National Building Code but this has only occurred within larger municipalities. Newfoundland and Labrador are considering province-wide adoption and pending legislation in PEI will likely result in the same.

1.3.1.2 Ontario and Quebec

Ontario remains the most backward of all provinces in Canada for not adopting the National Building Code radon provisions. Limited radon provisions apply in three narrowly defined areas of the Province. However, very progressive proposals made during 2016 (and still under consideration) would apply the national code provisions province-wide and add mandatory post-construction testing to confirm compliance. Quebec is almost as backward as Ontario given that updates to its *Construction Code* incompletely adopt the national code including retaining the out-of-date radon reference level of 800 Bq/m^3. In the policy vacuum created by this lack of provincial action, some municipalities in both provinces have moved ahead with stronger action including in some cases via protective standards in local bylaws.

1.3.1.3 Prairie provinces

Manitoba, Saskatchewan and Alberta have all updated provincial codes to meet or exceed (in Manitoba) radon provisions in the National Building Code. A demonstration project in Winnipeg indicated problems with implementation. A radon survey in Alberta helped to assess the impact of code requirements and the consequences of inadequate knowledge among builders.

1.3.1.4 British Columbia and the north

BC has a longstanding approach of dividing the province into Area 1 (coastal mountains and westward and considered to have low radon levels) and Area 2 (most of the province east of the coastal mountains). As well, the City of Vancouver (considered to have low radon levels) has its own building bylaw. For Area 2, BC has adopted the National Building Code radon provisions. Code updates in 2014 allow builders to apply either prescriptive or performance-based radon provisions so long as the outcome is not a hazard. These updates also applied more stringent radon provisions than are in the national code on the basis of tests of newly mitigated homes in Castlegar. Currently, BC proposes to replace the Area 1 and Area 2 designations with a more precise list of municipalities with high radon risk on the basis of test data from the Cross Canada Radon Survey of Radon in Homes. As well, these municipalities could accept delegated authority over whether to apply radon protective measures.

Considerable research has occurred in high radon areas of BC to inform building code changes and learn from experience, including demonstrating that radon levels can rise to unsafe levels in energy efficient homes.

Across the Northwest Territories, Nunavut, and the Yukon, building codes are all in line with the most recent radon provisions in the national code. Like Nova Scotia, some Ontario municipalities, and some European countries, (Finland, the UK and Switzerland) Yukon has facilitated radon testing and mapping by offering free test kits.

1.3.1.5 The need to learn from experience

Our research revealed that there continue to be significant gaps between what is now in codes, and what happens on the ground. We discuss a demonstration project in Winnipeg that found problems with implementation (see sec. 4.2.4.1). As well, a radon survey in Alberta helped to assess the impact of code requirements and the consequences of inadequate knowledge among

builders (see 4.2.4.2). As noted above, key informants, including C-NRPP certified professionals, told us they felt there is insufficient knowledge, expertise and/or inspection of radon mitigation systems across the building industry (builders, home inspectors, building inspectors). We also heard reports that builders in Calgary leave gaps in the foundation under heaters, creating a "furnace driven radon pump" that actively draws radon in through holes in the foundation located near the furnace. These findings point to the need for more systematic examination of how building code changes are translated into practice and the need to learn whether current building code provisions are sufficient to reduce radon. Of particular concern is consistent neglect of the need for post-construction testing.

In comparison, most of the European countries we surveyed have had radon provisions in their building codes much longer than Canada, typically since 2004, and have been better able to integrate code changes with industry practice. We found that Sweden, Switzerland, Finland and Denmark have conducted research and follow-up surveys to determine the impacts of their building code changes on radon levels in homes and other buildings. These data have been used to determine where further action on the building code is necessary.

Also, some European countries have begun to look more closely at the role of building materials in contributing to high radon concentrations, and to take steps to control the use of dangerous substances. Norway has a program to test aggregate, developed after discovery that some gravel quarries had elevated levels of uranium. Given the distribution of uranium across Canada, aggregate may be an unappreciated contributor to radon in buildings.

1.3.2 Occupational health and safety

With an estimated 188,000 Canadians exposed to radon in the workplace, insufficient attention is paid to this exposure. We report on recent research from Europe about "effective dose" that suggests a doubling of estimated risk raising a significant challenge to whether radon safety is effectively addressed in the workplace.

The European Union Directive sets out requirements for the testing and mitigation of workplaces. All of the European countries we surveyed have programs in place to test radon in workplaces and most set radon exposure limits of either 200 or 300 Bq/m^3. Switzerland also requires testing and mitigation of radon in workplaces and requires that these services are conducted by authorized providers.

1.3.2.1 Canada Labour Code and NORM Guidelines

As noted above, the radon reference level in the *Canada Labour Code* is excessively out of date. The Naturally Occurring Radioactive Materials (NORM) Guidelines offer more appropriate radon protection since their more up to date provisions ostensibly apply to any indoor workplace in Canada. However, they have no legal force unless incorporated into formal policy or statutes. Dunn and Cooper, 2014 found confusion and inconsistent opinions among provincial/territorial occupational health and safety officials concerning whether the NORM Guidelines apply. We found little indication that the situation has improved. One notable exception is in Ontario where

the Ministry of Labour has now adopted a policy of reading the NORM Guidelines into Ontario's *Occupational Health and Safety Act.*

1.3.2.2 General duty clauses, indoor air quality and ventilation, and radiation regulation

General duty clauses in workplace safety legislation require employers to minimize hazards. These clauses are broad enough to include radon, and in no case is radon specifically exempted. Ontario's recent policy actions, noted above, invoke the general duty cause by referring to the need to protect workers from radon and to consider the NORM Guidelines when doing so.

Legislative provisions to address indoor air quality and ventilation in workplaces might offer some limited indirect protection from radon but they are not specifically designed to do so. Given that radon building science shows the need for depressurization systems (as opposed to simple ventilation techniques) these are unreliable protections, especially in the absence of mandatory testing requirements.

Most provinces and territories have specific regulations that apply to radiation sources, such as for uranium workers or radiation medicine technologists. These generally are worded in ways that require specific technologies and we did not see that they could be extended to cover radon in the workplace. We found radon-specific measures only in Ontario (with the recent policy changes noted above) and the Yukon's occupational health regulations but here corrective action is required only where radon levels are very high.

1.3.2.3 Worker's compensation

We looked at worker's compensation schemes across the country and found no radon claims and no clear policies within workers compensation boards, again with the exception of recent changes in Ontario. Such claims could arise on the strength of general duty provisions, the large number of radon-exposed workers, and new knowledge of the links between radon concentrations and effective dose. That said, confusion still reigns concerning whether "background radiation" would be exempt from compensation regimes. Worker's compensation boards need to pay greater attention to radon. Scope remains for programs to educate board staff concerning radon, its risks, and how compensation boards and employers could work to reduce risks. We found that some jurisdictions, such as British Columbia, already list lung cancer as an occupational disease and link it to radon exposure. Other provinces need to make the link explicit and so ease the burden on workers to prove causation. These efforts need to work in concert with mandatory testing and reporting of radon in the workplace.

1.3.2.4 Government as employer

Governments are significant employers across Canada and are bound by occupational health and safety, and workers compensation laws. They are at risk of radon-related litigation and compensation claims from workers if workplace levels are elevated. Beyond employer liability, governments have a range of public interest reasons to test and mitigate their own buildings. By addressing radon in government buildings (and publicly posting results of pre- and post-mitigation test results) such as service centres, schools, or offices, governments can help spread awareness, lead by example, and, in the case of the federal government, further support the radon

mitigation industry. We summarize these testing and mitigation activities by provincial/territorial governments across Canada.

1.3.3 Real estate transactions and home warranty programs

The rule of "buyer beware" continues to rule much of real estate transactions. We analyzed case law in this area noting that the courts distinguish between actual knowledge and a duty on the seller to investigate (or test). There is generally no duty to investigate. In the normal case if no radon test has been done (and so the seller is ignorant of radon levels) or if the buyer does not ask, the seller will avoid liability. However, if the buyer asks, then the seller must disclose what they know. If a seller discloses what they know—including high radon levels—that is usually sufficient to escape liability. There is now significant movement towards including radon concerns during the purchase of homes, in a number of ways.

1.3.3.1 Property disclosure statements; latent defects

We provide the details of how property disclosure statements might be used to address radon. In Alberta and New Brunswick this is being worked into normal real estate practice. In some cases real estate organizations are providing guidance for real estate agents. More positively, property disclosure can benefit both buyers and sellers if disclosure includes a radon test result showing a low level or that a radon mitigation system is in place.

Courts do hold in some cases that a seller has a positive obligation—without being prompted—to disclose a "material latent defect" to prospective buyers. If the defect renders a property dangerous or unfit for habitation, the seller must tell the buyer. There appears to be some movement to classify radon as such a defect. Litigation in Quebec has demonstrated that elevated radon levels can be considered a "defect" and should be disclosed during a real estate transaction. In a 2018 bulletin, the Real Estate Council of Alberta suggests that agents should consider radon concentrations over 200 Bq/m^3 to be latent defects.

1.3.3.2 New home warranty

Warranties for personal property or consumer goods have existed since the 19^{th} century whereas warranties for real property/real estate are much more recent. Home warranty legislation (that is, a warranty on new home construction) exists in only five Canadian provinces. Only Ontario's home warranty program explicitly recognizes radon. We describe each of these programs. We think it reasonable to interpret new home warranty coverage as covering radon, as part of general protections against defects of materials or design, especially so where radon mitigation is required in local building codes. As radon awareness increases, this issue may be litigated. Ample space exists for education and outreach to warranty providers on the dangers of radon and risks of liability for builders.

New home warranty programs are also successfully used in Denmark and Finland where data from these programs is also assessed to determine the impact of the building code changes and to refine code requirements.

1.3.3.3 Radon contingency clauses

During the complex and often time-sensitive process of real estate sales, a three-month radon test during winter months can be impossible. Innovative approaches exist to ensure a radon test and any necessary mitigation costs can be covered. CARST provides a Radon and Real Estate Tool Kit noting the relative merits of available options to buyers and sellers including the use of a radon contingency clause wherein the seller agrees to pay for radon mitigation should a test reveal a high level. An example of this approach is the Radon Retention Bond used in the UK where a bond is held in trust by the purchaser to pay for mitigation if needed and otherwise returned to the seller following the finding of a low radon level. Real estate boards in New Brunswick and Alberta both recommend this approach with New Brunswick also requiring realtors to learn about radon and mitigation techniques.

1.3.3.4 Notice on title

Various provincial laws addressing public health, municipal zoning or environmental site conditions allow for filing notices on a property title, alerting potential purchasers. While this mechanism might be applied to radon, we found no evidence of same although time and resource limits prevented an exhaustive search.

1.3.3.5 Third-party certification of buildings

Various certification schemes exist that certify builders and buildings to provide specific information to prospective buyers. We describe several that address environmental or other "green" measures and that might be applicable to or that already address radon such as LEED-certified homes or the WELL Building Standard promoted by the Canada Green Building Council. While these may be helpful measures they are voluntary on the part of builders and can be replaced by objective enforceable standards in building codes.

Taken together, the above approaches are different techniques for ensuring buyers might be informed of radon in a home. Other jurisdictions, such as Switzerland have taken a simpler and more powerful route—simply requiring radon testing, mitigation, and reporting in a central database.

1.3.4 Occupier's Liability

For existing buildings few options exist, particularly for tenanted buildings, to regulate indoor air or require landlord's to specifically address radon. Those who rent will often move frequently, particularly those living on low income, and they have little ability or even incentive to seek radon testing or mitigation by landlords. We found no explicit radon standards for tenanted buildings and even where tenants might establish a legal claim, many barriers exist to bringing an action. While principles of occupier's liability might enable relief through the Courts, a review of case law found no cases addressing radon. Moreover, significant challenges would arise in terms of causation given the long latency period of radon-induced lung cancer, the need to show damages in terms of illness or loss of income, and how to apportion responsibility as between landlord and tenants when both bear responsibility for inaction.

1.3.5 Residential Tenancies

Residential tenancies laws across Canada are broadly similar and mainly focused on navigating contractual relations between tenants and landlords and adjudicating disputes related to rent and rent increases, evictions, and rights related to quiet enjoyment, and housing or maintenance standards. These laws contain no specific provision to address either testing or mitigation for radon. Tenants are also relatively powerless to address radon issues under such laws, a fact that prompted an unsuccessful law reform campaign in Ontario for mandatory radon testing and mitigation and disclosure of test results to tenants or during sale of property.

In comparison, Norway requires landlords to test. The UK explicitly addresses landlord-tenant roles with regards to radon. Landlords are required to test, or face a fine under Section 6 of the Radiation Protection Regulations. Tenants can also request testing. Landlords are required to mitigate if levels exceed 200 Bq/m^3 or the tenants can remediate at the landlord's expense.

1.3.5.1 Good state of repair and quiet enjoyment provisions

Our reading of Residential Tenancies law suggested that tenants who experience high radon concentrations in their homes should be able to convince residential tenancies boards or tribunals that high radon concentrations ran afoul of general principles of quiet enjoyment or good state of repair. A number of cases in Quebec suggest this, although each failed on the basis of evidence. One case was successful in Ontario. Explicit radon provisions are necessary in relation to renters. But in the absence of provincial law and policy change, room for advancement on radon and renters is possible through a program of education and outreach to residential tenancies administrative agencies and to renters' rights and advocacy organizations.

With respect to the principle of quiet enjoyment (or "reasonable enjoyment" in Ontario law), such provisions are included in all provincial/territorial residential tenancies laws but they also predate such statutes. While we found no cases that specifically addressed radon, multiple cases related to second hand smoke (also a known cause of lung cancer) point to the likelihood that radon exposure could be interpreted as a breach of quiet enjoyment.

1.3.5.2 Public health and housing regulations

Residential tenancies law may also refer to the maintenance of standards and these might be included in the statute itself or an associated regulation, or they may be in public health laws and regulations. In most Canadian provinces, there are either no, or very limited standards of this type, making public health action for renters unlikely. An exception is that of Alberta, where this has led to public health officials being able to order radon mitigation. Similarly the United Kingdom regulates radon in residential tenancies by way of the *Health Act* which mandates that local housing authorities review housing conditions in their districts, such as through conducting inspections and issuing orders. While this cross reference to public health standards is common in residential tenancies laws the wording of such standards makes them unlikely to be useful to address radon with the possible exception of recent changes in Ontario, as discussed below.

1.3.5.3 Investigative powers

Where public health powers are directed at inspecting residential tenancies they can be used to work with tenants to both test for radon and at times order mitigation. Such measures may also be available under residential tenancies law. While most provincial/territorial tribunals limit their case review to hearing evidence, some provide for investigative powers. Time and resources did not permit a thorough canvassing of whether such powers are commonly used.

1.3.5.4 Government as landlord and occupier

Social housing, whether directly owned by government or managed by non-profit corporations, comprises a large number of housing units across Canada. Some of these properties have been tested for radon but for the most part little attention has been given to radon. CAREX Canada is currently doing a review of this topic nation-wide.

1.3.6 Child care and schools

Legislation addressing safety in child care facilities or schools is comparable to occupational health and safety in terms of including general provisions for student health and safety. Unlike occupational health and safety laws, there are no specific provisions to address indoor air quality or to specifically address radon. Pilot projects have occurred in child care facilities in Manitoba and BC to test for radon. Alberta's *Radon Awareness and Testing Act (2017)*, not yet proclaimed, calls for increased public awareness and mandatory testing of all child care facilities. Yukon also mandated testing of all child care centres.

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. Quebec tests schools in a collaborative arrangement between ministries of Health and Education. The majority of the European countries we surveyed had radon plans that included the explicit testing of schools and child care/pre-school facilities.

1.3.7 Public health

Public health statutes exist federally and provincially but authority to act in response to health hazards rests mainly with provinces/territories. This authority is often delegated to regional or local public health departments. Inspectors are empowered to respond to suspected or known health hazards, often broadly defined, that can or may threaten public health. The system is typically complaint-driven and can address issues of indoor air quality including radon although public health statutes and associated regulations, like legislation addressing child care or schools, contain broadly worded provisions and do not specifically name radon. As described above with respect to residential tenancies law, public health inspectors may be empowered to apply minimum standards from public health statutes to address building maintenance and repair requirements.

We found little change in the situation identified in Dunn and Cooper, 2014 in terms of limited complaints being made (understandable given that radon is an odourless, colourless, invisible

contaminant), procedural obstacles to inspection such as lack of consent for inspections, and a lack of concern or perceived mandate among public health officials to act on this issue.

However, Ontario has made progress during the regular process of updating the Ontario Public Health Standards (OPHS). Although not legally enforceable, the OPHS are the *de facto* rules followed by local health units. Updates published in 2018 direct local Boards of Health to undertake public education about radon risks in the built environment. The associated Healthy Environments and Climate Change Guideline recommends the development of public awareness and mitigation strategies for radon.

Alberta Health Services has ordered radon mitigation and developed a guidance document about radon in rental accommodation empowering inspectors to apply general nuisance provisions in Alberta's *Public Health Act* and associated regulations. Likewise in BC, the actions noted above with respect to radon testing in child care facilities in the BC Interior Health Authority relied upon authority in the BC *Public Health Act*.

1.3.7.1 Maintenance standards

As described above with respect to residential tenancies law, public health inspectors may be empowered to apply minimum standards from public health statutes to address building maintenance and repair requirements.

1.3.8 Incentive programs for mitigation

In the face of an ongoing lack of public awareness about radon, or resistance to addressing an uncertain/distant (but potentially quite expensive) problem even when the risk is known, incentive programs can play an important role.

Evidence is growing that radon testing and mitigation is a public health intervention worthy of public investment. There are a wide array of possible investments, including directly paying or subsidizing radon mitigation, funding education and outreach campaigns or academic and policy research, dedicated time for public health officials, refining mapping efforts to identify high radon potential areas, and financing databases. Equity considerations arise as well. Homeowners with lower incomes will tend to push off into the future radon testing and any needed mitigation while tenants have little to no capacity or incentive to invest in radon testing or mitigation in property they do not own and are not likely to live in for a long time. Subsidies and incentives work to share the costs of a collective good. Such subsidies can be as simple as paying for free radon testing, a low-cost effort undertaken in various jurisdictions, especially those known to have high radon potential.

1.3.8.1 Tax credits or grants

Testing is inexpensive but mitigation is not. This cost is more than a barrier to radon mitigation since knowledge of this expense acts as a deterrent to even test for radon when results might demonstrate an expensive problem. We found no federal or provincial programs to help offset mitigation costs. After more than ten years of laudable federal action to promote radon

awareness, testing and mitigation, it is a logical next step for the federal government to direct either its spending or taxation powers to assist Canadians with the costs of radon mitigation.

By comparison, we found variations on tax credit programs to cover radon mitigation costs in all of the European countries in the scan. In the UK, commercial buildings can offset the costs of remediation as a business deduction. Finland also operated a subsidized test kit program and the Swiss cantons have born the costs of testing many buildings in their jurisdiction.

At the municipal level we note the impressive programs in Victoriaville, Quebec, in which radon is included in a broad suite of sustainability initiatives to help the environmental performance of buildings, extending to subsidies in new builds and retrofits.

1.3.8.2 Prizes, loan programs, and landlord and tenant cost sharing

Comparable to the relatively low cost of government paying for radon testing, prizes are a low cost way to incentivize action. For example, the multi-stakeholder collaborative Take Action on Radon partnered with CARST to offer a total of $10,000 for a Radon Reduction Sweepstakes that gave contest winners up to $1000 towards mitigation costs. Similarly, loan programs can assist with paying for large up-front costs and creative means of long term payment can be used such as on-bill financing (on property tax or utility bills). Numerous models exist in the US but this approach is rare in Canada with the exception of programs in Manitoba and Yukon to address energy upgrades and home repairs respectively. Both programs include the ability to finance radon mitigation. A Manitoba program also enables landlord-tenant cost sharing for repairs but it has not been used for radon.

1.4 Recommendations for Health Canada to achieve increased radon testing and mitigation across Canada

The following recommendations are organized according to actions that can be taken by the federal government. The next section is more specific to actions that are the purview of provincial/territorial governments or others but that can be encouraged by the federal government.

A bolder National Radon Program

1. The federal government should consider creation of a bolder version of the National Radon Program comparable to the Basic Safety Standards Directive established by the European Union in 2013. Using the EU model, the federal government could expand its current focus on research, education, and public outreach. Recognizing that jurisdictional authority in the Canadian federation is not directly comparable, nevertheless, an expanded National Radon Program could more comprehensively address matters covered in the EU Directive including providing direction and advice to provinces and territories on addressing radon in the workplace and in public and private buildings, in developing and coordinating provincial/territorial radon action plans, and in establishing a system of enforcement. A key overarching recommendation from the federal government to provincial/territorial

governments is the need to revise laws that address the indoor environment with explicit direction about radon.

Whether or not the federal government chooses to gather up future actions under a revised National Radon Program, the following recommendations are crafted on the assumption that such a bolder approach at the federal level can help to achieve a more comprehensive approach to addressing radon across Canada than currently exists.

The *Canada Labour Code* outdated radon limit undermines federal credibility

2. For the federal government to expect more comprehensive radon action by provinces and territories it needs to get its own house in order and update the radon limit in the *Canada Labour Code*, applicable to federal employees and federally-regulated workplaces. Both the slow pace of change and the fact that this limit is based on more than 20 year-old science, undermines the federal government's credibility on radon.

Continue to test in radon-prone areas and assess National Building Code effectiveness

3. The federal government should continue to encourage radon testing by provincial/territorial and municipal governments, particularly in radon-prone regions identified by Health Canada. Complementary action is necessary in provincial law to require post-construction radon testing (see below). Federal action in this area can assist via pilot programs to undertake post-construction radon testing that would evaluate the impact and effectiveness of those Building Codes that have been updated to reflect the National Building Code.

4. The federal government should draft model language for incorporation into provincial/territorial Building Codes to require post-construction radon measurement and to make the services of C-NRPP trained and certified professionals mandatory when radon mitigation occurs. (See additional recommendations below regarding Research and Training.)

A tax credit or grant program to assist with radon mitigation

5. To complement federal government programs for radon research, education and outreach, and certification of radon mitigation firms, and to follow the leadership of multiple European countries, the federal government should incent radon mitigation for homes having radon levels above the federal guideline – either a tax credit for individuals and small-scale landlords or a direct grant program (both options will have positive/neutral net federal and provincial tax impacts and provincial health care savings). Such a program should be integrated with any efforts to assist Canadians with achieving energy efficiency improvements in their homes. If such programs are phased in or targeted, priority should be given to low-income Canadians and households with young children.

FPT Radiation Protection Committee could do more to address radon

6. To address the stated mandate of the Federal-Provincial-Territorial Radiation Protection Committee of "advancing the harmonization of radiation protection practices and standards across Canada," this committee could do more to address radon. As recommended in 2014, this committee should convene provincial and territorial officials and affected stakeholders to investigate effectiveness of building code changes and to investigate and clarify duties and responsibilities of inspectors in the areas of occupational health and safety and public health. This work should also include a review of new research regarding the relationship of radon concentration to effective dose in the context of the current review (consultation deadline October, 2018) of the NORM Guidelines.

Research and training

7. The federal government should coordinate pan-Canadian collection of all publicly and privately collected radon test results, as occurs in Switzerland, to facilitate more robust mapping of radon-prone areas while respecting personal privacy.

8. The federal government should address radon in ongoing negotiations with respect to First Nations about the supply and conditions of on-reserve housing and conduct/commission additional specialized research in this area.

9. Expanding and complementing the work to update the National Building Code, the federal government should test post-construction homes for radon to assess the effectiveness of national code upgrades including whether they are properly installed and any impacts of improper installation. Results of this research should be widely publicized to the public and affected stakeholders.

10. Complementing the establishment and funding of the C-NRPP, the federal government should research and design/co-design with provincial/territorial and multi-stakeholder input, radon training programs for builders, building inspectors, home inspectors, and the real estate industry to address the many concerns we heard expressed about general lack of awareness about radon and whether radon mitigation systems are being installed or inspected adequately.

Facilitating pan-Canadian best practices

11. The federal government should work with the real estate industry to create a best practices framework for real estate transactions. This work should encourage modernization of forms and property disclosure statements during home sales to remove outdated issues such as urea formaldehyde foam insulation (UFFI) and to add radon. It should also assist with the use of contingency clauses and radon bonds, as occurs in the UK, to build radon testing and mitigation into the real estate process.

12. The federal government can provide additional support to the real estate industry and the home-buying public by advancing the inclusion of radon in home warranty programs,

currently only in place in Ontario, and help to clarify and improve the legal uncertainty created by generalized language in home warranty programs such as "free from defects of materials and labour."

13. To support Canadians in financing radon mitigation, the federal government could develop a tool kit for municipalities, utilities, and financial institutions borrowing from measures used in the home energy efficiency sector, showing where these players could create forms of subsidy, such as through on-bill financing, low or zero interest loans, or direct subsidy, especially for low-income individuals, housing cooperatives, social housing or private sector purpose-built rental accommodation.

14. The federal government should prepare a toolkit for public health authorities laying out the legal basis for action on radon, best practices, and the benefits of public health standards to address radon (as in Ontario). Complementary action should include development of training programs for public health officials.

15. The federal government should prepare a radon toolkit for municipalities about municipal roles and measures to address radon. It could profile innovative action in other municipalities and lay out steps to operationalize radon goals including implementing and/or exceeding Building Code practices, addressing radon during the application of tenancy maintenance laws/bylaws, coordination among property standards and public health officials and with local tenant advocacy organizations or during inspection of schools, child care and other settings addressed by public health officials, education of homeowners and businesses, and financing or subsidy programs.

In sum, the above recommendations seek a role for the federal government in either direct regulation of radon or in expanding the federal role beyond research, training, and education to both model and enable a more comprehensive and where necessary coordinated pan-Canadian radon strategy.

1.5 Recommendations for provincial/territorial governments in Canada to achieve greater radon protection

The focus of this research is on actions that can be taken by the federal government. However, given that much legal jurisdiction over radon falls within the provincial/territorial sphere, the following recommendations are framed in the context of Recommendation #1 above. That is, the provinces and territories should devise radon action plans to comprehensively address radon matters in the multiple areas addressed below.

Research and education; testing of provincial/territorial government buildings

16. Provincial/territorial governments, in coordination with local/regional public health authorities, should engage in radon research, education, and outreach as well as testing (and

where necessary mitigation) of publicly owned or operated buildings including schools, offices, administrative buildings, social housing and care facilities.

Provincial/territorial building codes

17. All provinces and territories need to benefit from systematic examination of how building code changes are translated into practice and if building code changes are sufficient to reduce radon. These efforts should be coordinated and results shared across the country, including the results of the Winnipeg demonstration project and Alberta research into implementation of building code requirements.

18. All provincial/territorial building codes should require a post-construction radon test. Results of this testing should be centrally held by the province and used to generate maps that refine the understanding of radon-prone regions and contribute to a better sense of how housing characteristics impact radon levels (see Recommendations 7, 9 and 10 above).

Occupational health and safety

19. All provincial/territorial occupational health and safety legislation should be updated to incorporate new data on the relationship of radon concentration to effective dose and to clearly reference the NORM Guidelines as the means by which workers in any indoor occupational setting should be protected from radon exposure. Provinces and territories should also support research estimating potential liabilities to workers compensation funds from radon induced lung cancer and work with their respective workers' compensation boards to have clearer language on radon induced lung cancer as an occupational disease for compensation purposes and to otherwise ease radon-related compensation claims.

Real estate transactions and home warranty programs

20. Provincial/territorial governments should mandate radon testing during real estate transactions via amendments to property disclosure documents to explicitly address radon (similar to other indoor hazards such as formaldehyde) and update home warranty legislation to address radon using the Tarion model from Ontario.

Residential tenancies

21. Provincial/territorial law (or in some cases municipal bylaws) governing residential tenancies should be amended to provide explicit provisions to protect tenants from radon via mandatory testing by both public and private sector landlords and mitigation where there are above-guideline levels. Results of such testing, including a post-mitigation clearance test, should be made public. Alongside or even absent such legislative amendments, provincial/territorial governments should expand educational and outreach activities for tenants/tenant associations to include radon, Likewise, absent mandatory radon testing, provincial/territorial governments should expand the practice of some progressive

municipalities and offer free radon test kits to all tenants as part of educational outreach activities.

Child care and schools

22. Provincial/territorial governments should amend legislation governing safety in child care centres and in schools to include explicit provisions to address radon including requiring testing and, where necessary mitigation. Provincial/territorial funding should be provided for mitigation costs.

Public health

23. Provincial/territorial public health legislation and associated standards should be amended to include explicit provisions to address radon including training and empowering public health inspectors to protect the public from radon exposure in public buildings and residential tenancies.

Incentive programs for mitigation

24. In coordination with federal actions to incent radon mitigation (as recommended above) and recognizing that provincial/territorial governments will pay most of the health care costs of radon-induced lung cancer, provinces and territories should actively encourage and incent Canadians to undertake radon mitigation where above-guideline levels occur choosing from the suite of options described herein and taking particular effort to assist those living on low income.

Part 2 - Jurisdiction over radon law and policy in Canada

2.1 Radon and Canada's constitutional framework

Flowing from Canada's *Constitution Act*, jurisdiction, or law-making power, in Canada is divided between the federal government and the provincial/territorial governments. In general, the Constitution grants federal powers over matters of a national interest or that cross provincial boundaries, such as consumer products. Provincial and territorial powers are those that concern matters of a more regional or local nature including the power to pass enabling legislation giving municipalities powers to act at an even more local level.

Radon arguably falls into the areas of either "health" or "environment" and these are matters of shared responsibility among federal, provincial, and municipal governments. Radon affects the indoor built environment and its regulation may involve areas regulated by all orders of government, such as homes, schools, care facilities, and workplaces.

The Constitution does not specifically situate jurisdiction for either 'health' or 'environment' at either the federal or provincial level. These are both broad subject areas that intersect with several other law-making powers. As such, the courts have determined that they are areas of shared jurisdiction where both levels of government may act under their respective legislative powers, as set out in ss. 91 and 92 of the *Constitution Act*.[2]

Legal definitions of "environment" have tended to refer only to the 'natural,' or outdoor, environment. Built, or indoor, environments have received relatively little legislative attention, despite increasing evidence of health risks associated with indoor environments, and in particular, indoor air quality.[3]

2.1.1 Federal jurisdiction

Areas of federal power that may be relevant to indoor air may include the federal criminal law power where the courts have held that the legitimate scope of such power includes the protection of public health and of the environment. Additional areas may include the power to regulate interprovincial works and undertakings, and the federal spending power.[4] The federal government holds jurisdiction over federal employees and nuclear energy. As well, radon-related provisions are included in the *National Building Code*, an advisory/model code provided to provinces and territories but that requires provincial/territorial legislative action to have the force of law.

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[2] Friends of the *Oldman River Society v. Canada (Minister of Transport*), 1992 CanLII 110 (SCC), [1992] 1 SCR 3, at para. 99, online: http://canlii.ca/t/1bqn8.
[3] Pollution Probe, "Achieving Health Indoor Environments: A Review of Canadian Options", online: (main body of report): http://www.pollutionprobe.org/old_files/Reports/IAQ%20front%20section.pdf Appendices online: See Joseph Castrilli, "Appendix III – Legal Aspects of Indoor Air Quality in Canada," pp. 163 – 168.
[4] *Ibid*.

The *Constitution Act* also creates a particular and unique relationship between First Nations and the federal government given that section 91(24) of the *Constitution Act* assigns legislative authority to the federal government over "Indians and lands reserved for the Indians" and section 35 protects First Nation treaty rights. The tenure and housing provisions in the *Indian Act* may be relevant to radon. Likewise, radon-relevant provisions may exist within treaties between First Nations and the federal government and within the many federal government policies, programs, and funding arrangements related to on-reserve housing

2.1.2 Provincial jurisdiction

Multiple sections of the *Constitution Act* enumerate provincial powers that may be relevant to indoor air quality.[5] In general, provinces and territories have radon-relevant jurisdiction and law or policy in place in the following areas:

- naturally occurring radioactive material and the health effects of radon;
- the design and construction of new buildings (and major renovations of existing buildings);
- employment/occupational health and safety;
- provincial/territorial services including schools, hospitals, and public health promotion;
- real estate transactions including sales, warranties, and occupier's liability; and
- residential tenancies.

2.1.3 Municipal jurisdiction

Municipalities derive their powers from the provincial/territorial legislatures that create them, and that delegate to them certain powers, typically through Municipal Law Acts, and at times City Charters (such as the *Vancouver Charter*.) Municipalities tend to be delegated the responsibility for delivery, implementation, or enforcement of public services/standards such as water supply, sewage and garbage disposal, public health, building codes and building permits, property maintenance standards, land use planning and approvals, local roads and parks, etc. As such, local inspection and enforcement powers may be directly relevant to radon, e.g., those related to public health, inspection of new construction, or maintenance for existing buildings. Local inspectors often may have powers to issue orders necessary to direct compliance with applicable (provincial/territorial) laws, and regulations, such as Building Codes, Fire Codes or Health Acts.

2.2 Radon protection is infrequently codified in federal or provincial law

Explicit radon protection, as opposed to general provisions for health and safety, is rarely in place in federal or provincial/territorial law across Canada,[6] or in either the *Indian Act* or treaties

[5] For example the *Constitution Act*, 1867, 30 & 31 Vict, c 3, addresses property and civil rights at s. 92(13), matters of a local and private nature at s. 92(16), municipalities at s. 92(8), the management and sale of public lands belonging to the province at s. 92(5), the establishment, maintenance, and management of hospitals, prisons, education, and local works and undertakings, at s. 92(7), s. 92(6), s. 93, and s. 92(10), respectively.

between First Nations and the federal government.[7] Where radon protection measures are codified in law, they are captured by provincial/territorial building codes and in the *Canada Labour Code* regulations.[8] (However, *Canada Labour Code* provisions for radon are woefully out of date, still referencing a limit of 800 Bequerels per cubic metre (Bq/m^3). Yukon is alone among provincial/territorial labour codes or employment standards legislation to specifically include a reference to radon gas.[9] However, (and as discussed below) some jurisdictions, such as Ontario, have adopted policies for interpreting general purpose provisions of its *Occupational Health and Safety Act.*

2.3 Additional radon-focused activities and areas of shared jurisdiction

Beyond the enactment and enforcement of laws or by-laws, additional activity to address radon occurs at all three levels of government. For example, multiple governmental activities occur in the areas of research, monitoring, educational outreach, training programs, the establishment of model codes, etc., particularly at the federal level. These activities can often involve areas of shared jurisdiction/interest, or may be efforts towards harmonization of approaches across the country.

Given that most legal jurisdiction to address radon protection resides at the provincial/territorial level, for example in labour and building codes, requirements tend to differ across the country. These variations continue despite the existence of a Federal-Provincial-Territorial Radiation Protection Committee (FPTRPC), an intergovernmental Committee established to support Federal, Provincial and Territorial radiation protection agencies.

The stated mandate of the FPTRPC is to advance the development and harmonization of practices and standards for radiation protection across jurisdictions, and to communicate these to the people of Canada.[10] As noted in our 2014 report, this harmonization of practices and standards, particularly in the areas of public health and workplace health and safety is not apparent although some improvements have occurred in terms of increased public outreach, radon testing and/or policy updates within some public health or occupational health and safety agencies (see discussion in Sections 3.3 ,4.3, 4.8, and 5.2 below concerning the continued broad diversity of approaches to radon across Canada including ignoring it altogether). This committee's mandate could also be usefully directed towards addressing issues raised herein about whether radon provisions in updated Building Codes are being effectively implemented and inspected (see relevant discussions in Sections 3.3, 4.2, and 4.4).

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[6] Dunn, B. and K. Cooper. "Radon in Indoor Air - A Review of Policy and Law in Canada," November 2014, Canadian Environmental Law Association. Online at: https://www.cela.ca/publications/radon-indoor-air-review-policy-and-law-canada

[7] Note however that the scope of our research did not permit a review of First Nations treaties.

[8] *Canada Occupational Health and Safety Regulations*, SOR/86-304, s.10.26(4)

[9] *Occupational Health and Safety Act*, RSY 2002, c 159, ss.43-46. online: <http://canlii.ca/t/kfkt.

[10] Federal Provincial Territorial Radiation Protection Committee website: http://www.hc-sc.gc.ca/ewh-semt/radiation/fpt-radprotect/index-eng.php

Part 3 – Areas of federal responsibility

3.1 Introduction

Under the umbrella of the National Radon Program, the federal government addresses radon in multiple ways and often in partnership with provinces and territories. These include research, pan-Canadian monitoring and mapping, periodic review and updates to the *National Building Code*, the creation of national guidelines and guidance documents for diverse professionals (contractors, health care providers, etc.), and educational outreach to Canadians about health concerns, how to effectively test for radon, hiring a certified radon professional, etc.[11]

Key among these activities is the revision in 2007 to the federal Radon Guideline and the subsequent incorporation of the reference level of 200 Bq/m^3 into the *National Building Code*. This guideline is meant as a reference to encourage radon testing and to provide guidance on when remedial action should be taken.

The Radon Guideline is intended to apply to the 'normal occupancy area' of 'dwellings', which includes residential homes and public buildings with a high occupancy rate, such as: schools, hospitals, long-term care residences, and correctional facilities.[12] It does not apply to uranium mines, (regulated by the Canadian Nuclear Safety Commission), other mines (such as fluorspar mines regulated by provincial mining authorities), and other workplaces addressed by other guidelines for naturally occurring radioactive materials (the NORM guidelines,[13] discussed elsewhere[14] with respect to occupational exposure).

The only area of federal purview that includes legislated requirements for radon (outside of the nuclear fuel cycle) is, as noted above, within the Occupational Health and Safety Regulations under the *Canada Labour Code*.

The following discussion addresses a subset of these areas of federal activity in the National Radon Program, namely the existence, use, perceived value, etc., of pan-Canadian radon monitoring and the national radon certification program, ongoing efforts to address radon in the National Building Code (discussion of efforts to incorporate these provisions into provincial/territorial codes is addressed in Section 4.2), and a general discussion of the federal role in addressing radon in First Nations communities.

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[11] Health Canada website; See multiple links, e.g.,: "Radon": https://www.canada.ca/en/health-canada/services/environmental-workplace-health/radiation/radon.html; "Testing your home for radon": http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/environ/radon-eng.php#a7; Government of Canada Radon Guideline: http://www.hc-sc.gc.ca/ewh-semt/radiation/radon/guidelines_lignes_directrice-eng.php.

[12] Health Canada, Guide for Radon Measurements in Residential Dwellings (Homes), HC Pub.: 4171 (2008), online: http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radon_homes-maisons/index-eng.php; Guide for Radon Measurement in Public Buildings (Schools, Hospitals, Care Facilities, Detention Centres" HC Pub: 4175 (2008), online: http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radon_building-edifices/index-eng.php

[13] Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM) available online at: https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/environmental-contaminants/canadian-guidelines-management-naturally-occurring-radioactive-materials-norm-health-canada-2000.html

[14] Dunn and Cooper, 2014, *op. cit*. at pp. 26-29, 38-40.

3.2 Testing and mapping efforts in federal buildings and private homes

During 2009-2010 Health Canada's National Radon Program conducted the "Cross-Canada Survey of Radon Concentrations in Homes."[15] These and later test results indicate that no areas of Canada are "radon free." The study found that 6.9% of homes in Canada likely have radon gas levels above the guideline of 200 Bq/m^3. Geographic distribution of these results also indicated that radon levels vary significantly across the country with the highest indoor radon levels found in Manitoba, New Brunswick, Saskatchewan, and the Yukon.[16]

At the outset of the Cross-Canada Survey, Health Canada entered into data sharing agreements with the provinces/territories, allowing study results to be provided to them. The study results intended as a tool to support policy development and planning.[17] For example, Public Health Ontario used the information from the Cross-Canada Survey in its provincial burden of illness risk analysis of radon,[18] and Nova Scotia used it for its online radon risk assessment mapping tools.[19]

Extensive testing has also occurred in federal workplaces. From 2007 to 2013 Health Canada tested nearly 13,000 federal workplaces for radon. The stated purpose was to identify federal workplaces with radon levels above the Radon Guideline to allow federal employers and building managers to address the need for mitigation where necessary.[20] This study found approximately 3.8% of the federal buildings tested with average radon concentrations above the Radon Guideline. Of the 12,865 federal workplaces tested, 12,371 had radon levels below the Radon Guideline reference level of 200 Bq/m^3, 426 had radon levels between 200 Bq/m^3 and 600 Bq/m^3, and 68 had radon levels above 600 Bq/m^3.[21]

Health Canada's National Radon Program is currently working to have all radon data sets available on a government open portal. Additional work with Natural Resources Canada is using existing data about indoor radon levels to develop radon potential and risk maps to help direct

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[15] Health Canada, "Cross-Canada Survey of Radon Concentrations in Homes, Final Report" ((March 2012) ISBN: 978-1-100-20115-3, online: http://www.hc-sc.gc.ca/ewh-semt/alt_formats/pdf/radiation/radon/survey-sondage-eng.pdf.

[16] *Ibid.*

[17] Personal Communication with Health Canada, Jan 28, 2014.

[18] Emily Peterson, et al., "Lung cancer risk from radon in Ontario, Canada: how many lung cancers can we prevent?" Cancer Causes Control (2013) 24:2013-2020, online: http://www.publichealthontario.ca/en/BrowseByTopic/EnvironmentalandOccupationalHealth/Pages/Radon-Burden-of-Illness.aspx#.Uy8SxvldWuI

[19] Government of Nova Scotia website, Department of Natural Resources, "Potential for Radon in Indoor Air in Nova Scotia" (2013): http://www.novascotia.ca/natr/meb/download/dp486.asp. To access the radon risk map see: "OFM ME 2013-28 Map Showing the Potential for Radon in Indoor Air in Nova Scotia (1:750,000)": http://www.novascotia.ca/natr/meb/download/mg/ofm/htm/ofm_2013-028.asp. And to access the interactive map,, searchable by postal address, see: "DP ME 486, Version 1, 2013, Digital Data Showing Potential for Radon in Indoor Air" at http://gis3.natr.gov.ns.ca/Radon/index.html.

[20] Health Canada website, Environmental and Workplace Health, "Radon Testing in Federal Buildings – Highlights": http://www.hc-sc.gc.ca/ewh-semt/radiation/radon/buildings-edifices-eng.php

[21] *Ibid.*

strategy for the program and define at-risk/radon-prone areas.[22] Presumably this work will help refine the map[23] created by Radon Environmental in 2011for all of Canada and that is at a level of resolution not particularly helpful at a local scale in such a large country.

3.2.1 Radon testing in First Nations communities

While no federal or provincial policies exist specifically to address radon in First Nations (FN) communities (see further discussion in Section 3.5 below), some radon testing has occurred in FN housing and community buildings.

Historically, the Geological Survey of Canada and Health and Welfare Canada tested for radon in FN housing in communities with high radon potential (Canadian National Native Home Radon Survey[24]). At the time of the survey, the radon guideline was 800 Bq/m^3. This survey found 5.6% of homes above guideline and mitigation was undertaken. A high level overview of the results of this work is available through the Geological Survey File 3061.[25]

More recently, the federal government tested some FN administration buildings, schools and childcare facilities within its Federal Building Testing program,[26] (described above) that was initiated in 2007. Buildings above the 2007 guideline (200 Bq/m^3) are being mitigated.

Provincially, radon testing in FN housing has been conducted in some specific regions via Health Canada collaborative initiatives and partnerships with non-profit organizations.[27,28,29,30] In 2016, The BC First Nations Health Authority (FNHA) began testing housing throughout the province where communities are able to accommodate and consent to the costs of testing and/ or mitigation.[31]

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[22] Health Canada, Radiation Protection Bureau. National Radon Program, slide deck. February, 2018.
[23] Radon Environmental Management Corp. Radon Potential Map, Canada. 2011. www.radoncorp.com.
[24] Cocksedge, W, et al. 1993 in Shives, R, Ford, K and Charbonneau, B Geological Survey of Canada, Minerals Resources Division, 1995 Workshop Manual OPEN FILE 3061, Geological Survey of Canada, Open File 3061, (ed. 2)
[25] Geological Survey of Canada workshop manual: applications of gamma ray spectrometric/magnetic/VLF-EM surveys; Shives, R B K; Ford, K L; Charbonneau, B W. Geological Survey of Canada, Open File 3061, (ed. 2), 1995, 85 pages, https://doi.org/10.4095/203485
[26] https://www.canada.ca/en/health-canada/services/environmental-workplace-health/radiation/radon/radon-testing-federal-buildings-highlights.html
[27] Brossard, Mathieu, Renato Falcomer, and Jeff Whyte. "Radon Mitigation in Cold Climates at Kitigan Zibi Anishinabeg." *Health Physics* 108.1 (2015): S13-S18.
[28] Hebert, Leo Successes and Challenges in mitigation of radon *from* Housing Health and the Aboriginal peoples of Canada. National Collaborating Centre for Environmental Health. Vancouver, BC CPHA 2015
[29] Sarkar, Atanu, Derek HC Wilton, and Erica Fitzgerald. "Indoor Radon in Micro geological Setting of an Indigenous Community in Canada: A Pilot Study for Hazard Identification." *The international journal of occupational and environmental medicine* 8.2 April (2017): 1001-69.
[30] Nowicki, V.K., The occurrence of radon on the Tobique First Nation Reserve and its implication for radon occurrence along the Saint John River Valley.
[31] Neathway, Casey. Community Champions and Radon Testing in First Nations Communities CARST 7th Annual Radon Conference Kanata, Ontario April 24, 2018

3.3 National certification program

3.3.1 Establishing the Canadian certification program

A key element of the National Radon Program in support of effective application of the federal Radon Guideline was the creation of the Canadian National Radon Proficiency Program (C-NRPP) to ensure a trustworthy program for the training and certification of radon mitigation specialists. The C-NRPP was established in 2014 to provide a certification program, including guidelines, training, and resources for the provision of professional radon services. Created under an agreement between the Canadian Association of Radon Scientists and Technologists (CARST) and Health Canada, C-NRPP took over from the services that had been offered to the Canadian mitigation industry by the US-based program (the NRPP).

Establishing the Canadian program benefited from a US Environmental Protection Agency (USEPA) program audit of the NRPP done in 2009.[32] This report focused on the accuracy and reliability of radon testing devices, do-it-yourself kits, and radon laboratory analyses. However, its findings were more broadly useful to establishing the C-NRPP including providing support to the decision in Canada to insist upon a long-term (minimum of three months) radon test for ensuring reliable results, and the related need to have confidence in the proficiency of radon mitigation experts.

3.3.2 C-NRPP policies and procedures

C-NRPP works closely with the Canadian Association of Radon Scientists and Technologists (CARST) and Health Canada to develop and uphold high standards of practice in the industry. Drawing upon lessons learned from the USEPA report and the pre-2014 experience of Canadian mitigators working under the NRPP, the C-NRPP and its certified members saw the need for having key tools in place including clear guidance and policy manuals.

A foundational set of policies and procedures are in place, developed by CARST and that govern the daily operations of the C-NRPP. As well, the C-NRPP is governed by a Policy Advisory Board that oversees implementation of C-NRPP policy and standards for multiple aspects of new/renewed certification, several course requirements including curriculum content and the setting of examinations, certification of radon testing technology, fees, and a code of ethics/discipline.

3.3.3 Evaluating C-NRPP

There is currently no formal or published evaluation of the C-NRPP. The following discussion summarizes internal/informal evaluation by staff and Board members as well as interviews conducted with C-NRPP certified members.

[32] US Environmental Protection Agency Office of Inspector General, Evaluation Report – EPA Does Not Provide Oversight of Radon Testing Accuracy and Reliability. Report No. 09-P-0151, 12 May 2009.

All persons interviewed agreed that overall, the program brings great benefit by providing necessary training for radon measurement and mitigation, offering valuable support to radon-focused businesses across Canada via regular conferences, easy access to staff, and online resources, the latter also including training and providing a nation-wide referral service. While praise was given for the C-NRPP training, some concern was expressed that it lacked the rigour applied to US-based training under the NRPP. It was also noted that greater recognition was needed by provincial and federal organizations to understand what certification means, and that it costs money to do the work properly (e.g., for initial and regularly updated training, for ensuring the use and regular maintenance of professional equipment, having errors and omissions insurance, etc.).

Most noted a key area for improvement is increasing demand for the services of C-NRPP members. While they are keen to obtain certification in a program that provides valuable training and that comes with the imprimatur of trustworthiness, demand remains low given the continued lack of public awareness about radon risks. However, others noted that lack of public awareness is less of a problem than in past. Instead, a key barrier is lack of money to pay for mitigation and they echoed the longstanding recommendation made by many individuals and organizations that the logical next step for federal government action on radon is a tax credit or grant program to assist individual homeowners with mitigation costs.

3.3.3.1 Lack of mandatory requirements for hiring C-NRPP professionals

A common issue raised by C-NRPP members is the lack of a mandatory requirement for hiring C-NRPP certified professionals when radon mitigation is required. Currently, there are only three instances across Canada where hiring a professional radon mitigator certified by C-NRPP is mandatory. They include:

- Policy established by Alberta Infrastructure (a provincial government agency) requiring that radon mitigation in newly constructed schools by done by a C-NRPP professional.
- Policy within Manitoba Hydro such that anyone wanting to access their loan program for radon mitigation must hire someone with C-NRPP credentials.
- The Tarion home warranty program in Ontario which allows for homeowners to conduct their own long-term test (so long as the test kit is C-NRPP approved and the evaluating laboratory is C-NRPP certified), and where mitigation is needed, it must be by a C-NRPP certified mitigator.

C-NRPP members who we interviewed were not aware of any other situations where C-NRPP certification is mandatory. They also felt this was a serious concern given that they are aware of radon testing and mitigation services being offered by uncertified people, potentially increasing radon health risks. They compared their services to other trades such as electricians or plumbers who have to be certified and their work inspected by equally qualified individuals, noting that such assurance of quality work should be as important when dealing with a radioactive gas and known cause of cancer.

A related concern was raised about recent changes to Building Codes. While recognizing the importance of updated Building Codes to require the rough-in of a radon mitigation system, C-NRPP members noted a lack of expertise by home builders to do these installations or building inspectors to know if they are done properly. They recommended that C-NRPP certification was necessary to oversee and/or conduct both the installation and inspection, including clearly labelling the roughed-in system so that future owners would know its intended purpose. This certification would be needed on the part of the builders and the inspectors or the same expertise should be hired for both steps. They stated that Building Codes should make C-NRPP certified professionals in both steps mandatory as well as require follow up radon testing after construction is completed and the home is occupied.

Similarly, concern was expressed about the practice of engineers involved in mitigation of large facilities (such as schools or commercial buildings) who have C-NRPP certification but little or no practical experience with mitigation. Their involvement may be used to certify the work of contractors who are not C-NRPP trained or certified but engineers may be signing off on a mitigation system without ever going on site. Interviewees thus suggested the solution of requiring, as noted above, that both the design and implementation of these mitigation systems be done by C-NRPP certified mitigators.

Interviewees also felt that there was a need for mandatory radon testing. They cited inconsistencies, comparing the progressive actions of British Columbia's Interior Health Authority in requiring radon testing in all child care facilities with another health unit in the same province that does not consider radon to be a problem. They note that mandatory testing is the only way to ensure equal protection for all residents.

3.3.3.2 Radon testing during real estate transactions

For real estate transactions of existing homes, the C-NRPP members we interviewed had much to say about the role of realtors and the challenges that arise during the often very tight timeframe of home sales. Some see realtors as an important part of the problem of radon testing not occurring during home sales given that they perceive a radon test as an annoying barrier to completing a sale. Examples were noted of realtors actively discouraging clients from having a test done, saying it was unnecessary.

On the other hand, given the central involvement of realtors in the existing housing stock across the country, it was commonly felt that realtors need to be more engaged on this issue. Some even felt that realtors play a crucial role in driving radon testing and using short-term (2 to 4 days) tests as a useful screening tool to indicate whether radon might be a problem. They would like greater outreach to realtors to increase awareness, have them take C-NRPP training, as well as use of escrow riders (or contingency clauses) on house sales to pay for mitigation should a long-term test indicate elevated levels (see discussion of this topic in Section 4.4 below).

It seems clear from these interviews, and as discussed further in Section 4.4, that realtors are among the many public and private sector individuals and professionals involved in the diversity of residential, commercial and institutional building stock across Canada that need to take the issue of radon more seriously. The roles played by the C-NRPP for its members and the public

offer a useful lens to view whether, when, and how greater action is necessary, including where such actions should be mandatory.

3.4 National Building Code

As discussed in detail in Dunn and Cooper (2014), the National Building Code is one of five national model codes relating to building construction (as well as substantial renovation of existing buildings) in Canada. Code updates published in 2010, further updated in 2012, included a wide range of radon-specific measures. Centrally, it called for homes to have a radon "rough in" –a system of impermeable membrane, a suction point and a stub with a cap, on top of which a full sub-slap depressurization system could be added if needed. Hereinafter, reference to NBC 2010 is taken to mean radon-relevant measures included in both the 2010 and 2012 versions of the NBC. A new edition of the National Building Code was published in 2015 but it does not appear to include additional radon-specific measures.[33]

The National Building Code is an advisory document without legal force. Provisions may be adopted by provincial/territorial governments and thereby become mandatory (as discussed in Section 4.2 below).

It appears to be the case that radon-specific research conducted during 2016 and ongoing within the National Research Council, in collaboration with Health Canada, is structured to address certain questions about existing best practices in radon mitigation systems. Answers to these questions may result in proposals for Code revisions in the future. Key research questions include:

- Can full-size passive radon stacks in Canadian homes control radon in the habitable space, maintain negative pressure in sub-slab areas, and create sufficient chimney effect in the stacks? What are the key requirements for the design and installation of such systems to ensure their effectiveness?
- Will a roof turbine vent added to a passive radon stack improve the performance of the stack? What are the key requirements for the design and installation of such systems to ensure their effectiveness?
- What is the minimum insulation level required for passive radon stacks in unheated attic spaces to avoid freezing problems and a reduction in stack effect?

In parallel to the above research efforts, the Canadian General Standards Board has convened a Committee Radon Mitigation. In 2017 they published a national standard for "Radon mitigation

[33]National Research Council Canada, 2018. National Building Code 2015: Significant Technical Changes. Available at https://www.nrc-cnrc.gc.ca/eng/solutions/advisory/codes_centre/technical_changes_2015.html We relied on this summary given it is not publicly available without purchase

options for existing low-rise residential buildings."[34] The standard addresses system design and installation requirements for radon mitigation, including diagnostic methods, design and installation instructions, and acceptable materials and product specifications, to maximize the radon reduction capacity of the system. This standard is advisory only and would not have the force of law unless incorporated by reference into Provincial/Territorial Building Codes. The degree to which this standard is incorporated into these binding instruments, or just otherwise made use of during renovations of existing buildings would need to be the subject of future research.

3.5 The federal government and First Nations

Section 91(24) of the *Constitution Act*, 1867 assigns legislative authority over "Indians and lands reserved for the Indians" to the federal government. The *Indian Act*, which regulates much of the operation of most First Nation communities, was enacted pursuant to this power. Section 35 provides **constitutional** protection to the indigenous and treaty rights of indigenous peoples in Canada and we note that First Nations do claim treaty rights concerning housing.

We take seriously First Nations claims concerning duties of the Crown over housing and indoor health but feel this is a specialized area beyond the scope of this study. Outside of s.35, we did not find a firm legal basis for federal or provincial government responsibilities for housing on reserve. However, the federal government has assumed a significant *de facto* responsibility for housing and social services in virtue of the unique relationship First Nations have with the federal government.[35]

Since the 1830s, British colonial policy and later Canadian government policy worked to segregate First Nations people on small reserves separate from emerging settlements. By the turn of the 20th century, almost all First Nations people lived on reserves. The reserves were defined as the appropriate scale for the provision of services to First Nations people, and the funding and administration of these services was defined as the responsibility of the federal government.[36] The dependence of First Nations on the federal government has also been maintained through a unique land tenure system. Under the *Indian Act*, reserve lands are held by the Crown "for the use and benefit of the respective bands for which they were set apart." "Ownership" of lands on reserves is therefore distinct from the fee simple title that characterizes ownership of lands off-reserve. Section 89 of the *Act* restricts the seizure of reserve lands, meaning that while Canadians living off-reserve can use their land as collateral when obtaining a mortgage, First Nations people on reserve cannot securitize their mortgages due to this restriction. As a result, many financial institutions are reluctant to grant traditional mortgages for on-reserve properties. Furthermore, sections 24 and 28 of the *Act* operate together to prohibit the transfer of reserve lands to any entity other than the band or band members. Many First Nations people live in

[34] Canadian General Standards Board, Radon mitigation options for existing low-rise residential buildings. CAN/CGSB-149.12-2017. Online at: http://publications.gc.ca/collections/collection_2017/ongc-cgsb/P29-149-012-2017-eng.pdf

[35] Peters, E. 2006.''[W]e do not lose our treaty rights outside the... reserve'': challenging the scales of social service provision for First Nations women in Canadian cities. *GeoJournal* 65: 315–327

[36] Peters, E. 2006.''[W]e do not lose our treaty rights outside the... reserve'': challenging the scales of social service provision for First Nations women in Canadian cities. *GeoJournal* 65: 315–327

housing on reserve through Certificates of Possession (or CP and formerly known as "Location Tickets"). Under the *Indian Act*, CP holders need to seek approval from Indian Affairs and Northern Development (INAC) to develop their CP parcel for their own personal benefit. A CP holder also needs to seek the consent of INAC to sell their CP rights to the Band or another Band member. A CP holder cannot sell their CP to a non-Band member.[37]

The federal government has had long standing policies of providing funding for on reserve housing. In the 1960s, what was then Indian and Northern Affairs Canada implemented a housing program that provided subsidies to assist with home construction and renovation on reserves. By 1996 the high-level Royal Commission on Aboriginal People published a massive report including a chapter damning "intolerable housing" conditions and citing poor housing as giving rise to direct threats to health that would not be tolerated in other Canadian communities.[38] The government of the day developed the On-Reserve Housing Policy and has earmarked special funds. For instance, in 2009 the Canadian Government earmarked US$400 million to support new on-reserve housing, and renovations of existing social housing. Despite these resources, many First Nations experience extreme overcrowding, leaks, inadequate insulation, mould and condemned housing on reserves. Housing on reserve was a significant concern for the Idle No More movement.[39] For instance, addressing the native housing crisis was central to Chief Theresa Spence's hunger strike and her declaration that was ultimately signed by the NDP and Liberals in Ottawa in 2013.[40]

By 2015, the federal government provided on-reserve housing support to First Nation communities primarily through funding and programs offered by what was then Aboriginal Affairs and Northern Development Canada (AANDC) and by the Canada Mortgage and Housing Corporation (CMHC). The federal government's current annual investment to address housing needs on reserve is an estimated $303 million a year: $146 million through INAC and $157 million through CMHC. An average of 1,750 new residential units are built and more than 3,100 existing units are renovated on reserves every year, through a combination of First Nations' own investments and federal funding.[41] INAC also provided the Income Assistance Program—$125 million annually to assist recipients with rent, utilities and other costs related to shelter. As well, the Ministerial Loan Guarantee Program is intended to address the restriction on the seizure of reserve lands under section 89(1) of the *Indian Act*. A Ministerial Loan Guarantee (MLG) acts as "government-backed security for loans issued on reserve." The current guarantee authority limit is $2.2 billion, of which $1.82 billion is currently issued; almost one third of on-reserve housing is currently financed through a Ministerial Loan Guarantee.[42] The First Nations and Inuit Health

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[37] Prince, A. 2014. Your Rights on Reserve: A Legal Tool-Kit or Aboriginal Women in BC. Atira Women's Resource Centre. pp. 26-31

[38] Webster, P. 2015. Housing triggers health problems for Canada's First Nations. *The Lancet,* 385, 9967: 495-496

[39] CBC News, 2015. Idle No More co-founder launches First Nations housing campaign. Oct 11, 2015 https://www.cbc.ca/news/canada/saskatchewan/idle-no-more-saskatoon-oct-11-1.3266568

[40] CBC News, 2013. Chief Theresa Spence to end hunger strike today. Jan 23, 2013 available at https://www.cbc.ca/news/politics/chief-theresa-spence-to-end-hunger-strike-today-1.1341571

[41] Interim Report of the Standing Senate Committee on Aboriginal Peoples February 2015: Housing on First Nation Reserves: Challenges and Successes. Available at https://sencanada.ca/content/sen/Committee/412/appa/rep/rep08feb15b-e.pdf

[42] Interim Report of the Standing Senate Committee on Aboriginal Peoples, February 2015: Housing on First Nation Reserves: Challenges and Successes. Available at https://sencanada.ca/content/sen/Committee/412/appa/rep/rep08feb15b-e.pdf

Branch of Health Canada delivers an environmental public health program in First Nation communities. The objective of this program is to identify and prevent environmental public health risks in First Nations communities. It has been used to address mould and mould prevention.[43] Radon gas exposure could be considered in a similar context.

Most First Nations and most First Nations members have come to regard the provision of housing as a Treaty right. Existing treaties do not have specific provisions, but most band governments have been providing free housing to their members (in turn financed by federal government programs) such that the right to housing on reserve has come to be perceived among First Nations as a right.[44] The Government of Canada denies this, and points to the Indian Act provisions, such as, section 81 that allow a Band Council may make bylaws related to housing to regulate the residence of Band members and other persons on the reserve. Band Councils also have the right to obtain overall authority for land and housing management under section 60 of the *Indian Act* or under the *First Nations Land Management Act,* S.C. 1999, c. 24.CMHC thinks that it is a funding body (like a financial institution) and is not responsible for more than making funds available, while INAC sees itself as administering a complex web of governmental, treaty and aboriginal programs that don't include a positive obligation to house everyone.[45] The federal government claims that "Providing and managing housing on-reserve is the responsibility of First Nations. The Government of Canada provides funding to First Nations for safe and affordable on-reserve housing."[46]

[43] Interim Report of the Standing Senate Committee on Aboriginal Peoples
February 2015: Housing on First Nation Reserves: Challenges and Successes. Available at https://sencanada.ca/content/sen/Committee/412/appa/rep/rep08feb15b-e.pdf

[44] Fenwick, F. 2003. On reserve housing: the 2003 federal auditor general's report. *Law Now*; Edmonton Vol. 28, Iss. 1, (Aug/Sep 2003): 37-38.

[45] Fenwick, F. 2003. On reserve housing: the 2003 federal auditor general's report. *Law Now*; Edmonton Vol. 28, Iss. 1, (Aug/Sep 2003): 37-38.

[46] Indigenous and Northern Affairs, Canada. 2018. Roles and responsibilities in First Nations housing. http://www.aadnc-aandc.gc.ca/eng/1476904944575/1476905026701

Part 4 – Areas of provincial/territorial responsibility

4.1 Introduction

As noted above, jurisdiction over multiple areas relevant to indoor air quality and thus radon-relevant law or policy rests at the provincial/territorial level in Canada. The following discussion addresses several areas. It aims to update information and analysis contained in Radon in Indoor Air: A Review of Policy and Law in Canada,[47] published in 2014, in the following areas:

- Building Codes
- Occupational Health and Safety
- Real Estate Transactions and Home Warranty Programs
- Occupier's Liability
- Residential Tenancies
- Education/Schools and Child Care Facilities
- Public Health
- Incentive Programs for Mitigation

In the above areas, most areas of law and policy are silent about radon with the exception of radon protection requirements or policies contained in most provincial/territorial building codes and some labour codes (or occupational health and safety regulations),

4.2 Provincial/Territorial Building Codes

4.2.1 Introduction

The following section updates from Dunn and Cooper (2014), the status of Provincial/Territorial adoption of the National Building Code radon provisions (those adopted in the 2010 version of the NBC and in the 2012 update). We looked for Provincial/Territorial information evaluating the effectiveness of adopting radon-protection measures in Building Codes as well as any radon testing programs conducted by this level of government. We also interviewed some provincial officials and Health Canada's regional radiation specialists. For additional regional or local radon testing initiatives, see Sections 4.7 and 5.2 below.

We heard a common refrain from provincial authorities and Health Canada's regional radiation specialists, concerning insufficient inspection of radon mitigation systems and a lack of builder knowledge about design, purpose, and proper installation of radon mitigation systems. Similarly for existing buildings, a repeated concern is that radon mitigation is often overlooked in whole or in part during home inspections, due to lack of resources, lack of understanding of radon issues, lack of clarity regarding who is responsible for inspecting radon mitigation systems and the

[47] Dunn and Cooper, 2014, op. cit. Chapter 4.

difficulty involved in inspecting sub-slab mitigation requirements. While these issues were raised anecdotally in several of the interviews conducted as part of this research, they suggest the need for more systematic exploration.

4.2.2 Atlantic Canada

Newfoundland and Labrador has adopted the NBC 2010 by reference in its Fire Protection Services Regulations, effective June 1, 2012. [48] According to Section 3.(1) of this regulation, the NBC 2010 applies to all buildings, except Part 9, which does not apply to single and two-family dwellings.

However, the Code is not province-wide but only empowers municipalities to pass regulations that address building code requirements. As such, it is up to individual municipalities whether they will adopt the National Building Code radon provisions. Many of the larger municipalities in Newfoundland and Labrador have their own building code regulations implementing the NBC, while most of the smaller municipalities do not.[49] For example, radon is included in local building codes in the municipalities of St. John's,[50] Mount Pearl, [51] Paradise, [52] Conception Bay South, [53] Corner Brook, [54] Gander, [55] and Grand Falls-Windsor.[56]

The province is considering moving towards province-wide implementation 6 months after the issuance of new versions of the NBC.

No recent radon studies of newer buildings were identified during the research for this report and nor was the responsible provincial authority aware of any provincial or municipal studies into the impact of the NBC 2010 radon provisions.

New Brunswick, as of January 1, 2015, has updated its NBC-reference in its National Building Code Designation Regulation.[57] The previous reference to the NBC 2005 has been replaced by a reference to the NBC 2010. The City of Fredericton applies additional requirements that go beyond the NBC, specifically that sub-slab venting be extended all the way to the roof in all new

[48] Fire Protection Services Regulations, Newfoundland and Labrador Regulation 45/12, 2012, online: http://www.assembly.nl.ca/Legislation/sr/regulations/rc120045.htm
[49] Personal communication, Department of Municipal Affairs and Environment, Office of the Fire Commissioner (June 11, 2018).
[50] Building By-Law, By-Law no. 1438 (as last amended by By-Law no. 1610, May 14, 2018), Section 46, online: http://www.stjohns.ca/bylaws.nsf/nwByLawNum/1438.
[51] https://www.robertmiller.ca/node/8.
[52] Town Of Paradise Development Regulations, 2016, online: http://www.paradise.ca/en/town-hall/resources/Municipal-Plan/Municipal-Plan-Final/Paradise-Development-Regulations.pdf
[53] Building Regulations, Town of Conception Bay South, 2017, Section 15, online: https://www.conceptionbaysouth.ca/mdocs-posts/018-building-regulations/
[54] City of Corner Brook, online: http://www.cornerbrook.com/wp-content/uploads/2016/05/Building-By-Law1.pdf
[55] http://gandercanada.com/wp-content/uploads/2017/03/Residential.pdf.
[56] Development Regulations 2012-2022, Town of Grand Falls-Windsor, 2012, at p. 19, online: http://grandfallswindsor.com/images/GF-W_Development_Regs_2012-2022_JAN-13_edit_Full_Report_Single_Sided.pdf
[57] National Building Code Designation Regulation, NB Reg 90-128, Section 2, online: http://canlii.ca/t/52ctt.

buildings. While the requirement is merely for passive venting, the system can be retrofitted with a fan to turn this into an active system.[58]

We found no recent radon studies aimed at assessing radon levels in newer buildings in New Brunswick that would have been built according to the Code updates, and provincial authorities were not aware any such studies being either ongoing or planned.[59]

However, the Province of New Brunswick has radon tested all public buildings (including schools) and has mitigated these buildings where necessary. Mitigation has primarily been done using sub slab depressurization following CARST requirements, or in the form of ventilation corrections for larger buildings. Unfortunately, there is no public database of pre and post testing results available.[60]

Nova Scotia has adopted the NBC 2015, including all revisions, errata and corrections made on or before October 31, 2016. The amendments came into force on April 1, 2017.[61] Nova Scotia has generated radon mapping to indicate low, medium and high risk areas but has otherwise not assessed the effectiveness of implementing the radon provisions of the NBC 2010.[62]

Like New Brunswick, Nova Scotia has previously radon-tested all public buildings (including schools) and has mitigated these buildings where necessary. Mitigation has primarily been done using sub slab depressurization, or in the form of ventilation corrections for larger buildings. Unfortunately, there is no publicly available database of pre and post testing results.[63]

Nova Scotia has also established a loan-system, where approximately 80-90 digital reusable radon testing devices are available for free at public libraries. The public can borrow the testing device for the three months necessary to complete a long-term radon test. A similar approach is being considered in other provinces (Ontario and Quebec).[64]

Prince Edward Island only partially incorporates the National Building Code radon-provisions (as noted in Dunn and Cooper, 2014) insofar as non-municipally incorporated areas (about 70% of PEI) are not subject to the National Building Code. However, provincial regulation making authority exists to make these areas subject to the national code. Otherwise, municipally-incorporated areas have jurisdiction over issuing building /development permits and three municipalities (Charlottetown, Summerside and Cornwall) were early adopters of the national code.[65] More recently, PEI passed a new *Building Code Act* in 2017. Entry into force has yet to occur[66] but once in force, the Act will likely lead to province--wide adoption of the NBC,[67] in particular because one of the stated goals of the Act was to protect against radon gas.[68]

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[58]Personal communication, Health Canada Regional Radiation Specialist, Atlantic Canada (June 25-28, 2018).
[59] Personal communication, Department of Justice and Public Safety (June 11, 2018).
[60] Personal communication, Health Canada Regional Radiation Specialist, Atlantic Canada (June 25-28, 2018).
[61] Nova Scotia Building Code Regulations, N.S. Reg. 26/2017, S. 1.1.2.1., online: http://canlii.ca/t/52x04.
[62] Personal communication, Government of Nova Scotia, Office of the Fire Marshall, Building Code Coordinator (June 8, 2018).
[63] Personal communication, Health Canada Regional Radiation Specialist, Atlantic Canada (June 25-28, 2018).
[64] Ibid.
[65] Personal communication, Health Canada Regional Radiation Specialist, Atlantic Canada (June 25-28, 2018).
[66] http://www.assembly.pe.ca/bills/onebill.php?session=2&generalassembly=65&number=69.

PEI has also previously tested and mitigated a number of public buildings for radon. Due to its geology, the results were relatively low on average, and PEI therefore decided not to test any additional buildings. Like in New Brunswick and Nova Scotia, mitigation of these buildings was primarily done using sub slab depressurization, or in the form of ventilation corrections for larger buildings. Unfortunately, there is no publicly available database of pre and post testing results.[69]

4.2.3 Ontario and Quebec

The **Ontario** Building Code applies throughout Ontario but contains radon-related provisions that are more limited than the National Building Code and are also applicable to only three narrowly-delineated areas (i.e., in the towns of Elliot Lake, and the Townships of Faraday in Hastings County and Hyman in the Sudbury District), as described in detail in Dunn and Cooper, 2014.

Changes proposed in 2016[70] would update radon-related provisions to mirror the National Building Code and extend their coverage province-wide. Buildings would have to be designed and constructed to be below the federal guideline of 200 Bq/m^3 on an average annual basis[71] and lead to mandatory testing of buildings to confirm compliance with radon requirements.[72]

A possible entry into force in January 2019 has been proposed.[73]

Within this longstanding provincial policy vacuum, several Ontario municipalities (two of which are further profiled in Section 5.2 below) have moved ahead with stronger standards, including the City of Guelph Central Elgin, St. Thomas, and Thunder Bay, all of which require builders to incorporate radon prevention measures into all new home construction. Likewise, the Council in the Township of Southgate and the Municipality of Grey Highlands have recently approved by-laws for the implementation of a Radon Gas Mitigation Program in accordance with Section 9.13.4.1(1) of the OBC.[74]

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[67] http://www.cbc.ca/news/canada/prince-edward-island/pei-national-building-code-standards-1.4079209.
[68] Ibid., at p. 1182.
[69] Personal communication, Health Canada Regional Radiation Specialist, Atlantic Canada (June 25-28, 2018).
[70] Overview Summary Document - Potential Changes to Ontario's Building Code: Fall 2016 Consultation, Ontario Ministry of Municipal Affairs, 2016, at p. 5, online: http://www.mah.gov.on.ca/AssetFactory.aspx?did=15877.
[71] Proposed Change to the 2012 Building Code O. Reg. 332/12 as Amended, Ontario Ministry of Municipal Affairs, 2016, at page 1, online: http://www.mah.gov.on.ca/AssetFactory.aspx?did=15319.
[72] Changes proposed to Ontario Building Code by MMAH regarding radon - Executive Summary by Bob Wood, Canadian Association of Radon Scientists and Technologists, Oct. 23, 2016, at page 2.
[73] Overview Summary Document - Potential Changes to Ontario's Building Code: Fall 2016 Consultation, Ontario Ministry of Municipal Affairs, 2016, at p. 9, online: http://www.mah.gov.on.ca/AssetFactory.aspx?did=15877.
[74] https://www.publichealthgreybruce.on.ca/Portals/0/Documents/Publications/General%20Reports/Radon%20Policy%20Statement.pdf

In **Quebec**, amendments to the Quebec Construction Code (QCC) came into force in June 2015 and include some of the National Building Code radon measures with a number of specific changes unique to Quebec, these coming fully into force as of December 2016.[75]

Despite updating the Quebec Construction Code, the Province chose to ignore certain updated radon-protection measures in the National Building Code including retaining from the 2005 version the out-of-date radon reference level of 800 Bq/m^3.[76] This decision has been criticized as a step backward. [77] Indeed, Association de la Construction du Québec recommends that builders follow the NBC 2010 in addressing radon. [78] Nevertheless, the new code also requires building depressurization for areas known to have harmful soil gas emissions such as an area so designated by the authorities, and only in the case of buildings containing a single dwelling.[79]

As well, the Régie du bâtiment du Québec empowers municipalities to establish by-laws with stricter radon requirements and several municipalities have done so or are planning to do so including Ascension, Chelsea, Oka, Notre-Dame de Pont Main, La Pocatière, Saint-André-d'Argenteuil, Saint-Colomban, Saint-Hilaire, Saint-Pierre Île d'Orléans and Vallée-de-la-Gatineau. Radon requirements may thus differ from municipality to municipality, with some having implemented the NBC 2010 radon requirements.[80,81]

Provincial authorities state that the full suite of radon preventive measures in the current National Building Code will be included in next revision of the Quebec Construction Code. It remains to be seen whether such amendments will be carried out, and if so, when they may enter into force.[82]

4.2.3.1 Quebec's Pilot Mitigation Project

A pilot project on radon mitigation in social housing occurred in 2014 (as described in more detail in Section 4.6.7 below). Results of this pilot prompted radon testing of all social housing[83] that, once testing and any necessary mitigation is completed, could provide insight into the impact of the radon requirements in the NBC 2010, to the extent that one or several of these

[75] https://www.rbq.gouv.qc.ca/batiment/la-reglementation/chapitre-batiment-du-code-de-construction/entree-en-vigueur-des-modifications-au-chapitre-i-batiment-du-code-de-construction-du-quebec-incluant-le-cnb-2010.html.
[76] Robert Périnet, Fiche technique FT-9.13.4., Protection contre les gaz souterrains (le radon), l'Association de la construction du Québec, 2016, at p. 1, online: https://espace.acq.org/Web/Documents/Document/?hash=cbdab725ed86e63c53a17eac95591548deccdcc9f4f255f8848b393b9195ef6a.
[77] https://www.ecohabitation.com/guides/2473/que-preconise-la-loi-au-sujet-du-radon/.
[78] Partie 9 du Code de construction du Québec: Dix changements que vous devez connaître, L'Association des professionnels de la construction et de l'habitation du Québec (APCHQ), 2015, at p. 10, online: https://www.apchq.com/download/0f0eea579c0618282c159c67933ec09ec7d534c1.pdf.
[79] Ibid.
[80] https://www.apchq.com/documentation/technique/questions-et-reponses/le-radon.
[81] Personal Communication, Health Canada Regional Radiation Specialist, Quebec (June 12, 2018).
[82] Ibid.
[83] tp://espacehabitat.gouv.qc.ca/societe/detection-radon-linitiative-de-societe-dhabitation-quebec-saluee-partout-pays-2/.

buildings are located in the above-mentioned municipalities and have been built in accordance with the radon mitigation requirements in the NBC 2010. [84]

4.2.4 Prairie Provinces

Manitoba has incorporated the National Building Code radon-protection provisions and has added Manitoba-specific provisions.[85] Manitoba municipalities generally adopt the version that is put in place by the Province.[86]

Other than the Winnipeg Demonstration project described below, provincial authorities are not aware of any recent or ongoing radon studies in Manitoba, at the provincial or municipal levels, or of any efforts to determine the impact of the radon provisions in the NBC 2010.[87]

4.2.4.1 Winnipeg Demonstration Project on Building Code Application

A project in Winnipeg in 2013 looked at the application of the radon provisions in the NBC 2010.[88] They found that despite adoption during 2011 of updated radon-specific code requirements, Winnipeg home builders were not fully meeting them. More specifically, while radon rough-in pipes were installed in 23 out of 24 houses inspected, nearly half had been placed in non-accessible locations (typically under stairs), caps were of varying quality and airtightness, and less than half of the rough-in pipes had labels. [89]

Most problematic was the fact that sump pit airtightness had been almost completely overlooked by both home builders and home inspectors. Despite the fact that sump pits come with gaskets, weather-stripping and screw-down lids, most of the sump pits had been installed without including such sealing features.[90] Anecdotal evidence suggests that the issues identified in this study still remain, at least to some extent.[91]

Saskatchewan continues to apply the most recent version of the National Building Code throughout the province via the Uniform Building and Accessibility Standards Regulations,

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[84] tp://espacehabitat.gouv.qc.ca/societe/detection-radon-linitiative-de-societe-dhabitation-quebec-saluee-partout-pays-2/.
[85] Dunn, B. and Cooper, K. 2014. Radon in Indoor Air: A Review of Policy and Law in Canada. Canadian Environmental Law Association. at p. 36.
[86] Personal communication, Government of Manitoba, Office of the Fire Commissioner (June 8, 2018).
[87] Ibid.
[88] Radon Demonstration: Application of Building Code Changes in Winnipeg New Home Construction, online: http://carst.ca/resources/Radon%20Demonstration_Application%20of%20Building%20Code%20Changes%20in%20Winnipeg.pdf.
[89] Ibid., at pp. 10-12.
[90] Ibid., at p. 12.
[91] Personal communication, Health Canada Regional Radiation Specialist, Manitoba and Saskatchewan (July 3, 2018).

which came into effect January 1, 2018.[92] [93] The radon provisions have been implemented as they appear in the NBC 2015 without amendments.[94]

Provincial authorities are not aware of any municipalities having put in place specific radon requirements, or of any ongoing radon studies in Saskatchewan, at the provincial or municipal levels, or of any efforts to determine the impact of the radon provisions in the NBC 2010. Uncertainty during the building inspection process was highlighted in terms of who is responsible for the inspection of radon mitigation, and, for example, whether radon rough-in requirements are caught during inspections.[95]

In **Alberta**, as of November 2015, the Alberta Building Code was updated to include National Building Code radon requirements.[96] Alberta has also passed, but not yet proclaimed, the Radon Awareness and Testing Act to require radon educational materials aimed at, *inter alia*, homebuyers.[97]

No work is currently carried out at the provincial level to assess the impact of the radon provisions in the NBC 2010, and no such efforts at the municipal level have been brought to the attention of the provincial authorities,[98] although a radon survey conducted during 2017 offers useful information.

4.2.4.2 2017 Alberta Radon Survey

This survey conducted in southern Alberta[99] tested 2382 homes and found an average radon level of 126 Bq/m^3, with 295 homes (12%) having levels above 200 Bq/m^3.

Homes built in 1992 or later had an average level of 142 Bq/m^3; those built before 1992 had an average level of 108 Bq/m^3. A clear and continued upward trend in radon levels could be observed in newer buildings, including those constructed in the period from 1992 to 2016.[100]

The study also provided an opportunity to look at the effectiveness of mitigation efforts. In 90 of the homes with levels above 200 Bq/m^3, owners opted for radon mitigation, consisting mainly of sub-slab depressurization with a smaller number of households opting for a radon-impermeable membrane. These homes were then re-tested post-mitigation.[101] Post-mitigation levels were reduced significantly, and in all cases to levels below 100 Bq/m^3. A new study occurred during

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[92] Uniform Building and Accessibility Standards Regulations, U1-2R5, online: http://www.publications.gov.sk.ca/freelaw/documents/English/Regulations/Regulations/U1-2R5.pdf.
[93] https://www.saskatchewan.ca/business/housing-development-construction-and-property-management/building-standards-and-licensing/national-building-and-fire-code-information.
[94] Personal Communication, Government of Saskatchewan, Building Standards and Licencing Branch (June 8, 2018).
[95] Ibid.
[96] http://www.municipalaffairs.gov.ab.ca/documents/BuildingFireEnergyCodes-NoticeApr29.pdf.
[97] http://www.qp.alberta.ca/546.cfm?page=R02p5_17.cfm&leg_type=fall.
[98] Ibid.
[99] Stanley, Fintan K.T. et al. "Comprehensive Survey of Household Radon Gas Levels and Risk Factors in Southern Alberta." CMAJ Open 5.1, 2017, at pp. E255–E264, online: http://cmajopen.ca/content/5/1/E255.full.
[100] Ibid., at p. E257-E258 and page E262.
[101] Ibid., at p. E256 and E259.

2017-2018, and another is planned for 2018-2019.[102] These studies may provide valuable insight into the impact of building code requirements put in place in Alberta.

Additional insights from Alberta researchers include evidence that builders in Calgary may be misapplying the Code and improperly sealing foundations around furnaces (note that furnaces are used for heating during construction, leading to improper slab construction where they are located). In consequence there can what radon expert Aaron Godarzi refers to as "the furnace driven radon pump," i.e., in cold winter months, the heat of the furnace actively draws radon in through holes in the foundation located near the furnace. Godarzi's research in this area remains preliminary and plans more detailed study of this phenomenon.[103]

4.2.5 British Columbia and the North

In **British Columbia**, the current Building Code is based on the National Building Code and an updated Code is issued every five years. Code requirements may differ depending on local variables such as climate, geology and urban density. The 2015 *Building Act* sought to create a harmonized building code system across the province. Previously, local governments could make rules in addition to the provincial code. Local government is empowered to administer and enforce provincial requirements but with considerable discretion with respect to inspections. The *Building Act* does not apply in the City of Vancouver, Indian Reserves and federal lands such as airports. Under the Vancouver Charter, the City of Vancouver has authority to adopt bylaws to regulate the design and construction of buildings and is the only community in B.C. with this authority.[104] Vancouver's Building Bylaw 2014 is based on the British Columbia Building Code 2012.[105]

In late 2014, the BC Building Code was updated to require an air barrier system and space below the building for movement of soil gases and a mitigation system radon rough-in but not a fan during initial construction, though recommends a fan if high radon concentration are later detected.[106] The code offers builders either prescriptive or performance-based requirements to address radon so long as the chosen option does not constitute a hazard.[107]

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[102] http://www.evictradon.ca/.
[103] Godarzi, A. 2018. Presentation at Canadian Association of Radon Scientists and Technologists Annual Conference, Ottawa. April 23, 2018, and personal communication.
[104] BC Government, 2015. A Guide to the Building Act: Modernizing B.C.'s Building Regulatory System, at page 4, online: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/guides/buildingactguide_sectiona2_june2015_web.pdf.
[105] http://www.bccodes.ca/vancouver-bylaws.aspx?vid=QPLEGALEZE:bccodes_2012_view.
[106] Government of British Columbia, 2014. Information Bulletin, Building and Safety Standards Branch. New Radon Rough-in Requirements. Information Bulletin, Building and Safety Standards Branch, online: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/bulletins/b14-07_new_radon_rough-in_requirements.pdf Accessed March 29, 2018.
[107] 2015. Understanding B.C.'s Building Regulatory System, online: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/guides/buildingactguide_sectiona1_june2015_web.pdf, at p. 7.

The longstanding approach to radon in BC has been to divide the province into Area 1 (Coastal Mountains and westward) and Area 2— the majority of the province east of the Coast Mountains. Based on an assumption that radon levels are lower in Area 2, the BC Building Code requires an air barrier below the floor slab in Areas 1 and 2 but additional requirements in Area 1 for a rough-in of a radon mitigation system.

Currently, on the basis of data from the Cross Canada Survey of Radon Concentrations in Homes (2009-11) the province proposes to replace the Area 1 and Area 2 system with a new table in the BC Building Code specifying municipalities where the full suite of radon protection measures (i.e., including the mitigation system rough-in) would be either required/not required. The revised code would also delegate authority to those municipalities designated as "required" to make a determination based on available data whether radon measures are necessary or in the absence of data, to apply the radon-protection measures.[108]

4.2.5.1 Castlegar Mitigation Comparison[109]

A study carried out by the BC Lung Association (BCLA) compared three radon systems in BC homes: a rough-in capped system; a passive system; and an active radon reduction system. They found that:

- The Rough-in Capped System required in the 2006 and 2012 Code (for Area 1 communities referenced in the 2012 Code) provides limited protection from the cancer health risk posed by radon.
- The addition of a Passive Radon Reduction System consistently reduced radon levels but in some cases the reduction levels were close to or above the Health Canada maximum radon exposure guideline of 200 Bq/m^3.
- Active Radon Reduction Systems reduced indoor radon levels to the most health protective level possible. In one case, radon levels were undetectable with the Active System.[110]

Based in these findings the BCLA recommended: code amendments to require a passive radon reduction system in all new houses in communities with known or suspected radon health risks; mandatory radon testing occur in areas with known high radon risks as a condition of building permit occupancy; that home builders be required to install active radon reduction systems, where results exceed the Health Canada guideline; and other recommendations in relation to ensuring compliance with radon requirements in the Building Code.[111] The BCLA credits these findings with achieving significant BC Building Code change, notably including the addition of a

[108] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/other/2018_bcbc_11_radon.pdf.
[109] A Comparison of Three Radon Systems in British Columbia Homes: Conclusions and Recommendations for the British Columbia Building Code, BC Lung Association, 2015, online: http://www.radonaware.ca/database/files/library/BCLung_Radon_Castlegar_reportG___updated(1).pdf.
[110] Ibid., at p. 5.
[111] Ibid.

full radon vent pipe (attached to the rough-in) exhausting to the outdoors, although it did not lead to the inclusion of a code requirement for an active radon fan.[112]

The study also led to a number of key observations regarding what needs to be done to ensure the success of new Building Code requirements. The observations deal with the importance of communication, collaboration and partnerships:

- Radon is a multi-stakeholder issue requiring dialogue between building code authorities and those working in the industry.
- Proactive leadership encouraging discussions between industry and building code authorities is vital to achieving an outcome.
- The NBC is a model only, meaning that opportunity and legal authority exists for every jurisdiction to introduce radon protection measures beyond the NBC.
- Building code regulators must consider many different factors, often requiring a balancing of costs and benefits.
- Effective radon protection measures require enforcement by authorities that understand the relationship between indoor radon exposure and the radon measures in the Building Code. To ensure their efficiency, radon measures must be implemented on a wide scale in dialogue with building inspection departments, home inspectors, builders and trades, realtors, and home warranty organizations.[113]

4.2.5.2 Tracking of Castlegar Radon Testing - Donna Schmidt Lung Cancer Prevention Society[114]

Radon testing in Castlegar has also been tracked by the Donna Schmidt Lung Cancer Prevention Society, with over 1,000 radon tests having been distributed and tracked so far. The results show that 44% of tested buildings have levels above 200 Bq/m^3.[115]

As well, tests of a subdivision with 33 new homes found unexpectedly high radon levels with 32 of the 33 homes having levels above 200 Bq/m^3, suggesting particularly high levels of radon in the soil and/or low air exchange in energy efficient homes. In comparing the results from all homes to the subset of energy efficient homes, the latter showed significantly higher radon levels.[116] While not part of these tests, information obtained from a contractor showed that 5 new homes with "radon resistant construction" at a cost of less than $ 200 per home, had radon levels around 100 Bq/m^3 without installation of a fan.[117]

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[112] Future Proofing: Protecting Consumers from Radon in New Homes, BC Lung Association, 2015, at p. 5, online: http://www.radonaware.ca/database/files/library/BCLung_Radon_Report4_.pdf.
[113] Ibid., at p. 6.
[114] Lessons from Castlegar, Donna Schmidt Lung Cancer Prevention Society, 2017, online: http://www.carst.ca/resources/Conference%202017/Presentations%202017/Radon%20Presentation%20CARST%202017%20-%20castlegar.pdf.
[115] Ibid., p. 5.
[116] Ibid., p. 8-9.
[117] Ibid., p. 15.

The **Northwest Territories** has adopted the 2015-edition of the NBC on November 15, 2016, through amendments to the Fire Prevention Regulations[118], which sees the reference to the NBC 2010 being replaced by a reference to the 2015-version.[119]

No recent radon studies of newer buildings were identified during the research for this report, and territorial authorities were not aware any such studies being either ongoing or planned. [120]

In **Nunavut**, the *Building Code Act*,[121] came into force on May 16, 2013, and was last amended on March 14, 2017.[122] It contains a provision to adopt, by reference, the National Building Code, although this does not appear to have occurred. Once in place, Section 5 of the Act will make the terms of the national code binding. The town of Iqaluit Building bylaw[123] is more specific and adopts, by reference, the latest edition of the National Building Code.[124]

However, as of 2016, it would appear that none of Nunavut's 25 municipalities were enforcing the National Building Code. This includes Iqaluit, which may thus not have enforced the above-mentioned Building By-law.[125]

In the **Yukon**, further to adopting the National Building Code radon measures, further adoption of the 2015 version of the code occurred in 2016 with enforcement beginning in April of 2017.[126,127] The national code is administered by the Yukon Government Building and Safety Standards Branch in all parts of Yukon, except for Whitehorse, where it is administered by the City of Whitehorse's Planning and Building Services Department.[128] There are, however, apparently issues with some builders not understanding the radon requirements in the NBC.[129]

Yukon Housing has facilitated radon testing/mapping of communities in the Yukon since 1989, and in particular in Whitehorse. Test kits are provided free of charge, and in total around 3,000 radon tests have occurred. While the mapping extends into recent years, no information is collected on the age of the homes tested (although this might be considered in future years),

[118] R.R.N.W.T. 1990, c.F-12.
[119] Northwest Territories Gazette, Volume 37, No. 8, at pp. 251-252, online: https://www.justice.gov.nt.ca/en/files/northwest-territories-gazette/2016/08_2.pdf
[120] Personal communication, Government of Northwest Territories, Department of Municipal and Community Affairs, Office of the Fire Marshall (June 11, 2018).
[121] Building Code Act, SNu 2012, c.15, online: https://www.nunavutlegislation.ca/en/download/file/fid/10835. This is a consolidated version, current to May 7, 2014, which can also be found here: https://www.canlii.org/en/nu/laws/stat/snu-2012-c-15/102842/snu-2012-c-15.html.
[122] An Act to Amend Certain Acts Respecting Codes and Standards, 2017, c.6, online: https://www.nunavutlegislation.ca/en/download/file/fid/11372.
[123] Iqaluit Building By-law #710, 2010, online: https://www.city.iqaluit.nu.ca/content/building-law-710.
[124] The City Planner of Iqaluit was contacted by phone and email, but no response was received.
[125] Territorial building inspection unit in the works for Nunavut, CBC, 2016, online: http://www.cbc.ca/news/canada/north/building-inspection-unit-nunavut-1.3603810.
[126] https://www.nrc-cnrc.gc.ca/eng/solutions/advisory/codes_centre/code_adoption.html.
[127] http://www.community.gov.yk.ca/pdf/2015_New_Objective_Based_Codes.pdf.
[128] Ibid.
[129] Personal Communication, Health Canada Regional Radiation Specialist, Alberta/Yukon/NWT (April 6, 2018).

making it difficult to determine with a sufficient degree of certainty whether the results show any upwards or downwards trends for newer homes.[130]

It furthermore appears that no specific efforts have been made in the Yukon in recent years, which could help determine the effect of the radon provisions of the National Building Code.[131,132]

4.3 Occupational health and safety

4.3.1 Introduction

CAREX Canada estimates that approximately 188,000 Canadians are exposed to radon in the workplace, with the most exposed workers being general office clerks (6,200 exposed); elementary school and kindergarten teachers (6,000 exposed); and janitors, caretakers, and building superintendents (5,000 exposed). Other exposed groups include: secretaries, light duty cleaners; and customer service, information, and related clerks. Miners and other workers who spend time underground (e.g. subway and utility tunnel workers) are also at increased risk.

However, under current Canadian (federal and provincial) laws, only a few select professions and workplaces have specific radon exposure requirements. Miners, for instance, are under a system of occupational radon exposure measurement mandated and managed by the Radiation Protection Bureau of Health Canada. These data are held in the National Dose Registry (NDR), which contains exposure data for workers exposed to radiation across Canada.[133] Some specific mining regulations also address radon.[134] However, and as will be discussed below, a combination of general duty clauses, and attention to radiation generally, suggests significant scope for workplace-based regulation. [135]

4.3.2 Effective Dose

The International Commission on Radiological Protection (ICRP) is the foremost international body for evaluating radiation safety. It has recently re-evaluated its estimates of lung cancer risk

[130] Personal communication, Government of Yukon, Yukon Housing Corporation, Research and Development Project Manager (July 6, 2018).
[131] Ibid.
[132] Personal communication, Government of Yukon, Building Safety and Standards, Chief Building/ Plumbing Inspector (July 5, 2018).
[133] Health Canada, 2018. National Dose Registry. https://www.canada.ca/en/health-canada/services/environmental-workplace-health/occupational-health-safety/occupational-radiation/national-dose-registry.html
[134] New Brunswick's *Underground Mine Regulation*, NB Reg 96-105 sec. 62; Ontarios' *Regulations for Mines and Mining Plants*, O. Reg. 583/.91(s. 289 to s. 291), Yukon's *Occupational Health Regulations*, YOIC 1986D/164 s. 44 to 46
[135] See Appendix 2 for a more detailed canvassing of provincial and territorial occupational health and safety law and provisions that are relevant to radon.

for radon progeny, detailed extensively in ICRP 137.[136] These new estimates were extensively discussed at the 2018 CARST annual meeting, including by leading European experts such as Jose Luis Gutierrez Villanueve.[137] The new estimates need to be carefully considered as they effectively double the estimated risk from exposure.

For analysis of the law, dose estimates are also important because they allow for comparison of many different ways that radiation is regulated. Regulations that cover workers exposed to radiation--in health care or the nuclear fuel chain-- typically use milliSierverts (mSv) to measure doses received from known radioactive sources. Effective dose calculations allow us to see if persons exposed to radon (whether at home, in government offices or other workplaces) are given the same protections as in industries for which radiation exposure is more widely discussed.

For instance, the *Nuclear Safety and Control Act* S.C. 1997, c. 9 and the accompanying *Radiation Protection Regulations* (SOR/2000-203) provide that workers who have a reasonable probability of receiving an effective dose greater than 5 mSv in a one year dosimetry period must be measured and monitored for doses of radiation. Persons who are not nuclear energy workers (but work in these industries) should not have an effective dose over 1 mSv. Once we bring in effective dose calculations we can see that gaps in legislation mean that people in Canada may be routinely exposed to radiation doses from radon that would not occur for other sources of radiation.

In what follows we give some sample calculations.

Effective dose = radon level × time × dose coefficient

For inhalation of radon and radon progeny in underground mines and in buildings, in most circumstances, the Commission recommends a dose coefficient of 3 mSv per mJ h m^{-3} (approximately 10 mSv WLM^{-1}). Using the standard equilibrium factor assumption of F = 0.4 (the ratio between the concentration of radon progeny and radon-222) for most situations, this corresponds to 6.9 x 10^{-6} mSv per Bq h m^{-3}.[138]

Note, however, that because people respire more under physical activity, the effective dose for work indoors involving substantial physical activity increases: The ICRP recommends a dose coefficient 6 mSv per mJ h m^{-3}. Using the standard equilibrium factor assumption of F = 0.4, this corresponds to 1.4 x 10^{-5} mSv per Bq h m^{-3}.

[136] Paquet, et al. 2017. Occupational Intakes of Radionuclides: Part 3. ICRP Publication 137. Annals of the ICRP. A summary is provided here: http://www.icrpaedia.org/index.php?title=Calculating_Radon_Doses
[137] Gutierrez Villaneuv, J.L. 2018. New EU Directive EURATOM BSS and the evaluation of doses due to radon at workplaces. Presentation to the Canadian Association of Radon Scientists and Technologists 2018 Annual Conference. April 23, 2018. Available at https://carst.ca/resources/Conference%202018/Presentations2018/20180422_CARST_JLGV.pdf
[138] ICRPaedia, 2018. Calculating Radon Doses. available at http://www.icrpaedia.org/index.php/Calculating_Radon_Doses. accessed June 30, 2018

Using the dose coefficient for most circumstances, breathing air with 50 Bq/m^3 of radon (a typical worldwide value indoors) for one year gives an effective dose of 3 mSv. (50 Bq/m^3 x 8,760 hours in a year x 6.9 x 10^{-6} mSv per Bq h m^{-3}.)

To achieve the goal of workers being exposed to no more than 1 mSv in the workplace in a year, radon concentrations would have to be below 75 Bq/m^3. (Assume a 2000 hour work-year, then 75 Bq/m^3 x 2000 hours x 6.9 x 10^{-6} mSv per Bq h m^{-3} = 1.035 mSv.)

An in-home child care worker, doing significant physical exercise (running after small children, washing dishes, cleaning floors) in a home that meets Canada's radon guidelines of 200 Bq/m^3 might receive an effective dose of 200 Bq/m^3 x 2000 hours x 1.4 x 10^{-5} mSv per Bq h m^{-3} = 5.6 mSv.

These new measurements of effective dose raise a significant challenge to radon protection measures currently in place in policy or law across Canada.

4.3.3 The *Canada Labour Code* and the NORM Guidelines

As discussed in Dunn and Cooper (2014), outside of radiation- and radon-specific provisions in legislation addressing the nuclear fuel chain (including radioisotopes in medical treatments) the only legally binding framework at the federal level that addresses radon is in the *Occupational Health and Safety Regulations* under the *Canada Labour Code* (CLC) and associated Occupation. Applicable to federal government employees and federally-regulated workplaces, the radon provisions in the CLC are woefully out of date. The legal limit for workers to be exposed to radon in the course of any year is an average concentration of 800 Bq/m^3.[139] The CLC or associated regulations make no legal requirement for employers to test for radon. As in all indoor environments, the only way for an employer to know if they are compliant with the CLC is to test. Since at least 2014, the federal Department of Labour (currently called the Department of Employment, Workforce Development and Labour) has made repeated statements that this out-of-date standard would be revised in line with the federal radon guideline of 200 Bq/m^3. Although publication in the *Canada Gazette* of a revised standard was anticipated for 2015, and again during 2017, discussion of this revision continues with the latest prediction for publication in the Canada Gazette to be in the fall of 2018.

Beyond the excessively out-of-date radon-specific provisions in the CLC, (and applicable to the above-noted areas of federal jurisdiction), radon in the workplace is a shared federal-provincial responsibility insofar as the Naturally Occurring Radioactive Materials (NORM) Guidelines[140] have been developed by a joint Federal-Provincial-Territorial committee. The NORM guidelines specifically address radon. As described in Dunn and Cooper (2014), the NORM Guidelines set out procedures for the detection, classification, handling and material management of radiation exposure in Canada, outside of the nuclear fuel cycle. They set universal effective dose limits

[139] Canada Occupational Health and Safety Regulations (SOR/86-304)
[140] Health Canada, "Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials" (2013), Prepared by the Canadian NORM Working Group of the Federal Provincial Territorial Radiation Protection Committee. Online: http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/norm-mrn/index-eng.php.

across all sectors—occupationally exposed workers have an annual effective dose limit of 20 mSv, and incidentally exposed workers and members of the public have an effective dose limit of 1 mSv (section 2.4, and table 2.1 in the NORM Guidelines). NORM can include many different types of naturally occurring radioactive materials, including radon.

These guidelines are an attempt to reduce inconsistent application of radiation protection standards across Canada. Unlike the nuclear fuel cycle and man-made radionuclides, (under the jurisdiction of the Canadian Nuclear Safety Commission), NORM-related activities fall under the jurisdiction of provincial/territorial governments. They apply to employment environments, including occupational exposures where workers have been "incidentally exposed" to background radiation in indoor air. "Incidentally exposed workers" are considered in the Guidelines as members of the public who work in an occupational exposure environment and whose regular duties do not include exposure to NORM sources of radiation.[141]

Multiple industries require the application of radiation protection and fall under the purview of the NORM Guidelines, such as mineral extraction and processing, oil and gas production, and metal recycling. However, the NORM Guidelines are intended to be applied to all occupational exposures, including those "incidentally exposed" to background radiation via the infiltration of soil gas into indoor air. Despite this very broad applicability to what are essentially any occupational settings that exist inside a building and that are outside the nuclear fuel cycle (where jurisdiction is federal), Dunn and Cooper (2014) found considerable uncertainty around the applicability of the NORM Guidelines to incidentally exposed workers versus workers engaged in NORM activities.

Via interviews with provincial/territorial Ministries of Labour, they noted the following:

- Workplaces that may have high indoor radon levels due to the infiltration of radon into buildings may neither apply the NORM Guidelines, nor have any provincial/territorial health and safety exposure limits in place.

- This lack of clarity on the applicability of the NORM Guidelines extends to the enforcement branches of provincial/territorial occupational health and safety standards. Not all departments responsible for investigating compliance with occupational health and safety requirements under provincial/territorial law take the NORM Guidelines into consideration when assessing workplace complaints, work refusals or issuing orders with respect to remedying workplace hazards.

- NORM Guidelines did not figure in any hard law, remaining as mere paper guidelines without enforcement teeth.

In this round of research, we did not find that the situation has significantly changed in the last four years, exception for one clear exception. As described below, Ontario has updated its Ministry of Labour guidelines and now reads in the NORM Guidelines as part of the *Occupational Health and Safety Act*.

[141] *Ibid* at 11.

4.3.4 General duty clauses

Beyond this uncertainty around provincial/territorial application of the NORM Guidelines, there is almost no explicit regulation of radon in indoor air (such as testing or mitigation requirements) in provincial/territorial occupational health and safety legislation/regulations.

Rather, in all provinces and territories, there are standards for workplace safety, in most cases as standalone legislation, but at times as part of general employment standards (as in Saskatchewan) or in regulations accompanying workers' compensation laws (as in British Columbia).

All provinces have general duty clauses, that require employers to minimize hazards: For instance Prince Edward Island's *Occupational Health and Safety Act*, RSPEI 1988, c O-1.01 states, at section 12:

> 12. Duties of employers
> (1) An employer shall ensure
> (a)that every reasonable precaution is taken to protect the occupational health and safety of persons at or near the workplace;
> (b)that any item, device, material, equipment or machinery provided for the use of workers at a workplace is properly maintained, and is properly equipped with the safety features or devices, as recommended by the manufacturer or required by the regulations;
> (c)that such information, instruction, training, supervision and facilities are provided as are necessary to ensure the occupational health and safety of the workers;
> (d)that workers and supervisors are familiar with occupational health or safety hazards at the workplace;
> (e) that workers are made familiar with the proper use of all safety features or devices, equipment and clothing required for their protection; and
> (f) that the employer's undertaking is conducted so that workers are not exposed to occupational health or safety hazards as a result of the undertaking.

Also see Newfoundland,[142] Nova Scotia, [143] New Brunswick,[144] Quebec, [145] Ontario,[146] Manitoba,[147] Saskatchewan,[148] Alberta, [149] British Columbia,[150] Yukon,[151] Northwest Territories[152] and Nunavut.[153] Radon is never explicitly exempted.

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[142] Occupational Health and Safety Regulations, 2012 under the Occupational Health and Safety Act(O.C. 2012-005) at s. 42
[143] Occupational Health and Safety Act, SNS 1996, c 7 at s. 13 (1)
[144] Occupational Health and Safety Act, SNB 1983, c O-0.2 at s.9
[145] Act respecting the occupational health and safety, CQLR c S-2.1 at s. 51
[146] Occupational Health and Safety Act, RSO 1990, c O.1 s. 25(2)(h)
[147] Workplace Health and Safety Act, s. 4(1)
[148] 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
[149] Occupational Health and Safety Act, RSA 2000, c O-2 at s. 2(1)

Further, provincial occupational health and safety regulation often specify that "measures must be taken to keep a worker's exposure to a level as low as is reasonably achievable: (ALARA). This intention can be stated in very general terms. As such, Newfoundland's Occupational Health and Safety Regulation states at s. 42. (7) that an employer shall ensure that:

> a) atmospheric contamination of the workplace by hazardous substances is kept as low as is reasonably practicable. In some cases this will be substance specific.

General duty clauses remain very broad, and it remains unclear how they are interpreted. They do not appear to have been litigated concerning radon. However, at least one province has invoked them and made a clear link to the NORM Guidelines.

In 2016 Ontario's Ministry of Labour updated its radon policies. It now states that the NORM Guidelines "are considered the industry standard for NORM protection in workplaces." As such, it invokes the general duty clause of Ontario's *Occupational Health and Safety Act* (OHSA)(s.25(2)(h)) and states that "this includes protecting workers from the hazards associated with radon exposure. When enforcing the general duty clause, the Ontario Ministry of Labour's Radiation Protection Service may take the NORM Guideline and its recommendations into consideration"[154]

As well, many provinces have specific regulation for persons exposed to radiation either contained in general health and safety regulation or as standalone regulations. Generally, these apply to "radiation workers" or to employers that use radiation emitting equipment (such as x-rays). These provisions are not easily extended to cover problems related to naturally occurring radiation such as radon and it is likely that when these provisions were drafted it was not contemplated that naturally occurring radiation could interact with building design to reach dangerous levels in seemingly innocuous locations (e.g. schools, daycares, offices and main street commercial outlets).

4.3.5 Indoor air quality and ventilation

Many provinces have occupational health and safety regulations that contain general language about indoor air quality or ventilation requirements. Typically, regulations define "air contaminant" in ways that would appear to include radon. For instance, New Brunswick's *General Regulation* defines air contaminant as "any gas, fume, smoke, vapour dust or other airborne concentration of a substance that may be hazardous to the health or safety of a person. It goes on to state that employers must keep workplaces well ventilated".[155] Similar ventilation

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[150] Occupational Health and Safety Regulation, BC Reg 296/97, Part 4 - General Conditions - 296/97 at s. 4.1
[151] Occupational Health and Safety Act, RSY 2002, c 159 at s. 3(1)
[152] Safety Act, RSNWT 1988, c S-1 at s. 4. (1)
[153] Safety Act, RSNWT (Nu) 1988, c S-1 at s. 4(1)
[154] Ontario Ministry of Labour, 2016. Radon in the workplace. Available at https://www.labour.gov.on.ca/english/hs/pubs/gl_radon.php accessed may 7, 2018.
[155] General Regulation, NB Reg 91-191 , (Occupational Health and Safety Act) at s. 2 and s. 20

provisions are provided in most provinces and territories: Newfoundland[156] Nova Scotia,[157] Prince Edward Island,[158] Quebec,[159] Manitoba,[160] Saskatchewan,[161] Alberta,[162] British Columbia,[163] Yukon,[164] Northwest Territories,[165] Nunavut.[166]In Ontario requirements for ventilation are spread amongst a variety of regulations and specifically worded in ways that do not allow radon to be covered. More important, while ventilation may help to reduce radon levels, buildings with elevated radon levels typically require radon-specific mitigation strategies to effectively reduce the ingress of radon.

In some cases, regulation on ventilation is more specific and refers to standards of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). [167] These are the people who bring us indoor air temperature standards: As well, ANSI/ASHRAE 62.1-2016 Ventilation for Acceptable Indoor Air Quality specifies minimum ventilation rates and other measures for new and existing buildings that are intended to provide indoor air quality that is acceptable to human occupants and that minimizes adverse health effects. As well ANSI/ASHRAE 62.1 contains building envelope requirements but explicitly states that while these can help with radon, they are not always sufficient, and radon prevention measures *per se* are not included as part of the standard.[168]

4.3.6 Radon-specific measures

Occupational Health and Safety regulations usually provide quite detailed provisions, such as outlining guides and procedures for particular substances such as asbestos. Aside from obvious settings where radon levels will be elevated, such as in mines, Dunn and Cooper (2014) note that "there is no explicit regulation of radon in indoor air (such as testing or mitigation requirements) in provincial/territorial occupational health and safety legislation/regulations".[169] Ontario's inclusion of the NORM Guidelines are now an exception to that.[170] Also, while the Yukon

[156] Occupational Health and Safety Regulations, 2012 under the Occupational Health and Safety Act(O.C. 2012-005) at s. 45, see also s.413 on underground works;
[157] Occupational Safety General Regulations, NS Reg 44/99 at s. 15
[158] Occupational Health and Safety Act General Regulations, PEI Reg EC180/87 at s. 11.1
[159] Regulation respecting occupational health and safety, CQLR c S-2.1, r 13 at s. 101.
[160] Workplace Health and Safety Regulation, Man Reg 217/2006 PART 4, General Workplace Requirements s. 4.1
[161] The Occupational Health and Safety Regulations, 1996, RRS c O-1.1 Reg 1 at s. 65
[162] Occupational Health and Safety Code, 2009, s. 53(1), (enabled under Occupational Health and Safety Act, RSA 2000, c O-2 and Occupational Health and Safety Code 2009 Order, Alta Reg 87/2009)
[163] Occupational Health and Safety Regulation, BC Reg 296/97, Part 4 - General Conditions - 296/97 at s. 4.72 (1)
[164] Occupational Health Regulations, YOIC 1986D/164 s. 7. (1)
[165] Occupational Health and Safety Regulations, NWT Reg 039-2015 s. 69.
[166] Occupational Health and Safety Regulations, Nu Reg 003-2016, s. 69
[167] Newfoundland Occupational Health and Safety Regulations, 2012 under the Occupational Health and Safety Act(O.C. 2012-005) at s. 45; New Brunswick General Regulation, NB Reg 91-191 , (Occupational Health and Safety Act) at s. 20 (1)(b) but referencing the older ASHRAE standard 62-1989; British Columbia— Occupational Health and Safety Regulation, BC Reg 296/97, Part 4 - General Conditions - 296/97 at s.4.72(1)(b) also referencing the older 1989 standard.
[168] ANSI/ASHRAE Standard 62.1-2016 Ventilation for Acceptable Indoor Air Quality, s. 5.14, at p. 49
[169] Cooper, K. and Dunn, B. 2014. Radon in Indoor Air: A Review of Policy and Law in Canada. Canadian Environmental Law Association, at p. 39
[170] Ontario Ministry of Labour, 2016. Radon in the workplace. Available at https://www.labour.gov.on.ca/english/hs/pubs/gl_radon.php accessed may 7, 2018.

Occupational Health Regulations, YOIC 1986D/164 appear to focus radon provisions regarding radiation monitoring, measurement, and record-keeping on mining operations, the language for radon limits appears to apply to any worksite. However, despite provisions that require employers to reduce radon levels as low as reasonably practicable, corrective action is required only after concentrations reach a very high level.

4.3.7 Worker's Compensation

All provinces and territories have schemes for compensating workers who suffer injuries or contract occupational diseases on the job. The federal government has a separate scheme for its workers through the *Government Employees Compensation Act*, RSC 1985, c G-5. Here, compensation is determined by the law of the province where the work is normally done (s. 3).The Government of Canada uses provincial workers' compensation agencies to provide services for federal employees.[171]

We have found no prior analysis of the legal status of radon claims in workers compensation and we here provide a short introduction. While no compensation cases were found, many Workers' Compensation institutions do, to some degree, recognize radon as a concern. We note that compensation claims are likely to not have proceeded through a combination of lack of awareness of the issue (not only among the general public but also that radon levels in workplaces are often unknown), the complex array of causes for lung cancer (e.g. smoking, residential radon, other occupational or environmental exposures) and a lack of specific provisions from workers compensation organizations.

Workers' compensation legislation provides benefits, medical care and rehabilitation services to individuals who suffer workplace injuries or contract occupational diseases. Workers compensation provides relief pay, and operates much like an insurance fund. Employers contribute and workers collect when they are injured. Workers cannot go through the courts and claim negligence or occupier's liability. Legislation typically creates a Workers' Compensation Board which operates as an administrative tribunal and is given exclusive jurisdiction over workers' compensation matters. Once an injured worker applies for compensation, the Board will begin to assess whether or not to accept the claim. Once the claim is accepted, the Board will then adjudicate the worker's entitlement to compensation benefits. Typically, compensation includes medical and return-to-work support costs, (e.g. physiotherapy, counselling), and lost income based on a percentage of a worker's net earnings. Monthly pension benefits are generally available to a surviving spouse and dependent children. Typically, workers compensation legislation grants powers for Boards to set rates and collect assessments from employers to create an Accident Fund.[172] Rates vary by the degree of safety of each industry. Board can typically use varying assessment rates to motivate industries to improve their health and safety performance.

[171] Employment an Social Development Canada, 2018 Accidents in the workplace: federal government employees available at https://www.canada.ca/en/employment-social-development/services/health-safety/compensation/federal-employees.html. accessed May 10, 2018

[172] (see for example BC's Worker's Compensation Act Division 4 — Accident Fund and Assessments—ss. 36 to 52).

Typically, workers compensation legislation includes very general language that provides for rights to compensation for workplace injury, accident or disease. Generally, for a disease case to succeed one needs a history of significant exposure - "the dose makes the poison" - and, secondly, one must have a disease typical to a particular exposure.[173] Here, victims of radon-induced lung cancer may face significant obstacles in showing causation. However, most Workers Compensation schemes provide for a class of "Occupational Diseases" for which the burden of causation is eased. Boards recognize specific diseases as likely or possibly caused by work, based on scientific evidence. These are then listed (e.g. in regulations) and these lists are updated as new scientific evidence becomes available. Newfoundland recognizes diseases of ionizing radiation,[174] as does Nova Scotia, [175]Quebec,[176] and Ontario.[177] Alberta has general provisions relating to "Poisoning by… toxic substances where there is "significant occupational exposure to toxic gases, vapours, mists, fumes or dusts", as well as "Radiation injury or disease…where there is significant occupational exposure to ionizing radiation."[178] British Columbia explicitly recognizes "Primary cancer of the lung" where there is "prolonged exposure to… radon gas and its decay products".[179] Claimants will need to look closely at the details of regulation and judicial interpretation in each province, and in some cases 'cancer' needs to be explicitly identified beyond simply "radiation disease".[180] That said, in many cases it does appear that regulation already contemplates workplace radiation issues and in some cases radon gas and its links to lung cancer.

Workers compensation boards generally do not appear to have clear policies around radon. Ontario is an exception— it explicitly adopts NORM Guidelines, and provides information as to employer responsibilities.[181] Otherwise, there continues to be a lack of clarity, and at least one research paper suggests naturally occurring radon might be excluded as "background radiation", and therefore, exempt.[182] Some government departments charged with workplace safety have issued bulletins describing radon and ways to mitigate, but without explicitly stating workers

[173] Decision No. 865/09, 2009 ONWSIAT 1631 at para 18; Decision No. 516/99, 2001 ONWSIAT 3774at paragraph 93.
[174] Newfoundland's Workplace Health, Safety and Compensation Act, RSNL 1990, c W-11 s. 90 in conjunction with the Workplace Health, Safety and Compensation Regulations, CNLR 1025/96 at s. 25.
[175] Workers' Compensation Act, SNS 1994-95, c 10 section 15, Compensation for exposure to radiation, and Workers' Compensation General Regulations, NS Reg 22/96 Schedule A
[176] Act respecting industrial accidents and occupational diseases, CQLR c A-3.001 section 7 and Division IV, Diseases caused by Physical Agents (5), referring to diseases caused by ionizing radiations; see also Workers' Compensation Act, CQLR c A-3 s. 111, in conjunction with Schedule D (8) describing Diseases caused by exposure to X-Rays or radium or othe radio-active substances.
[177] Workplace Safety and Insurance Act, 1997, SO 1997, c 16, sections 13, and 15, and Schedule 3 where Occupational diseases includes "any disease due to exposure to x-rays, radium or other radioactive substances (s. 22)
[178] Workers' Compensation Act, RSA 2000, c W-15, s. 24, along with Workers' Compensation Regulation, Alta Reg 325/2002 at s. 20(1) and Schedule B.
[179] Workers Compensation Act, RSBC 1996, c 492 6 (1) and Schedule B 4(e) . On the nature of the interaction of section 6 and Schedule B, see WCAT-2010-00802 (Re), 2010 CanLII 22794 (BC WCAT). For the history of these provisions see WCAT-2006-04191 (Re), 2006 CanLII 90863 (BC WCAT)
[180] WCAT-2006-04191 (Re), 2006 CanLII 90863 (BC WCAT)
[181] Ontario Ministry of Labour, 2016. Radon in the Workplace. available at https://www.labour.gov.on.ca/english/hs/pubs/gl_radon.php accessed May 9 2018.
[182] Copes, R. et al. 2009. Radon in British Columbia Work Places. Worksafe BC Research Secretariat RS2006-DG09

compensation policies, such as Worksafe Saskatchewan,[183] Worksafe Alberta,[184] Worksafe BC.[185] No results were found for Manitoba, PEI, Newfoundland, Yukon, Northwest Territories or Nunavut. Worksafe New Brunswick provides information on radon, but states that "The Province of New Brunswick does not regulate radon exposures in workplaces, except for underground mines. As with the practice at provincially operated workplaces (schools, health care facilities, etc.), WorkSafeNB recommends Health Canada's guidelines be followed in workplaces where non-radiation workers conduct work." [186]The Workers Compensation Board of Nova Scotia does not have public guides on radon, but did commission a study in 2009 which sampled radon levels in Nova Scotia workplaces. 185 alpha track detectors were used to test for radon in 21 selected NS industries over a three month period between May 2008 and January 2009. Only 2 were above 150 Bq/m^3 and did not exceed 400 Bq/m^3 falling into the NORM "management" classification, not requiring any mitigation activity.[187] However, Worksafe programs do routinely deal with cancers and occupational exposures, and include detailed provisions relating to problems of causation, limitation periods, and late onset of disabilities and new classifications of occupational diseases.[188]

There remains significant scope for Workers' Compensation Boards and agencies to improve policies to guide radon-affected workers. With other types of cancer, experience shows that without policy attention (such as classification of occupational diseases) sick workers and their families often have to forge a difficult path of proving causation with the aid of medical and epidemiological experts.[189] We also note that there may be considerable problems with Employer Assessments, with a systematic under-assessment of the dangers associated with many workplaces, especially given what experts have recently noted about the links between radon concentrations and effective dose. We also found no economic studies assessing the potential liabilities of accident funds for compensation payouts. The large numbers of radon-affected workers across the country suggests this may be large. Such studies would help show provincial boards why they should direct resources towards encouraging radon specific health and safety plans in the workplace and otherwise improving occupational health and safety standards.

[183] Worksafe Saskatchewan, 2018. Radon Gas. available at http://www.worksafesask.ca/prevention/environmental-risks/radon-gas/ accessed May 9 2018.
[184] Worksafe Alberta. Undated PDF. Radon in the Workplace. Occupational Health and Safety Bulletin.. available at https://work.alberta.ca/documents/ohs-bulletin-rad007.pdf accessed May 9 2018
[185] Worksafe BC, 2018. Radon. available at https://www.worksafebc.com/en/health-safety/hazards-exposures/radon accessed May 9 2018.
[186] Worksafe New Brunswick 2018. Radon in the Workplace. available at http://www.worksafenb.ca/safety-topics/radon-in-the-workplace/ accessed May 9, 2018.
[187] Mersereau, H. 2009. Breaking New Ground: Does Radon Present a Health Risk to Nova Scotia Workers? Worksafe BC and the Workers Compensation Board of Nova Scotia. RS2007-IG17 available at https://www.wcb.ns.ca/Portals/wcb/Mersereau_Radon_Breaking_New_Ground.pdf?ver=2014-08-26-135748-000 accessed May 9 2018.
[188] see for example, Worksafe BC. Volume II of the Rehabilitation Services & Claims Manual, Chapter 4 Occupational Diseases, Sec. 25.00 to 32.85 available at https://www.worksafebc.com/en/law-policy/claims-rehabilitation/compensation-policies/rehab-claims-volumeii
[189] (see Decision No. 2238/14, 2017 ONWSIAT 3630 and CBC News, 2018. Terminal cancer patient gets compensation in landmark ruling. May 07, 2018. http://www.cbc.ca/news/thenational/terminal-cancer-patient-gets-compensation-in-landmark-ruling-1.4652863

4.3.8 Government as employer

In each province/territory, occupational health and safety law binds the Crown.[190] Likewise, workers compensation binds the Crown, typically through defining 'employer' to include federal and provincial governments.[191]

Canadian governments may face radon related litigation and compensation claims from workers and may need to take steps to mitigate radon. Regardless, governments have other good reasons for measuring radon in buildings and mitigating.

For those provincial/territorial governments that chose to respond to our inquiries during the course of this research, the following Table summarizes knowledge about government testing of its own workplaces.

Newfoundland and Labrador	A dozen public buildings in St. Lawrence, NL tested high for radon gas in a January 2017 study. Test identified St. Lawrence Academy, the town hall, the US Memorial Health Care Centre and the recreation centre as having levels higher than 200 Bq/m^3. For St. Lawrence Academy, a school, all levels — from the basement to the third floor — tested high for radon, with levels ranging from 120 to 1,121 Bq/m^3. The area with the highest level was an office in the family resource centre, with a reading of 1,121 Bq/m^3. (Farrell, C. 2017. Public buildings in St. Lawrence test high for radon The Telegram. Nov 27, 2017 available at http://www.thetelegram.com/news/public-buildings-in-st-lawrence-test-high-for-radon-165357/ accessed May 10, 2018)

[190] NFLD— Occupational Health and Safety Act(O.C. 2012-005) at s. 3
PEI—Occupational Health and Safety Act, RSPEI 1988, c O-1.01 s. 3
Nova Scotia-Occupational Health and Safety Act, SNS 1996, c 7 s. 4
New Brunswick, Occupational Health and Safety Act, SNB 1983, c O-0.2 2(1)
Quebec— Act respecting the occupational health and safety, CQLR c S-2.1 at s. 6.
Ontario, Occupational Health and Safety Act, RSO 1990, c O.1 2(1)
Manitoba Workplace Safety and Health Act, 2016, s. 3
The Saskatchewan Employment Act, SS 2013, c S-15.1 section 1(3)
Alberta—Occupational Health and Safety Act, RSA 2000, c O-2 at s. 46
British Columbia — Workers Compensation Act, RSBC 1996, c 492, s. 2,
Yukon— Occupational Health and Safety Act, RSY 2002, c 159 at s. 2
NWT- Safety Act, RSNWT 1988, c S-1 s. 3
Nunavut- Safety Act, RSNWT (Nu) 1988, c S-1 s. 3

[191] Newfoundland— Workplace Health, Safety and Compensation Act, RSNL 1990, c W-11 s. 2 (1)(j)
Nova Scotia —Workers' Compensation Act, SNS 1994-95, c 10 sec. 2(n) (vii)(viii)
Prince Edward Island—Workers Compensation Act, RSPEI 1988, c W-7.1 at s. 1 (k)
New Brunswick —Workers' Compensation Act, RSNB 1973, c W-13, s. 1
Quebec-Act respecting industrial accidents and occupational diseases, CQLR c A-3.001, s. 3
Ontario—Workers' Compensation Act, RSO 1990, c W.11, s. 1(1))
Manitoba— The Workers Compensation Act C.C.S.M. c. W200,, s. 1
Saskatchewan —The Workers' Compensation Act, 2013, SS 2013, c W-17.11 r s.2 (1)(l)
Alberta—Workers' Compensation Act, RSA 2000, c W-15, s. 1(j)
BC Workers Compensation Act, RSBC 1996, c 492, s. 2,
Yukon Workers' Compensation Act, SY 2008, c 12 s 3(1)
Northwest Territories—Workers' Compensation Act, SNWT 2007, c 21 s. 2
Nunavut—Workers' Compensation Act, SNu 2007,c.15 s. 3(1)

Nova Scotia	In 2008 Nova Scotia Environment and Labour lead the inter-governmental Advisory Group on Radon (AGOR). During this time, AGOR completed radon testing at approximately 2,000 public buildings, as part of a comprehensive radon testing program which aims to test all public buildings within 5 years.(Nova Scotia Environment and LabourAnnual Accountability Report for the Fiscal Year 2007-2008 https://novascotia.ca/nse/pubs/docs/nsel-accountability2008.pdf) Test results have shown that 40% of buildings in the high risk areas exceed the radon guideline. In the medium risk areas, 14% of buildings exceed the guideline and in the low risk areas 5% exceed the guideline. Nova Scotia Environmental Health, 2018. Chemicals and Hazardous Substances - Radon. https://novascotia.ca/dhw/environmental/radon.asp Nova Scotia Govt testing most of their public buildings for radon 2010-2015 (correspondence with Richardson-Prager, Lance, April 12, 2018) All public schools in Nova Scotia have been tested for radon (CAREX Canada, 2017. Radon in schools: A summary of testing efforts across Canada. Available at https://www.carexcanada.ca/en/announcements/radon_in_schools/ accessed May 10 , 2018)
New Brunswick	New Brunswick Govt testing all public building for radon, including schools and mitigated using sub-slab depressurization in the period of 2010-2016 (correspondence with Richardson-Prager, Lance, April 12, 2018) (CAREX Canada, 2017. Radon in schools: A summary of testing efforts across Canada. Available at https://www.carexcanada.ca/en/announcements/radon_in_schools/ accessed May 10 , 2018)
PEI	PEI Govt tested about 30 building for radon 2012. Due to its geology, the results were relatively low on average, and PEI therefore decided not to test any additional buildings.. Any high radon buildings were mitigated using sub-slab depressurization. Unfortunately, there is no publicly available database of pre and post testing results (correspondence with Richardson-Prager, Lance, April 12, 2018) All public schools in Prince Edward Island have been tested for radon. (CAREX Canada, 2017. Radon in schools: A summary of testing efforts across Canada. Available at https://www.carexcanada.ca/en/announcements/radon_in_schools/ accessed May 10 , 2018)
Saskatchewan	All public schools in Saskatchewan have been tested for radon. (CAREX Canada, 2017. Radon in schools: A summary of testing efforts across Canada. Available at https://www.carexcanada.ca/en/announcements/radon_in_schools/ accessed May 10 , 2018)
Alberta	Radon testing in selected Alberta Government Buildings was initially done in 2007 and 2008. 41 buildings tested in 2007 by the Radiation Safety Institute of Canada. 28 buildings tested in 2008 by C5 Plus Ltd. All test results were well below 200 Bq/m^3, except in two Calgary buildings which have since been mitigated and re-tested. New testing in 2016 focused on buildings likely to have high levels, given information from radon potential maps, building type, and size. 11 test results gave "acceptable" levels (slide deck of Colin Wildgrube (ROHT, CET) Manager, Building Environment Unit Alberta Infrastructure, April 24, 2017 available at http://www.carst.ca/resources/Conference%202017/Presentations%202017/CARST%20AB%20Infrastructure-%20April%2024,%202017.pdf

	Changes to Building Code in 2014 have had a ripple effect through government building. Alberta Infrastructure is doing radon testing (report from Danny Da Silva, Building Environment Unit Manager to Christina Fok; confirmed by Robyn Luff, MLA Calgary East, in phone conversation April 13, 2018) Alberta Infrastructure developed an internal mandate for all new Government of Alberta Owned and Supported buildings to be designed and built to follow the ABC. These government buildings include schools, school board buildings, healthcare boards, municipalities, post-secondary facilities, and other public-sector organizations (CAREX, 2017.Radon in schools: A summary of testing efforts across Canada https://www.carexcanada.ca/en/announcements/radon_in_schools/ Alberta Infrastructure has also developed Radon Mitigation Rough-In Inspection and Testing Criteria (Now in Technical Design Requirements for Alberta Infrastructure Facilities, 2018 at http://www.infrastructure.alberta.ca/Content/docType486/Production/TechDesignRequirements.pdf). This will will apply to104 new school or post secondary projects under construction or proposed. .
BC	1999 study:. 38% of schools in Castlegar, 70% in North Thompson, and 45% in Nelson were above 150 Bq/m^3 Reported in Copes, R. 2009. Radon in British Columbia Work Places. Worksafe BC. In 2017/2018 there is a continuing program of Shared Services BC (SSBC), the British Columbia Lung Association and the BC Public Service Agency to test government-owned, managed and leased buildings. Radon testing was initiated by SSBC in the fall of 2015 in buildings across the province. This program will continue into the winter of 2017/2018. Government of BC, 2018. Radon Testing/Mitigation. https://www2.gov.bc.ca/gov/content/careers-myhr/managers-supervisors/occupational-health-safety/radon-testing-mitigation
Yukon	All public schools in the Yukon have been tested for radon. (CAREX Canada, 2017. Radon in schools: A summary of testing efforts across Canada. Available at https://www.carexcanada.ca/en/announcements/radon_in_schools/ accessed May 10 , 2018)
No results were found for Quebec, Ontario, Manitoba, Northwest Territories and Nunavut.	

4.4 Real estate transactions and home warranty programs

4.4.1 Introduction

Canadian property law (as developed at the provincial level but in generally similar ways) retains key aspects of 'buyer beware' or '*caveat emptor*': Absent fraud, mistake or misrepresentation, a property purchaser takes existing property as he finds it, whether it be dilapidated, bug-infested or otherwise uninhabitable or deficient in expected amenities, unless he protects himself by

contract terms.[192] The rationale stems from the *laissez-faire* attitudes of the eighteenth and nineteenth centuries and the notion that a purchaser must fend for himself, seeking protection by express warranty or by independent examination of the premises. However, over time there has been built up a series of practices within the real estate profession, and some laws that ameliorate these concerns. Much of this law is judge-made common law, and is shared across the country, but in some cases there is distinct provincial and territorial legislation. In recent years across Canada there has been some movement towards including concerns about radon in the purchase of new homes — in terms of testing and disclosure at the point of sale, and in warranties for newly constructed homes.

4.4.2 Property disclosure statements

Typically, vendors fill out standard form Property Disclosure Statements to highlight improvements to property as well as important problems, and these become incorporated into a contract of purchase and sale. Once made, disclosure become representations upon which a purchaser can rely. In some Canadian provinces, standard form disclosure statements are required by law, and in others they are conventions of realty practice. Below we detail where radon figures into disclosure statements, if at all. Sellers can disclose radon independently of using standard form statements, or even write new information pertinent to radon in their own handwriting directly on such forms. In some situations, sellers will want buyers to know that they have tested for radon and found low levels, or alternatively, installed a radon mitigation system. Property Disclosure Statements can thus potentially aid both buyers and sellers.

As well, some institutions that oversee real estate transactions have begun to take radon seriously. In 2016 The Manitoba Real Estate Association has issued a "radon alert" although it does not specify disclosure practice[193]. The New Brunswick Real Estate Association has issued recommendations for sellers, and the Alberta Real Estate Council (the governing regulatory body) has issued guiding documents relating to radon being a latent defect. The Canadian Real Estate Association has published a guide to radon.[194]

4.4.2.1 Only current actual knowledge counts

Canadian courts only give limited credence to such statements: A vendor is only obliged to disclose his or her current actual knowledge of the state of affairs of the property to the extent promised in the disclosure statement and need say "no more than that he or she is or is not aware of problems". In other words, the vendor must correctly and honestly disclose his or her actual knowledge, but that knowledge does not have to be correct. A vendor is not required to warrant a certain state of affairs but only to put prospective purchasers on notice of any current known

[192] Fraser-Reid v. Droumtsekas (1979), [1980] 1. S.C.R. 720; Outaouais Synergest Inc. v. Lang Michener LLP, 2013 ONCA 526

[193] http://realestatemanitoba.com/wp-content/uploads/2016/11/forweb_MREA-Radon-Release-F-Nov-21-16-.pdf

[194] Canadian Real Estate Association, 2016. A Homeowner's Guide to Radon. available at https://www.crea.ca/wp-content/uploads/2016/02/A_Homeowners_Guide_to_Radon_CREA.pdf accessed May 15, 2018

problems. The purpose of a disclosure statement is to identify any problems or concerns with the property, not to give detailed comments in answer to the questions posed.[195]

British Columbia courts have found that a vendor who signed a disclosure statement stating lack of knowledge of structural problems, water or a leaking roof was not liable when these problems were later found.[196] Sellers who said they were unaware of an insect or rodent infestation were not found liable, even though termites had previously been a problem and proved to be so in the future: The question was ruled to relate only to the present tense and not past infestations.[197] Courts thus hold that the information in the disclosure statement incorporated into a contract may be a representation upon which a purchaser can rely. However, a vendor is only obliged to disclose his or her current actual knowledge of the state of affairs. The knowledge does not have to be correct.[198] For instance, in a significant case involving a housing subdivision built by the Ontario government on radioactive waste, the courts found there was no breach of contract and no implied warranty of fitness or concealment because it was not known when the houses were sold that the soil was contaminated.[199]

4.4.2.2 Material latent defects

That said, courts do hold in some cases that a seller has a positive obligation—without being prompted— to disclose a material latent defect to prospective buyers. If the defect renders a property dangerous or unfit for habitation, the seller must tell the buyer. There are some signs that radon may be covered by that principle. Here, the courts differentiate between latent and patent defects. A latent defect is one that is not discoverable by a purchaser through reasonable inspection inquiries. Alternatively, patent defects are those that can be discovered by conducting a reasonable inspection and making reasonable inquiries about the property. A defect which might not be observable on a casual inspection may nonetheless be patent if it would have been discoverable upon a reasonable inspection.[200]

There is a fairly high onus on the purchaser to inspect and discover patent defects by conducting a reasonable inspection of the premises and by making reasonable inquiries into its qualities.[201] However, as with other breaches of contract, a vendor's knowledge of the latent defect is an essential element of liability. Without knowledge, the vendor cannot misrepresent, either negligently or fraudulently. If the defect is both latent and unknown to the vendor, the buyer will not have recourse.[202] To be actionable, the latent defect must render the property dangerous or unfit for habitation.[203] Courts have held that soil contaminated with radioactivity is a latent

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[195] Nixon v. MacIver, 2016 BCCA 8 at para 37, also citing Anderson v. Kibzey, [1996] B.C.J. No. 3008 (QL) (S.C.) at paras. 13-14; Zaenker v. Kirk (1999), 30 R.P.R. (3d) 9 (B.C.S.C.) at para. 19; Kiraly v. Fuchs, 2009 BCSC 654 at paras. 47, 49; and Roberts v. Hutton, 2013 BCSC 640 (CanLII) at para. 83.
[196] Arsenault v. Pedersen, 1996 CanLII 3519 (B.C.S.C.)
[197] Curtin v. Blewett, 1999 CanLII 2267 (B.C.S.C.)
[198] Nixon v. MacIver 2016 BCCA 8
[199] Heighington et al. v. The Queen in right of Ontario et al. Alejandria et al. v. The Queen in right of Ontario et al., 1987 CanLII 4425
[200] Cardwell v. Perthen, 2006 BCSC 333 (CanLII), aff'd 2007 BCCA 313 (CanLII) at para 122
[201] McIntosh v. Papoutsis, 2009 BCSC 174 (CanLII) at para. 64
[202] 1348623 Alberta Ltd. v Choubal, 2016 SKQB 129 (CanLII), <http://canlii.ca/t/gr86z>, retrieved on 2018-02-0 see also Cotton v Monahan, 2011 ONCA 697 (CanLII).
[203] Nixon v. MacIver, 2015 BCCA 8 at para 35

defect: If the vendor knew of the contamination then there is no doubt that it was under a duty to make disclosure.[204] Other cases include water damage or structural defects[205] and mould.[206] A recent decision from British Columbia summarizes the law: A recent drug land murder is not a latent defect for a mansion in the upscale neighbourhood of Shaughnessy, but a failure of the seller to mention this when asked about reasons for the sale did amount to fraudulent misrepresentation.[207]

In Quebec, the civil law system also contain rules about latent defects (at Article 1726 of the Civil Code) In *Pouliot c. Leblanc* (2011 QCCQ 7882), homebuyers found a house to be above the federal Radon Guideline reference level. The buyers mitigated and brought an action for the cost of the remedial actions. The court allowed that radon, as a defect of the soil, could amount to a latent defect under the Quebec Civil Code if found in levels over the Health Canada Guidelines of 200Bq/m^3. As such, if known to the sellers, they were under a duty to disclose. However, in that case the seller was found to be ignorant of the radon issue.

The Canadian Automobile Association Quebec obtained a legal opinion—rendered anonymous on its website— on latent defects and radon. [208] This confirms the view that in Quebec law radon concentrations over 200 Bq/m^3 can be considered a latent defect. However, in the event that a property sold posed obvious risks, at the time of the sale, for the presence of radon (e.g., cracked foundation walls, building located in a region already known for high concentrations of radon), a judge might rule that the buyer who chose not to conduct a test for radon did not behave prudently and diligently.

In a 2018 bulletin, the Real Estate Council of Alberta describes practice standards with respect to the detection, disclosure, and mitigation of radon gas when trading in real estate or providing property management services. Real estate professionals are advised to discuss the implications of unhealthy concentrations of radon gas with sellers, provide sellers radon-related information (e.g. various guides), ask if the sellers have tested their home for the presence of radon gas and if so ask for a copy of the test results. The bulletin states explicitly that if test results show 200 Bq/m^3 or higher, and the seller has done nothing to mitigate the radon gas, this is a material latent defect which must be disclosed to potential buyers. Alternatively, if the seller demonstrates that they have hired a C-NRPP certified professional to mitigate the home, this will likely appeal to prospective buyers. When representing buyers, professionals should ask the seller's representative if the sellers have tested their home for radon gas, and ask for information about the radon test they used, results, and possible avenues for, or completed mitigation. Professionals, when representing landlords, should also ask about testing, results, and mitigation.[209]

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[204] Heighington et al. v. The Queen in right of Ontario et al. Alejandria et al. v. The Queen in right of Ontario et al., 1987 CanLII 4425
[205] Stone v. Stewart (2009), 83 R.P.R. (4th) 309 (Ont. S.C.J.).
[206] Gibb v. Sprague, 2008 ABQB 298.
[207] Wang v. Shao, 2018 BCSC 377
[208] CAA Quebec, "Radon in the House: Legal Questions", online: https://www.caaquebec.com/en/at-home/advice/tools-and-references/radon-in-the-house/legal-questions/
[209] Real Estate Council of Alberta, 2018. Radon. https://www.reca.ca/industry/legislation/information-bulletins/radon.html

	DISCLOSURE RULES OR FORMS
Nova Scotia	The Standard Forms ask: "Are you aware of any radon problems?" With, yes, no, don't know, and unapplicable as suggested answers. Question 9a: copies at http://www.barwiserealty.com/public_docs/ddf_listings/39%20Fearn%20Lane,%20Taymouth%20-%20RPDC%20filled%20outpdf.pdf
New Brunswick	The Standard Forms ask: "Are you aware of any radon problems?" With, yes, no, don't know, and unapplicable as suggested answers. Question 9a: See Beslile ibid. copies at http://mackayre.com/wp-content/uploads/sites/79/2015/08/PCDS.pdf NB real estate association requires all buildings sold with a realtor to have buyer and seller sign a radon form and consider testing options Fall 2017 (Richardson-Prager, Lance correspondence April 12 2018
PEI	While various issues and defects mentioned, radon is not. http://www.youronlineagents.com/steveyoston/custom_WebPage_Files/file/PCDS-14NewCoveRd-08-02-2014.pdf Accessed May 15, 2018
Quebec	Since 2012, the real estate brokerage self-regulating organisation (Organisme D'Autoréglementation du Courtage Immobilier due Quebec. —'OACIQ') requires brokers to use a Sellers Declaration, formally titled the "Declarations by the seller of the immovable". It must be used for all transactions involving the sale of houses and small apartment buildings. The broker must complete this form with the seller and have him sign it when entering into a brokerage contract. It contains two potential places where radon can come up: D12.2 To your knowledge, are there or have there even been any other tests or expert evaluations done on the immovable? (ex. pirite, pyrrhotite, radon, other deposits, UFFI, asbestos, air quality, water quality or flow, foundation drain)? D 13.9 To your knowledge, or there any other factors relating to the immovable and not mentioned in these declarations that are liable to reduce the value or restrict the use thereof, reduce the income generated thereby or increase the expenses relating thereto (e.g. development or construction project, environmental problems [e.g. radon], abnormally high noise level, unpleasant odour, etc.)? (see Organisme D'Autoréglementation du Courtage Immobilier due Quebec. How to use the mandatory form Declarations by the seller of the immovable. Article number: 121838 Dec. 5 2017 https://www.oaciq.com/en/articles/how-to-use-the-mandatory-form-declarations-by-the-seller-of-the-immovable Accessed February 7 2018. https://www.oaciq.com/uploads/ckeditor/attachments/358/declarations-seller.pdf
Ontario	there is only a general question: "Are you aware of possible environmental problems or soil contamination of any kind on the property or in the immediate area? Eg: toxic waste, underground gasoline or fuel tanks etc. Ontario Real Estate Association. Seller Property Information Statement. Form 220. Available at https://s3.amazonaws.com/storage-ubertor-com/randymiller.myubertor.com/content/document/121.pdf at E1.

Manitoba	The Real Estate Brokers Act requires that the printed form of offer and printed form of acceptance (for a single family residential house or single family residential unit in a Condominium) be in a prescribed form. The Regulations provide a Form, which, at question 15 asks: " Are you aware if any building on the property contains — or do you have any reason to believe that it once contained — asbestos, insulation, zonolite/vermiculite insulation, radon gas, lead plumbing, aluminum wiring or mould? Form 1, Schedule A of the Real Estate Brokers Regulation, Man Reg 56/88 Example at http://www.johnchand.realtor/articles/property_disclosure_statement.pdf The Manitoba Real Estate Association has issued a "radon alert" in 2016 as part of Radon Awareness Month. However it merely asks homeowners to test and provides no legal guidance http://realestatemanitoba.com/wp-content/uploads/2016/11/forweb_MREA-Radon-Release-F-Nov-21-16-.pdf
Saskatchewan	The Association of Saskatchewan Realtors provides a standards Property Condition Disclosure Statement. It asks only very generally if the seller is "aware of any tests for mould, fungi, or indoor air quality in the property?" Available at http://www.kramerauction.com/real_estate/data/listing_files/listing_files/36_listing_files.pdf accessed May 15, 2018.
Alberta	A standard form Residential Purchase Contract is provided by the Alberta Real Estate Association. It states at section 3.1. that In fulfilling this contract, the seller and buyer agree to act reasonably and in good faith and agree that…(f) the seller will disclose known Material Latent Defects. Material Latent Defect means a defect in the Property that is not discoverable through a reasonable inspection and that will affect the use or value of the Property. As noted above, the Real Estate Council has issued a bulletin that states that if test results show 200 Bq/m^3 or higher, and the seller has done nothing to mitigate the radon gas, this is a material latent defect which must be disclosed to potential buyers.
BC	While the standard disclosure statements discuss various problems, none capture radon with any precision. For a copy see http://www.garbuttdumas.ca/wp-content/uploads/Property-Disclosure-Statement.pdf accessed May 15 2018
No results were found for Newfoundland and Labrador, Yukon, Northwest Territories or Nunavut	

4.4.3 New home warranty

A warrant of habitability would state that a contract for the building of a house carries with it an implied warranty of workman-like construction and reasonably suitable for the purposes it was made— that is, being suitable for being lived in. For individual consumer products this was developed in English common law in the late 19th century and codified into *Sales of Goods Acts.* It is also common to see reference to this principle in American cases and scholarship.[210] Such a warranty would mean buyers could sue on contract for a defect regardless of the seller's knowledge. However, in Canada this has not normally been accepted for real estate transactions: Many commentators and judges have remarked on the mismatch between the law for personal

210 King, 1993, p.152-3.

property and the law for real property.[211] In some cases the courts have been prepared to imply a warranty of quality in the case of a purchase of an incomplete house from a builder:[212] However, once a building is completed caveat emptor (with the exceptions noted above) continues to apply.[213]

In response to the continued force of *caveat emptor*, several provinces (including Alberta, British Columbia, Manitoba, Ontario, Quebec) have enacted home warranty legislation to provide consumer protection for the purchasers of new homes. These generally provide that there are implied warranties as between builder and purchaser, concerning the integrity of the home. Implied warranties are limited to the scope and duration of the warranties covered by the New Home Warranties Plan.[214] Only in Ontario is radon officially recognized in these plans. In Canada there are many cases of breach of warranty for problems like formaldehyde[215] and it should not be a difficult step to argue radon should warranted, drawing on Health Canada Guidelines.

Newfoundland, Nova Scotia, New Brunswick and Prince Edward Island. No state system was found. Atlantic New Home Warranty is an industry created non-profit which provides new home insurance services, but does not refer to radon in its coverage.[216]

Quebec: In 1999 The *Regulation respecting the guarantee plan for new residential buildings*, CQLR c B-1.1, r 8 sets up the Guarantee Plan for New Residential Buildings[217]. No references to radon were found. Prior to January 1, 2015 the administration of the guarantee on new homes was entrusted to three independent organizations: Garantie habitation du Québec, Inc. provided the Qualité Habitation guarantee; the Association des professionnels de la construction et de l'habitation du Québec (APCHQ) provided the Garantie Maison Neuve [New House Guarantee]; and Garantie Abritat, Inc. offered the Abritat guarantee.Since January 1, 2015, these three organizations have lost this authorization, and the administration of the Guarantee Plan for New Residential buildings is now entrusted to a new non-profit organization, the Garantie de Construction Résidentielle (GCR).[218]

Ontario. The *New Home Warranties Plan Act* R.S.O. 1990, c. O.31 provides at s. 13 (1) (a) that every vendor of a home warrants to the owner that the home is is constructed in a workmanlike

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211 see Laskin, "Defects of Title and Quality: Caveat Emptor and The Vendor's Duty of Disclosure" (1960), L.S.U.C. Special Lectures 389, and Haskell, "The Case for an Implied Warranty of Quality in Sale of Real Property" (1965), Georgetown L. Rev. 633 cited in Heighington et al. v. The Queen in right of Ontario et al. Alejandria et al. v. The Queen in right of Ontario et al., 1987 CanLII 4425 (ON SC).

212 Fraser-Reid et al. v. Droumtsekas et al. (1979), 1979 CanLII 55 (SCC), 103 D.L.R. (3d) 385, [1980] 1 S.C.R. 720, 9 R.P.R. 121.

213 Heighington et al. v. The Queen in right of Ontario et al. Alejandria et al. v. The Queen in right of Ontario et al., 1987 CanLII 4425 (ON SC), <http://canlii.ca/t/g122l>, retrieved on 2018-02-02; Nixon v. MacIver, 2016 BCCA 8 (CanLII), <http://canlii.ca/t/gmtx3>, retrieved on 2018-02-05 at para 32-36

214 TSCC 2130 v York Bremner Developments Limited, 2016 ONSC 5393 (CanLII),

215 Borner v. Kerr (Dist. Ct.), 1988 CanLII 4758 (ON SC); Proctor v. McMillan, 1991 CanLII 2625 (NB QB)

216 Atlantic New Home Warranty http://www.ahwp.org/what-does-the-home-warranty-cover/

217 Guarantee Plan for New Residential Buildings (see http://www.garantie.gouv.qc.ca/en.html).

218 see Lecture Obligatorie: Plan de garantie des bâtiments résidentiels neufs http://www.garantie.gouv.qc.ca/fileadmin/fichiers_plan_garantie/plan-garantie-batiments-residentiels-neufs-maison.pdf accessed May 15 2018

manner and is free from defects in material, is fit for habitation, is constructed in accordance with the Ontario Building Code. Tarion —the government agency which administers the Act and provides insurance— explicitly warrants construction against levels of radon exceeding 200 $Bq/m^{3.}$ Homeowners must submit test results that are undertaken using a C-NRPP certified test kit and evaluated in a C-NRPP laboratory (or otherwise have the test done by a C-NRPP certified professional). Tarion will cover the costs required to mitigate a home up to a limit of $15,000.[219] So far there have been 48 cases processed by Tarion, with a total value of $156,000.00.[220] However this number excludes cases where a homeowner and builder were able to reach informal agreement.

Manitoba. Currently, the New Home Warranty Program of Manitoba is a not-for-profit warranty program that covers defects in workmanship and materials for the 1st year following the date of possession and major structural defects for 5 years. The Program also offers 3rd party conciliation for resolving warranty disputes between homeowners and builder members. It makes available the standard form warranty which does not mention radon.[221] The *New Home Warranty Act*, CCSM c N85 is not yet in force, but will be starting in 2020. It provides for mandatory warranty coverage of one year for defects in materials, labour and design; Two years for defects violations of the *Manitoba Building Code* and defects to electrical, plumbing, heating, ventilation and air conditioning, exterior cladding, caulking, windows, doors, and building envelope, including defects resulting in water penetration; and seven years for major structural components. Warranties are provided by a third-party home warranty provider. Radon is not mentioned. We also found that one Winnipeg homebuilder, Kensington Homes Ltd., puts radon detectors in all show homes to gather information before they finalize factsheets for new home buyers.[222]

Saskatchewan. There are three voluntary new home warranty programs operating in Saskatchewan—two are private sector, the National Home Warranty and Progressive Home Warranty Solutions and the third is a not for profit — New Home Warranty Program of Saskatchewan (NHWP) formed by the building industry in 1976. Canada Mortgage and Housing Corporation (CMHC) and its private equivalents, Genworth Canada and Canada Guaranty require builders to belong to a Warranty Program in order to receive mortgage insurance on high ratio loans (80% or higher)[223] The *New Home Warranty Program of Saskatchewan Construction Performance Standards,* 2006, do not mention radon or radiation.[224]

Alberta: Mandatory new home warranty came into effect in Alberta on homes whose building permit was applied for after February 1, 2014. The *New Home Buyer Protection Ac*t, c. N-3.2,

[219] Tarion: Radon and Your Warranty. https://www.tarion.com/homeowners/your-warranty-coverage/radon-and-your-warranty
[220] Radon and Tarion's Warranty Coverage.PPT presentation to Canadian National Radon Proficiency Program.October 27, 2017
[221] http://www.mbnhwp.com/warranty_certificate.htm
[222] Personal communication, Health Canada Regional Radiation Specialist, Manitoba and Saskatchewan (July 3, 2018).
[223] Saskatchewan New Home Warranty, 2018. What is the NHWP? http://www.nhwp.org/about/about-whatis.htm
[224] New Home Warranty Program of Saskatchewan. 2006. Construction Performance Standards, available at http://www.beagleproductions.com/nhwp/docs/NHWP_Doc.pdf accessed May 15, 2018

at section 6 provides for a warranty for defects in materials, labour and building envelope. There is no general habitability clause. The *Construction Performance Guide for New Home Warranty in Alberta*, explicitly mentions radon.[225] It explicitly says that radon is naturally occurring, that radon entering the home does not amount to a defect, and that no warranty coverage is provided. This might not entirely settle the matter— no mention is given of concentration. Moreover, reference is made to the 2014 Alberta Building Code which does specify construction requirements intended to minimize the radon levels in a home.

British Columbia. Under the *Homeowner Protection Act*, SBC 1998, c. 31 every new home offered for sale or built under a construction contract in B.C. must be constructed by licensed residential builders, who are regulated by the Homeowner Protection Office. The cost of the warranty insurance is included in the purchase price and protects from construction defects for designated periods of time: two years on specified labour and materials; five years on the building envelope (which includes the components that separate the indoors from the outdoors, such as exterior walls, foundation, roof, windows and doors), including water penetration; and 10 years on the structure itself. Whether British Columbia's Act covers radon is somewhat unclear. The Act provides general language to the effect that builders and vendors agree that a new home be "free from defects in materials and labour" (s. 23 (1) including defects in the building envelope" but there is no general language of buildings being fit for habitation. (s. 23 (1)(b)) No significant case law was found on the meaning of the term 'defects': This is likely due to provisions in the Act and Regulations that provide for the mediation of disputes [226]The legislation is clear that this contractual term cannot be waived, excluded, limited or qualified. (s. 23 (2).) Not one of the Act, the *Homeowners Protection Act Regulations*, or the *Building Envelope Renovation Regulation* Reg 240/2000 particularly mention radon nor provide provisions that would have the necessary effect of protecting from radon ingress. That said applicants for a new residential builder licence as a general contractor need to successfully show proficiency in seven core competencies, as outlined in Schedule 6 of the *Homeowner Protection Act Regulation*. A detailed reading of documents that explain the core competencies do show these include identifying problematic soil conditions, including radon areas and mitigation strategies.[227]

Yukon, Northwest Territories and Nunavut. There appears to be no formalized home warranty systems in operation, although private sector guarantees and insurance may occur in practice.[228]

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[225] Alberta Government, 2015.Construction Performance Guide for New Home Warranty in Alberta http://www.municipalaffairs.alberta.ca/documents/2015_09_01_Performance_Guide.pdf accessed May 15, 2018, see sec. 17.22, p. 327)

[226] (Homeowner Protection Act Regulation, BC Reg 29/99, Schedule 2.)

[227] BC Housing, 2018. The Core Competency Requirements at https://www.bchousing.org/licensing-consumer-services/education-training/core-competency-requirements

[228] Canadian Mortgage and Housing Corporation, 2018. Yukon Fact Sheet. https://www.cmhc-schl.gc.ca/en/co/buho/cobugu/cobugu_007m.cfm; Canadian Mortgage and Housing Corporation, 2018. Northwest Territories Fact Sheet. https://www.cmhc-schl.gc.ca/en/co/buho/cobugu/cobugu_007f.cfm; Canadian Mortgage and Housing Corporation, 2018. Nunavut Fact Sheet https://www.cmhc-schl.gc.ca/en/co/buho/cobugu/cobugu_007h.cfm. Also see Blake, E. 2017. MLA reiterates need for home warranty program. Whitehorse Star, October 12, 2017. Available at http://www.whitehorsestar.com/News/mla-reiterates-need-for-home-warranty-program accessed May 15, 2018.

4.4.4 Radon contingency clauses

The purchase of a home involves a complex set of problems concerning who should test for radon and who should carry the costs of mitigation. CARST has recently formulated a "Radon and Real Estate Tool Kit" which considers the advantages and disadvantages of different options for who should bear these responsibilities.[229] If the seller tests and mitigates, they are faced with the problem that unconcerned buyers might not compensate them for the costs. Further, they have to plan to sell their house with enough warning to do tests and have mitigation work done, which can easily take six months and needs to be over the winter. If buyers test and mitigate they may have to absorb the cost. Theoretically, banks might allow financing for a "mortgage plus improvements" but this does not protect them from a real estate market that does not fully recognize or value radon. Absent formal state regulation requiring sellers to test and mitigate a third option is proposed. A "Radon Indicator/Assessment" process involves an initial short term radon test, and allocation of money into a special account if results reach a certain level (CARST suggests 75 Bq/m^3). Follow up long-term test conducted during the first winter after new owner moves in then lead to a determination as to whether to use the money to mitigate or give it back to the seller. This is a form of radon contingency clause that is used in many jurisdictions.

In a typical radon contingency clause the parties establish a standard, typically that recommended by national guidelines (by the EPA in the US, for instance). The seller agrees to take remedial action or potentially lose the sale if tests determine that radon levels exceed this. If the estimated mitigation costs exceed the predetermined amount, the seller can also credit the buyer.[230] Academic scholarship from the United States has recommended such clauses, arguing that they have had the effect of forestalling litigation.[231] A common approach in the United Kingdom is the use of a Radon Retention Bond (as described in more detail in Appendix 1). Such a bond is worked into the agreement entered into by the buyer and seller of a home. The bond is retained by the purchaser and held in trust, e.g., by a lawyer. After the home is purchased, a radon test can be done and the bond can pay for radon mitigation, if it is necessary. If not, the funds are returned to the seller. This approach ensures that a proper long-term radon test is done, a step that may be impractical during the time available when the home is being offered for sale, and avoids any chance of the seller tampering with the test to avoid the consequences of a high result.[232]

Both the New Brunswick Realty Association and the Real Estate Council of Alberta suggest this as a possible route. In New Brunswick: "A Buyer may ask for a clause stating that the seller agrees to put a negotiated amount in trust with the Buyer's attorney towards the cost of a radon monitoring report, and/or the cost of mitigation should the testing have to be completed after the

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[229] Warkentin, P. and Curry, E. 2018. Radon and Real Estate Tool Kit. Presentation to the Canadian Association of Radon Scientists and Technologists Annual Conference. April 24, 2018. available at http://www.carst.ca/resources/Conference%202018/Presentations2018/Real%20Estate%20presentation%20-%20Conference%202018.pdf accessed May 15, 2018.

[230] A model form from Virginia can be found here: http://www.virginiamls.com/forms1/contingency-clauses.pdf Accessed April 11, 2018; and from Michigan, here: https://www.realestateindc.com/sites/default/files/1332%20-%20Addendum%20of%20Clauses%20-%20512.pdf accessed April 11, 2018

[231] King, R.D., 1993. Legal Implications of Residential Radon Contamination: The First Decade. Wm. & Mary J. Envtl. L., 18, p.107. p. 162

[232] BRE Global, 2018. Frequently Asked Questions About Radon. https://www.bre.co.uk/page.jsp?id=3150#buying4

sale closes, with funds only dispersed after documentation of the mitigation being completed. If radon testing is not above 200 Bq/m^3, the balance of funds in trust would then be returned to the Seller. This clause may cause concern with some financial lenders."[233] The Real Estate Council of Alberta suggests to prospective buyers, where the seller has not tested for radon that they consider including in an offer to purchase a holdback term for the offer that contemplates reliable testing and mitigation, as necessary (but to be sure to provide for an alternative in the event the seller does not agree to a holdback provision).[234]

The New Brunswick Real Estate Association (NBREA) also requires that realtors take a radon course that teaches them about the dangers of radon as well as the different radon mitigation methods. In addition to this training it is now required that both the seller's and the buyer's realtor mention radon during the course of a real estate transaction.[235]

4.4.5 Notice on title

There are various forms of provincial legislation that allow for the filing of a notice on property, alerting potential purchases. City governments, for instance, might be required by provincial legislation to file in provincial Land Title Office a notice of development permit or variance permit[236], and under divorce proceedings one spouse can file a notice of interest against property.[237]

We have not seen that this has ever happened with respect to radon, but there are a number of distinct possibilities. In what follows we did not attempt to do a cross Canada survey, but only supply illustrative examples. Given that we found no evidence of such notices being put on title or in registries this discussion pertains only to the possible rather than actual practice.

(i) **Public health hazards.** In some provinces public health legislation allows for health authorities to file a notice of health hazard at the Registrar of Land titles: in Alberta[238], British Columbia[239] and Saskatchewan[240]. These provide that where an order is issued, the regional health authority may file a notice of the health hazard with the Registrar of Land Titles.

(ii) **Bylaw infraction notices**. Provincial statutes that lay out municipal powers may allow bylaw infractions to be registered. British Columbia's *Community Charter* provides at s. 57 that local governments can go through a process to register a notice, via the Land

[233] New Brunswick Real Estate Association, 2018. I am selling my house. What should I know about Radon? http://nbrea.ca/i-am-selling-my-house-what-should-i-know-about-radon/ see also New Brunswick Real Estate Association, 2018.I am buying a home. What do I need to know about Radon?http://nbrea.ca/i-am-buying-a-home-what-do-i-need-to-know-about-radon/
[234] Real Estate Council of Alberta - radon bulletin. Online at: https://www.reca.ca/industry/legislation/information-bulletins/radon.html
[235] Personal communication, Health Canada Regional Radiation Specialist, Atlantic Canada (June 25-28, 2018).
[236] c.f. Local Government Act, RSBC 2015, c 1, section 503(1)
[237] Family Law Act, S.B.C. 2011, c. 25, section. 99
[238] Public Health Act, RSA 2000, c P-37, s.64 (1)
[239] Public Health Act, SBC 2008, c 28, s 3
[240] Public Health Act, SS 1994, c P-37.1, s. 29(1).

Title Office registrar, on the title of a property where there is or has been a building code or bylaw infraction, including where a permit is not held in good standing. We find similar provisions for Saskatchewan[241] and the City of Winnipeg.[242] In section 5.2 we discuss how some cities are beginning to put radon testing and mitigation into their bylaws.

(iii) **Zoning conditions**. In some cases municipalities can attach conditions onto zoning, Ontario's *Planning Act* allows that where this happens the owner of the land and the municipality can enter into agreements relating to the conditions, and register this at the Land Registry.[243] In section 5.1 we discuss how cities could do this with respect to radon.

Environmental Site Registries. A number of provinces have Site Registries for environmentally or contaminated sites, allowing notice of site conditions, corrective action plans, site assessments, and environmental protection orders, available for public review. Examples include Manitoba [244] British Columbia[245] Saskatchewan [246] Ontario [247] PEI[248] Yukon.[249] This will depend on whether radon can be captured under provincial Environmental Management laws: While we found no evidence that this route has ever been taken in Canada we did not see that it could not be used for identifying locations with very high radon potential or where Public Health agencies have ordered mitigation.

4.4.6 Third-Party Certification of Buildings

Buyers can also seek out homes that are third-party certified. A number of different systems certify builders and buildings, informing potential buyers of the environmental stewardship or health and wellness characteristics of new buildings.

The best known "green building" label is LEED (Leadership in Energy and Environmental Design). It is recognized in over 160 countries. Since 2004, the Canadian Green Building Council (the Canadian LEED administrator) has certified over 3,300 LEED buildings in Canada and registered over 7,800.[250] LEED certification shows that builders used a range of strategies aimed at achieving high performance in key areas of human and environmental health: location and transportation, sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality. LEED has several rating systems to meet the needs of different building and project types – both for new construction and renovations. Each LEED rating system consists of prerequisites and credits. Prerequisites are required elements, or green

[241] The Municipalities Act, SS 2005, c M-36.1 (s. 364(5))
[242] The City of Winnipeg Act, SM 1989-90, c 10 section 490.1
[243] Planning Act, RSO 1990, c P.13 section 34(1) 16.2
[244] The Contaminated Sites Remediation Act, CCSM c C205 section 7(1)
[245] Environmental Management Act, SBC 2003, c 53 section 43
[246] Environmental Management and Protection Act, 2010, SS 2010, c E-10.22
[247] Ontario Regulation 153/04 Records of Site Condition, under the Environmental Protection Act, section 8.
[248] Contaminated Sites Registry Regulations, PEI Reg EC656/06
[249] Contaminated Sites Regulation, YOIC 2002/171
[250] Canada Green Building Council, 2018. LEED.
https://www.cagbc.org/@/CAGBC/Programs/LEED/Going_green_with_LEE?hkey=54c44792-442b-450a-a286-4aa710bf5c64

building strategies that must be included in any LEED certified project. Credits are optional elements, or strategies that projects can elect to pursue to gain points toward LEED certification.

Radon mitigation is considered an important component of Indoor Environmental Quality[251] and radon resistant construction is a prerequisite for single family houses, and multi-family midrises.[252] However, radon is not considered for commercial and institutional buildings. [253] The prerequisite has previously called for passive sub-slab depressurization with the ability to add active ventilation if and when it is confirmed to be needed.[254]Active depressurization was given 1 point as a credit.[255] LEED Standard v.4 recommends following the techniques prescribed in USEPA *Building Radon Out* and other comparable sources. EPA *Building Radon Out* is calibrated to USEPA standards 4.0 pCi/L (148 Bq/m^3). It recommends a passive sub-slab depressurization system, with further testing and upgrading with a fan to active sub-slab depressurization if necessary.[256] For multifamily homes in high radon risk areas there is a requirement for testing every five years.[257] Cities in Canada that have been proven to have an average radon concentration of 4 pCi/L (148 Bq/m^3) or less through testing in accordance with the Health Canada Guide for Radon Measurements in Dwellings (with a minimum of 50 tests) are exempted from the radon requirements of this prerequisite.[258]

Another third-party certification that addresses radon is the WELL Building Standard launched in October 2014, and described as '…the world's first building standard focused exclusively on human health and wellness. It marries best practices in design and construction with evidence-based medical and scientific research – harnessing the built environment as a vehicle to support

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[251] LEED v4: Reference Guide for Homes, Design and Construction. Available at https://www.usgbc.org/sites/all/assets/section/files/v4-guide-excerpts/Excerpt_v4_HOMES.pdf at p. 364

[252] LEED v4 for Homes Design and Construction Includes LEED BD +C for Multifamily Lowrise and LEED BD +C for Multifamily Midrise at https://www.usgbc.org/sites/default/files/LEED%20v4%20ballot%20version%20(Homes)%20-%2013%2011%2013.pdf accessed May 21, 2018 p. 83

[253] LEED v4 for Building Design and Construction, Updated April 6, 2018 Includes: LEED BD+C: New Construction
LEED BD+C: Core and Shell, LEED BD+C: Schools. LEED BD+C: Retail, LEED BD+C: Data Centers, LEED BD+C: Warehouses and Distribution Centers LEED BD+C: Hospitality, LEED BD+C: Healthcare. available at https://www.usgbc.org/sites/default/files/LEED%20v4%20BDC_04.6.18_current.pdf accessed May 21, 2018.; LEED v4 for Interior Design and Construction, Updated April 6, 2018, Includes: LEED ID+C: Commercial Interiors LEED ID+C: Retail LEED ID+C: Hospitality available at https://www.usgbc.org/sites/default/files/LEED%20v4%20IDC_04.6.18_current.pdf, accessed May 21, 2018

[254]LEED Canada for Homes,2009. https://www.cagbc.org/cagbcdocs/LEED_Canada_for_Homes_2009_RS+addendum_EN.pdf at 9.1

[255] ibid at at 9.1

256 .Environmental Protection Agency, 2001. Building Radon Out. EPA/402-K-01-002 available at https://www.epa.gov/sites/production/files/2014-08/documents/buildradonout.pdf accessed May 15, 2018..

257 LEED v4 for Building and Operations Maintenance, Updated January 5, 2018, Includes: LEED O+M: Existing Buildings LEED O+M: Schools LEED O+M: Retail LEED O+M: Data Centers LEED O+M: Hospitality LEED O+M: Warehouses and Distribution Centers LEED O+M: Multifamily available at https://www.usgbc.org/sites/default/files/LEED%20v4%20EBOM_01.5.18_current.pdf, accessed May 21, 2018. at p. 72.

258 (LEED v4 Canadian Alternative Compliance Paths (ACPs) As of June 24, 2014 https://www.cagbc.org/cagbcdocs/leed/LEED%20v4%20Canadian%20ACP%20Language-as%20of%202014-06-24.pdf

human health and wellbeing.'[259] The standard states that radon levels are not allowed to be higher than 4 pCi/L (or 148 Bq/m3) at the lowest occupied level.[260] The radon requirement in WELL is applicable to all project types, including residential buildings, office buildings, schools, and other institutional buildings. WELL is administered by the International WELL Building Institute (IWBI), a public benefit corporation. It is third-party certified by Green Business Certification Inc. (GBCI), which administers the Leadership in Energy and Environmental Design (LEED) program, and WELL is designed to work in conjunction with LEED. The Canada Green Building Council promotes WELL.[261]

Several other third-party certification systems that do not specifically mention radon include Built Green Canada, Passive House, and the Living Building Challenge.

Built Green Canada is a non-profit organization that works with builders interested in responsible sustainability practices in the residential building sector. In Ontario, the programs are referred to as "Green Seal". Among multiple areas for certification of residential construction, radon is not mentioned.[262]

Likewise, Passive House (Passivhaus) describes itself as the most rigorous voluntary energy-based standard in the design and construction industry.[263] The formal standards do not mention radon[264] although it is mentioned in particular case studies. Svartbäcksvägen 11 in Bagarmosse, Stockholm, Sweden, is an energy retrofit case study of a concrete block villa from the 1950's that relies on a simple membrane system or "radon-shield" rather than passive or active depressurization.[265] Some Passive House practitioners acknowledge that the claims to balanced ventilation and airtightness do not do enough, and that air leakage permitted by the Passive House standard can allow substantial amounts of radon to infiltrate a home.[266] A pilot study from Belgium confirms that some passive houses continue to have radon problems. [267]

259Gray, W. et al. 2015. Canada and the WELL Building Standard. Sustainable Architecture and Building Magazine, September 1, 2015. available at https://www.wellcertified.com/en/articles/canada-and-well-building-standard accessed April 11, 2018.

260 See, the WELL Building System v. 01 , Part 3, Below-Grade Air Quality Standards, at p. 28 available at https://www.wellcertified.com/sites/default/files/resources/WELL%20Building%20Standard%20-%20Oct%202014.pdf

261 The Canadian Green Building Council, 2008. CaGBC® and the WELL Building Standard™ in Canada. https://www.cagbc.org/CAGBC/Programs/WELL_Building_Standard/The_WELL_Building_Standard.aspx

262Built Green Canada, 2018. Indoor Air Quality. Available at http://www.builtgreencanada.ca/iii-indoor-air-quality accessed May 21, 2018.

263 Passive House Canada, 2018. About. at http://www.passivehousecanada.com/about-passive-house/ accessed May 15 2018

264 http://www.passiv.de/downloads/03_building_criteria_en.pdf

265 https://www.passipedia.org/planning/refurbishment_with_passive_house_components/thermal_envelope/floor_replacement_svartbaecksvaegen?s[]=radon

266 Honig, P. 2015. Radon and a Passive House. Green Builder Advisor. Feb 15, 2015. available athttp://www.greenbuildingadvisor.com/blogs/dept/guest-blogs/radon-and-passive-house#ixzz5DKrjx7pZ. Accessed April 21, 2018.

267 Poffijn, A., Tonet, O., Dehandschutter, B., Roger, M. and Bouland, C., A Pilot Study on the Air Quality in Passive Houses With Particular Attention to Radon https://pdfs.semanticscholar.org/398e/d093c562794505d2f2366020165dc5aaec7c.pdf

The green building certification and sustainable design approach in the Living Building Challenge tends to be stricter than LEED in many respects (such as energy use and carbon emissions) but the most recent iteration makes no explicit reference to radon.[268]

Finally, while not a certification program for homes/buildings there is the Canadian – National Radon Proficiency Program (C-NRPP) providing a certification program that establishes guidelines, training and resources for the provision of testing and mitigation services by radon professionals. The C-NRPP is discussed in Section 3.3 above.

4.5 Occupier's liability

While the preceding sections document some limited provisions relating to workplace safety and predominantly new buildings, few if any laws exist of general application that cover the majority of homes or apartments in Canada. As Dunn and Cooper (2014) emphasize "no provincial laws were specifically drafted to regulate radon in indoor air".[269] Especially in the case of persons who rent— and who have little ability to influence landlords where there are no legal requirements—there are few options.

Renters also face various problems with "split incentives". If the landlord buys and supplies all of the components of a home, they have an incentive to do so at the lowest possible cost. Alternatively, the tenant has various incentives (such as to have efficient energy heating and radon mitigation) but little control over the means to do so. There can also be a time element. Tenants often have no idea for how long they will reside in their current location. This uncertainty detracts renters from capital cost investments in their units. Household surveys typically show renters move every two years, with the result that they would incur much higher costs than owners if they were to fund their own upgrades.

Low-income tenants in private housing are particularly prone to these problems. Typical solutions are for the state to fund improvements (such as weatherization), impose direct regulation, or particular forms of agreement for landlord and tenant to share financing.[270] However, provinces have not incorporated explicit and hard minimum radon standards for renters or housing in general. Even where tenants can establish a legal claim absent a specific radon requirement, the expense and practical difficulties of bringing a case in court are often prohibitive. That said, there may be limited action for renters under occupier's liability, residential tenancies law and public health initiatives.

Under principles of occupier's liability a plaintiff can seek relief in the Courts if a hazard causes the plaintiff to suffer losses.[271] This suggests the possibility for substantial damages awards

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268 International Living Future Institute. 2016. Living Building Challenge 3.1: A Visionary Path to a Regenerative Future. available at https://access.living-future.org/sites/default/files/16-0504%20LBC%203_1_v03-With%20Crop%20Marks.pdf Accessed may 15, 2018.

[269]Dunn, B. and Cooper, K. 2014. Radon in Indoor Air: A Review of Policy and Law in Canada. Canadian Environmental Law Association. at p. 77

[270] Bird, S. and Hernandez, D., 2012. Policy options for the split incentive: Increasing energy efficiency for low-income renters. Energy Policy, 48, pp.506-514.

[271] MacLeod v. Yong, [1997] B.C.J. No. 2108 (S.C.), aff'd 1999 BCCA 249 (CanLII), 67 B.C.L.R. (3d) 355.

where plaintiffs can show on the balance of probabilities that their sickness or loss of employment income is attributable to radon exposure. As Dunn and Cooper (2014) review, the common law established general obligations of an "occupier"— a person in control of premises— to exert a duty of care. Liability could attach to occupier if a plaintiff could show: (1) the damage must have been caused by an unusual danger; (2) the danger must be one about which the occupier knew or ought to have known; (3) the occupier must have failed to use reasonable care to prevent the invitee's injury or damage from the unusual danger; and (4) the invitee must have employed reasonable care for his or her own safety and security. However, traditionally, at common law, no duty of care was owed by a landlord to his or her tenant.[272]

Provincial legislation sets up a statutory duty of care which the courts have ruled is a distinct duty from that of negligence at common law.[273] For instance, Ontario's Occupiers' Liability Act has a specific provision giving landlords a duty of care towards tenants, as well as any visitors.[274] BC's Act specifies that it applies to tenancies.[275] Courts have also suggested that in assessing what counts as an undue hazard, landlords should bear risk rather than tenants.[276] Further, the government is bound by the act, such as where it owns buildings or acts as a landlord—such as in social housing.[277] For instance, one can find cases where the Toronto Community Housing Corporation accepts a duty of care under occupier's liability[278], similarly with New Brunswick Housing.[279]

No cases were found that deal with radon, nor have there been significant changes to the law since 2014. We looked for and could not find successful cases on formaldehyde, lead-based paint and asbestos. However, the following factors suggest high radon concentrations might give rise to a successful claim.

(a) Other cases appear similar. British Columbia cases consider, inter alia: failure to install smoke alarms in residential premises[280] slip and fall due to absence of handrail on steep stairs[281] or snow and icing conditions[282] a faulty balcony railing which gave way leading to a three story plummet[283] an unlit and unguarded basement stairwell at the back of the residence at night resulting in the loss of vision in one eye.[284] insufficient locks leading to a sexual assault[285] to theft of goods[286] an unsecured planter that ultimately fell and hurt a

[272] Sythes and Co. Ltd. v. Gibsons Ltd., 1927 CanLII 41 (SCC), [1927] 2 D.L.R. 834 (S.C.C.). MacLeod v. Yong, 1999 BCCA 249 (CanLII), 67 B.C.L.R. (3d) 355
[273] Rendall v. Ewart (1989), 1989 CanLII 232 (BC CA), 38 B.C.L.R. (2d) 1 (C.A.).
[274] Occupiers' Liability Act, R.S.O. 1990, c. O.2 s. 8(1); Miaskowski v. Persaud, 2015 ONSC 1654 at para 16
[275] Occupiers Liability Act R.C.B.C 1996, c. 337 s. 6 (1)
[276] MacLeod v. Yong, 1999 BCCA 249 (CanLII), 67 B.C.L.R. (3d) 355; Tolea v. Ialungo, 2008 BCSC 395
[277] (For Ontario, see s. 10 (1)), with an exception for public highways or roads (s. 10(2)); for BC see s. 8(1)
[278] Hamilton v. Ontario Corporation #2000533 o/a Toronto Community Housing Corporation, 2017 ONSC 5467
[279] Hickey v. New Brunswick Housing Corporation, 2014 NBCA 36 (CanLII)
[280] Bueckert v. Mattison (1996), 1996 CanLII 6701 (SK QB)Daniels v. McKelvery, 2010 MBQB 18 (CanLII), Leslie v. S & B Apartment Holding Ltd., 2011 NSSC 48 (CanLII)
[281] McLeod v. Yong, 1999 BCCA 249 (CanLII)
[282] Hunter v. Anderson, 2010 BCSC 1037
[283] Jack v. Tekavec, 2010 BCSC 1773
[284] Zavaglia v. MAQ Holdings Ltd. (1986), 1986 CanLII 919 (BC CA), 6 B.C.L.R. (2d) 286 (C.A.
[285] Q et al. v. Minto Management Ltd. et al., 1985 CanLII 2103 (ON SC) upheld (1986), 1986 CanLII 2518 (ON CA), 57 O.R. (2d) 781

small child[287] a cracked sidewalk causing a broken ankle.[288] In Ontario cases consider falling dumb bells at a fitness club,[289] unsecured park benches[290] unsecured apartment garages allowing in attackers,[291] and dangerous bricks around a fire pit.[292] Across Canada there are also a few more specific cases that consider environmental health problems, including: faulty renovation procedures leading to release of heavy metals ;[293] use of chemical defoliants creating toxic areas of a military base[294] and mouldy housing affecting a First Nations reserve.[295]

(b) The test of reasonable foreseeability means that occupiers cannot hide behind ignorance of radon. There are positive obligations on occupiers to inspect. The onus on occupiers extends to inspecting the premises and that 'doing nothing at all' in the face of a known risk does not satisfy the standard of 'reasonable care'.[296] An occupier cannot passively rely upon lack of knowledge of the premises' condition, but has a positive duty to inspect and take whatever reasonable steps are necessary to ensure its premises are safe. Moreover, the courts will also consider whether an occupier has been provided with an indication as to potential risks of harm. Courts hold that the standard of reasonableness for each party must be determined according to their respective positions and responsibilities. The standard of reasonable inspection imposed on a landlord will likely be elevated above that imposed on a tenant where the landlord has observed the evolution of a residence through multiple tenancies and repairs and alterations; the landlord has the legal responsibility for maintaining and repairing the premises; and where the area of concern relates to a structural defect that existed prior to the current tenancy. The tenant's duty will likely be limited to the reporting of defects or damages discoverable by reasonable inspection in the circumstances, not apparent upon ordinary visual observation.[297] The courts may thus consider the particular features of radon— structural and hidden— and the extensive public outreach about, and testing for, radon conducted by the federal and provincial governments as well as the ease with which the risk could have been remedied.

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[286] Robertson v. Stang, 1997 CanLII 2122 (BC SC); Coueslan v. Public Storage Canadian, 2000 BCPC 137

[287] Klajch v. Jongeneel et al., 2001 BCSC 259, affirmed (on this point) Klajch (Guardian ad litem of) v. Jongeneel, 2002 BCCA 14 (CanLII)

[288] Kiceluk v. Oliverio, 2001 ABQB 704

[289] Sores v. Premier Fitness Clubs, 2011 ONSC 2220

[290] Doyle v. Petrolia (Town), 2003 CanLII 6577 (ON SC)

[291] Allison v. Rank City Wall Canada Ltd., 1984 CanLII 1887

[292] Taylor v. Allard, 2009 CanLII 10986

[293] MacIntyre v. Cape Breton District Health Authority, 2009 NSSC 202 (court finding breach of duty of care but not causation); affirmed MacIntyre v. Cape Breton District Health Authority, 2011 NSCA 3 (CanLII)

[294] R. v. Brooks, 2009 SKQB 509 duty of care found (at para 102) but certification falters on basis of lack of common class, affirmed R. v. Brooks, 2010 SKCA 55

[295] Grant v. Canada (Attorney General), 2009 CanLII 68179, class proceeding certification, duty of care under Occupier's Liability prima facie established at para 107

[296] Waldick et al. v. Malcolm et al., 1987 CanLII 4303 (ON SC) aff'd Waldick v. Malcolm, 1991 CanLII 71 (SCC), [1991] 2 S.C.R. 456

[297] Zavaglia v. MAQ Holdings Ltd. (1986), 1986 CanLII 919 (BC CA), 6 B.C.L.R. (2d) 286 (C.A.) Klajch (Guardian ad litem of) v. Jongeneel, 2002 BCCA 14 (CanLII), 174 B.C.A.C. 184, Tolea v. Ialungo, 2008 BCSC 395

(c) Courts impose an objective standard distinct from customary practices or existing building codes: What is reasonable depends on the context. Compliance with local custom is not determinative of whether a particular defendant met the requisite standard of care, and "the existence of customary practices which are unreasonable in themselves, or which are not otherwise acceptable to courts, in no way ousts the duty of care owed by occupiers" [298] The mere fact that a structure (such as a staircase) may be compliant with a building code, a building by-law or evidence as to industry standards, does not determine the question as to whether it was unsafe. That is a determination for the court on all the evidence. [299]

Assuming the courts accept a duty of care to remove high radon concentrations, plaintiffs will face a series of further challenges.

(a) **Causation**: Radon-induced cancer has a long latency period, and only in the rare case with indoor radon exposure stand out from other factors, such as genetics, smoking, diet, age, and other chemical exposures.[300] Causation is established where the plaintiff proves to the civil standard on a balance of probabilities that the defendant caused or contributed to the injury. The basic test for causation is the "but for" test, which requires the plaintiff to show that the injury would not have occurred but for the negligence of the defendant. [301] This applies to multi-cause injuries. The plaintiff bears the burden of showing that "but for" the negligent act or omission of each defendant, the injury would not have occurred. Having done this, contributory negligence may be apportioned (and provinces have specific legislation that provides for this).[302] Canadian courts have recognized that causation is established where the defendant's negligence "materially contributed" to the occurrence of injury. Courts impose liability under this test not because the evidence establishes that the defendant's act caused the injury, but because the act contributed to the risk that injury would occur. Recourse to a material contribution to risk approach is necessarily rare, justified only where it is required by fairness.[303]

(b) **damages.** The plaintiff will likely have to show actual harm (illness, loss of income etc.) Most jurisdictions follow the precedent established by centuries of Anglo-American tort law and deny recovery for "at risk" injuries absent physical harm or manifested disease. Canadians courts however are adamant that "the risk of a future disease is not

[298] Waldick v. Malcolm, 1991 CanLII 71 (SCC), [1991] 2 S.C.R. 456 at p. 474

[299] Musselman et al v. 875667 Ontario Inc. et al 2010 ONSC 3177, aff'd in: Musselman et al v. 875667 Ontario Inc. et al 2012 ONCA 41; see also Mott v. Brantford (City), 2008 CanLII 1948 (ON SC)

[300] Dearing, D. "Radon Litigation: An Overview of Homeowners' Potential Causes of Action", 20 Cumb. L. Rev. 825 1989-1990, p. 837-38; Cross, F., and Murray, P. 1988., Liability for Toxic Radon Gas in Residential Home Sales, 66 N.C. L. Rev. 687; Prussman,J. 1991. The Radon Riddle: Landlord Liability for a Natural Hazard B.C. Envtl. Aff. L.Rev. 715

[301] Athey v. Leonati 1996 CanLII 183 (SCC), [1996] 3 S.C.R. 458

[302] Resurfice Corp. v. Hanke 2007 SCC 7 (CanLII), [2007] 1 S.C.R. 333 at para 21, see also, e.g. Negligence Act, R.S.B.C. 1996, c. 333, section 1; Negligence Act R.S.O. 1990, c. N.1, section 1

[303] Clements v. Clements 2012 SCC 32 (CanLII), [2012] 2 S.C.R. 181 at para 15. There so few Canadian cases its better to look to United Kingdom law for precedent: see Fairchild v. Glenhaven Funeral Services Ltd., [2002] UKHL 22, [2002] 3 All E.R. 305; and Barker v. Corus UK Ltd., [2006] UKHL 20, [2006] 2 A.C. 572. Sienkiewicz v. Greif (UK) Ltd., [2011] UKSC 10, [2011] 2 All E.R. 857.

actionable in the absence of a present injury".[304] Likewise, Canadian courts appear unwilling to award damages for cost of medical surveillance in anticipation of cancer.[305] Courts will accept psychiatric illness[306] (for long labeled as 'nervous shock'[307] but now taken much more seriously[308]). It thus remains possible, but unlikely, that a Canadian court would find "cancerphobia" to meet this threshold.

(c) **Apportionment of responsibility and duty to mitigate**. Provincial Negligence statues provide for apportionment of liability for damages, and this can also include apportionment between multiple plaintiffs as well as between plaintiff and defendant. Courts can hold that plaintiffs contributed to damages by failing take reasonable care for their own safety.[309] For instance, if a seatbelt was available but not worn, the evidence must establish that it was operational and the plaintiff's injuries would have been reduced by usage to justify a finding of contributory negligence. Although there is no hard and fast rule as to apportionment in cases involving a successful seatbelt defence, the plaintiff is often held to be 10% to 25% contributorily negligent.[310] As such, a person who contracts lung cancer from both radon exposure and smoking is not thereby excluded from recovering due to radon exposure. However, the radon-related defendant (such as a builder) will not then be responsible for the full amount of compensation owed. Alternatively, defendants are likely to argue, and courts accept, that as between, say a builder and a tenant both of whom took no action to reduce radon exposure, that the plaintiff contributed to her problem. If both builder and tenant should have known about radon but failed to act, the courts are unlikely to put all the blame on the builder. This may well significantly reduce any damage awards.

Once the injury occurs, there continues to be a duty on the defendant to mitigate losses. It is well established that a plaintiff should not be able to recover damages which could have been avoided by taking reasonable steps.[311] Where there is an ongoing complaint, such as noise from a bridge that impacts on a hotel, the plaintiff should do more than merely protest, but also take stapes to abate.[312] The law requires the plaintiff makes contextually reasonable and sincere efforts to limit his or her damages and loss.[313] Radon affected plaintiffs then, might be held to account for allowing ongoing chromosomal damage that accrues once they become aware of a radon problem.

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[304] Dow Chemical Company v. Ring, Sr., 2010 NLCA 20 at para 58, citing Grieves v. F T Everard & Sons and others, [2007] UKHL 39.
[305] Dow Chemical Company v. Ring, Sr. (2010) 2010 NLCA 20
[306] Saadati v. Moorhead, [2017] 1 SCR 543, 2017 SCC 28
[307] Duwyn et al. v. Kaprielian (1978), 1978 CanLII 1271 (ON CA), 22 O.R. (2d) 736 at p. 755 (C.A.).Heighington et al. v. The Queen in right of Ontario et al. Alejandria et al. v. The Queen in right of Ontario et al., 1987 CanLII 4425 (ON SC),
[308] Saadati v. Moorhead, [2017] 1 SCR 543, 2017 SCC 28 at para 21
[309] Bradley v. Bath, 2010 BCCA 10 (CanLII), paras. 24-27
[310] Harrison v. Brown, 1985 CanLII 724 (BC SC), [1985] B.C.J. No. 2889 (S.C.); Thon v. Podollan, 2001 BCSC 194 (CanLII); Ford v. Henderson, 2005 BCSC 609 (CanLII).
[311] Jones v. Fabbi et al.; Jones v. Fleck et al., 1974 CanLII 1210 (BC SC) and Giesbracht (J.) & Sons Cranes Ltd. v. Saskatchewan Government Insurance, 1986 CanLII 3041 (SK QB),.Janiak v. Ippolito, [1985] 1 SCR 146, 1985 CanLII 62 (SCC).
[312] Osler Dev. Ltd. et al v. H.M.T.Q et al, 2001 BCSC 129 (CanLII)
[313] Qiao v. Buckley, 2008 BCSC 1782 (CanLII); Antoniali v. Massey, 2008 BCSC 1085

From the foregoing, it should be clear that tort action will face significant uncertainties and obstacles concerning: causation, whether the standard of care requires attention to radon when this was not in building codes at the time of construction or other legislation during the tenancy, and problems of cost of (uncertain) litigation in the face of uncertain, or not large, damages. Further, there are uncertainties how successful cases might advance radon regulation. Some defendants, such as governments and residential property holding companies, may well house persons for long periods, but many landlords see considerable turnover in tenants. They may thus simply be willing to take the chance that litigation remains unsuccessful. That said, it reminds possible for there to be a successful case although this canvassing of legal remedies also strongly underscores the value of prevention of harm vs reaction after it has occurred.

For a listing of Occupier's Liability law across provinces and territories, See Appendix 3.

4.6 Residential tenancies

4.6.1 Introduction

In surveying residential tenancies legislation across Canada,[314] possible routes for action are apparent. However, to date, use of these laws to address radon has not been widely pursued. Generally, landlords do not feel they are under any obligation to test and mitigate for radon, and tenants seldom use provincial and territorial residential tenancies institutions and organizations to pursue remedies concerning radon. For the most part provisions remain vague and open to the uncertain interpretation of residential tenancies commissions, tribunals or officers (as the case may be). While courts generally have the power to review tribunal decisions, they typically adopt a deferential attitude to the decisions of what are seen as expert, specialized tribunals. They thus will not overturn decisions that are a reasonable construal of the legislation. That said, our interviews did reveal some occasions where tenants complained to public health officials, and we found a number of cases where radon was raised before landlord-tenant tribunals. As the following will document, there are possible actions on radon before landlord-tenant tribunals and in some jurisdictions there are rental housing standards that allow for public health orders to be made for landlords to mitigate. Below we address actions based on general requirements to ensure homes are in a good state of repair, rights to quiet enjoyment, and minimum housing standards.

Residential tenancies systems across Canada are broadly similar, setting out necessary terms and procedures for interactions between landlords and tenants. While all residential tenancies legislation contain some provisions that touch on health, safety and other standards for units, this is by no means the central focus of residential tenancies law, concerned as it is, often with issues of tenant privacy, rent increases, security deposits, evictions and transparency in the contractual relationship. Provinces and territories differ considerably in terms of how tenants (and landlords)

[314] See Appendix 4 for a more detailed canvassing of provincial and territorial Residential Tenancies law and provisions that are relevant to radon.

can access the system, possibilities for intervention by public health officials, and the levels of detail in which health and safety standards are specified.

For the most part residential tenancies law is construed in terms of contractual relations between the landlord and tenant. As such the powers of residential tenancies tribunals is primarily that of deciding disputes between parties in relation to amounts of rent or when tenancies rightfully end (such as whether damage deposits or rent reductions are owed). Remedies (that might apply to the radon problem) thus tend to be restricted to orders for rent reduction, being able to vacate a tenancy earlier, or work orders. The latter could conceivably include installation of a mitigation system. In some cases, such as British Columbia, there are general provisions allowing for compensation and courts have recognized the overlap between residential tenancies and occupier's liability.[315] That said, we do think there is potential room for residential tenancies institutions and organizations to direct landlords to mitigate high radon residences. In some cases there are sufficiently robust Public Health and Housing Regulations that can offer renters protections. Notably in Alberta, a renter has been able to work with public health inspectors to have mitigation occur. (See further discussion at Section 4.6.5 and 4.8.2.) We also note that in many cases, municipal level bylaws may also provide room for action concerning tenants. While we do not attempt to capture local bylaws in this review, we do discuss some exceptional municipalities that have taken action on radon and discuss that in Section 5.

We found no general or specific provisions in any Canadian jurisdiction that calls on landlords to test for radon and communicate results to current or prospective tenants. This lack can be attributed to the overall inattention to radon in most legislation governing existing vs. newly built indoor spaces, and to the quasi private nature of the landlord-tenant interaction. The latter is reflected in the process of tenant inspections where aspects of *caveat emptor* remain. For instance, in British Columbia, rather than impose objective duties for landlords to report any problems, residential tenancies legislation provides for a formalized process of inspections with the landlord and tenant walking through the unit, noting any deficiencies and both signing a condition inspection report.[316] Details of what needs to be included might be closely specified in Regulations (such as directions to check window coverings or appliances) but these are limited to short term inspections and visual observation by the landlord and tenant. However, radon requires longer term testing than a short inspection can reveal. Further, in tight rental markets with low vacancies, tenants seldom have the ability to make demands not explicitly provided for in law.

The relative powerlessness of tenants and the disincentives they face to address radon, together with procedural obstacles and unclear law has led this to be a prime area for advocacy by radon action groups. In 2016 there were consultations concerning changes to the Ontario *Residential Tenancies Act*. Various organizations pushed for provisions relating to radon, including the Canadian Association of Radon Scientists and Technologists (CARST), the Ontario Lung Association, and the Canadian Environmental Law Association, buttressed by publicity from

[315] Zavaglia v. MAQ Holdings Ltd. (1986), 1986 CanLII 919 (BC CA), 6 B.C.L.R. (2d) 286 (C.A.) Klajch (Guardian ad litem of) v. Jongeneel, 2002 BCCA 14 (CanLII), 174 B.C.A.C. 184 Tolea v. Ialungo, 2008 BCSC 395
[316] Residential Tenancy Act S.B.C. 2002, c. 7 s. 23

Mike Holmes, a television home renovation celebrity.[317] The campaign focused on having radon testing be mandatory in all residential tenancies; for mitigation to be mandatory where radon levels are above 200 Bq/m^3; test results to be made available to all tenants upon request; and, property disclosure statements to disclose whether there is a known presence of radon in homes at the time of sale or transfer of real property. Unfortunately these did not make it into legislation.[318]

4.6.2 Maintenance and good repair obligations

All provincial and territorial residential tenancies legislation contain general terms around landlords having a responsibility to maintain residences, and generally use language of a good state of repair and fit for habitation and for complying with health, safety, housing and maintenance standards.[319] (This language is used even when the residential tenancies legislation provides no accompanying standards). We think this is a sufficient basis for action on radon mitigation, at least where levels may exceed Health Canada Guidelines. We believe that were renters to be better acquainted with radon and have ready access to radon testing, more cases would be heard and be likely to be successful.

In one case, radon appears to have been an important factor in a successful tenants' action. In the Ontario case of *CET-67599-17 (Re)*[320] (the 'Tenant') applied for an order determining that the Landlord failed to meet the maintenance obligations under the RTA, or failed to comply with health, safety, housing or maintenance standards. The 78 years old tenant was not living in the unit at the time of application, but was undergoing cancer treatment and living with relatives. He argued that he experienced seizures because of the condition of the unit and claimed several repair issues, submitting an Inspection Report from a Property Inspections company. The Board held that the evidence demonstrated structural issues with the roof and crawlspace including the risk or radon gas permeating the rental unit. Therefore, a 100% rent abatement was warranted until repairs were complete including ensuring radon did not permeate the unit.

As well, there are series of cases before Québec's Régie du logement that deal with radon. While these were not ultimately successful, in each case the issue before the court was not whether radon was problematic, but whether high radon levels had been proven by the tenant.

(i) In *Duff Conacher c. National Capital Commission* (2006) [321], Administrative Judge Pierre Thérien ruled that the very high radon levels (between 680 Bq/m^3 and 1,280

[317] Canadian News Wire, 2016. Mike Holmes Asks Ontario Residents to Push for Mandatory Radon Testing. June 29, 2016 available at https://www.newswire.ca/news-releases/mike-holmes-asks-ontario-residents-to-push-for-mandatory-radon-testing-584890761.html accessed April 15, 2018

[318] Testimony of Bob Wood,: Standing Committee on General Government - 2017-May-09; http://www.ontla.on.ca/web/committee-proceedings/committee_transcripts_details.do?locale=en&Date=2017-05-09&ParlCommID=8998&DocumentID=32241; Warkentin, P. 2017. CARST/ACSTR & Lung Association-Ontario Urges Wynne Government To Protect Residential Tenants/Homeowners Lungs. available at http://www.carst.ca/carstblog/4766058 accessed April 15, 2018.

[319] c.f. Residential Tenancies Act, 2006, SO 2006, c 17 section 20

[320] CET-67599-17 (Re), 2017 CanLII 60362 (ON LTB), <http://canlii.ca/t/h5xxj>, retrieved on 2018-03-02

[321] Duff Conacher c. National Capital Commission , file 22-051117-006G; 22-060118-001T-060227 decision of 28 September 2006, cited in Barak c. Osterrath, 2012 CanLII 150609 (at para 114)

Bq/m^3) constituted a "serious threat", triggering article 1913 CcQ. ('unfit for habitation').

(ii) In *Barak c. Osterrath*, (2012) [322] the plaintiff lived in Chelsea, a township well known to have high radon levels. He claimed $ 3,400 for exposure to radon and uranium contaminated water; $169.58 for the purchase of clean water; $ 8,000 in punitive damages against the landlord, for having knowingly failed to inform the tenants of the presence of the contaminants compromising their integrity and safety and other damages. The tenant was able to conduct his own radon test over 7 days in April 2009 and found a concentration of 400.8 Bq/m^3. The Régie noted that this result was double what is considered acceptable by Health Canada (at para 49).The landlord's own tests showed 125.1 Bq/m^3 and the Régie found the tenant had not followed Health Canada testing guidelines. The administrative judge held that the presence of a contaminant does not automatically lead to a polluted environment, but rather only does so if the concentration is above regulatory standards or prohibited by government regulation (at para 121).

(iii) In *Bonin c. National Capital Commission* (2013)[323] the issue was whether the National Capital Commission could demolish a rental house in Gatineau Park (town of Chelsea, north of Hull, Quebec). A variety of factors and major repairs were cited to support the need for demolition, including the presence of radon that exceeded Health Canada standards and the associated costs of mitigation (i.e. the installation of a water treatment system at the well, continued maintenance and surveillance of the air and underground). The Superior Court of Quebec maintained the initial decision of the Régie that demolition was acceptable and denied the plaintiff's (tenants) claims.

(iv) In *Pickard c. Arnold* (2015)[324] the plaintiff asked the Régie for damages at $ 7,304.70 as rent reduction given the presence of radon in the dwelling. The landlords, however, hired a consulting engineer who concluded that the measurement period used by the tenant was too short to draw conclusions on an excess of radon. The Régie Tribunal denied the plaintiff's claims based on the expert's conclusions.

(v) In *Bramley c. Vanwynsberghe* (2017)[325] the tenants vacated earlier than the term of their lease and the landlord sought damages for less of rent. The tenants, however, argued they left due to radon concerns. In prior communications with the rental agent, the tenants had asked that the landlord complete two tests, one in the short term and the other in the long term, as a condition of renting. After some negotiation, the landlord and tenant agreed that the tenants would complete the tests and if levels were too high, the tenants would have the right to terminate the lease at no expense and to be refunded for any rent remaining beyond the departure date.. The Tribunal recognized the importance and relevance of the Health Canada radon guidelines, but was faced with conflicting test

[322] Barak c. Osterrath 2012 CanLII 150609
[323] Bonin c. National Capital Commission, 2013 CanLII 122747 (QC RDL)
[324] Pickard c. Arnold, 2015 CanLII 129833
[325] Bramley c. Vanwynsberghe, 2017 QCRDL 11313

results and concluded radon levels were not problematically high. The tenants were deemed to have left without right and ordered to pay damages.

4.6.3 Quiet enjoyment

Further guidance might be taken from interpretation of the principle of quiet enjoyment. This is a common law principle and exists prior to, and independent of statutory wording. A breach of the covenant of quiet enjoyment is a breach of a material term of the tenancy agreement.[326] For an act to breach the covenant, it must substantially interfere with the resident's quiet enjoyment, restricting the tenant's ability to use their residence in an ordinary lawful way, that is, it "must be of such severity that the premises become "untenable"— uninhabitable as a residence".[327] Most residential tenancies legislation incorporates aspects of this idea, although it does also, at times undergo significant shift in meaning. For instance, Nova Scotia's RTA provides that a statutory condition of the landlord tenant agreement include "Good Behaviour—A landlord or tenant shall conduct himself in such a manner as not to interfere with the possession or occupancy of the tenant or of the landlord and the other tenants, respectively".[328] Even here, it might be reasonably argued that building design is under the control of, and so is a question of the conduct of, landlords.

A succession of cases across Canada have honed in on second hand smoke as a breach of such enjoyment, particularly given that clear evidence exists of an association between cigarettes and second hand smoke with lung cancer, suggesting ways it might be extended to apply to radon.

i. In *Hassan v Niagara Housing Authority*,[329] the Ontario Divisional Court held that a landlord has a positive obligation to provide a tenant with quiet enjoyment, as such one tenant wafting cigarette and marijuana smoke interfered with another's reasonable enjoyment of his premises.

ii. In *Feaver v. Davidson*, 2003 a landlord sought to evict a tenant whose smoke was upsetting the landlord.[330] The tribunal accepted the Health Canada's opinion that increasing ventilation will dilute smoke in a room, but will not make it safe since there is no known safe level of exposure to the carcinogens in cigarette smoke. The fear of the threat posed by second-hand smoke was found to be sufficient to warrant a breach of quiet enjoyment: If the tenant did not stop smoking in his unit, an eviction order would be justified.

iii. In 2010, the BC Supreme Court in *Lawrence v. Kaveh*, (2010) held that it is "conceivable that the exposure of a tenant and her children to second hand smoke, with all of the associated health risks, could interfere with quiet enjoyment or breach the tenant's right to be free from unreasonable disturbance". The Court found that the Dispute Resolution Officer's

[326] Lawrence v. Kaveh, 2010 BCSC 1403 (CanLII), see also the extensive discussion Y.A., Y.E., S.A. & B.A. v Regina Housing Authority, 2017 SKORT 75, upheld Regina Housing Authority v Y.A., 2018 SKQB 70
[327] Y.A., Y.E., S.A. & B.A. v Regina Housing Authority ibid. para. 95)
[328] Residential Tenancies Act R.S.NS. 1989, c. 401 sec. 9 (1)(3)
[329] Hassan v Niagara Housing Authority (February 5, 2001), Hamilton Docket No.99-002412-DV [2000] O.J. No.5650 (Div Crt),
[330] Feaver v. Davidson, 2003 CarswellOnt 4189, [2003] O.H.R.T.D. No. 103

failure to consider this at first instance, and her basis for rejecting the existence of an implied term prohibiting smoking in the rental unit constituted errors that were patently unreasonable.[331]

iv. In *TST-38271-13 (Re),*[332], the Ontario Landlord and Tenant Board awarded a rent abatement to a tenant as a result of experiencing second hand smoke.

v. In *TNT-83545-16 (Re),* another successful case, the Ontario Landlord and Tenant Board concluded that "having to live with the constant smell of second-hand smoke, and particularly cigarette smoke that is hazardous to one's health, amounts to substantial interference with reasonable enjoyment".[333]

vi. The above cases (and others) were extensively canvassed in a recent case before the Saskatchewan Office of Residential Tenancies. It is an interesting case as it was carefully argued by activist lawyers. In *Y.A., Y.E., S.A. & B.A. v Regina Housing Authority* three tenants with the Regina Housing Authority suffered from second-hand smoke intrusion into their suites.[334] The case was carried by Carly Romanow, Staff Lawyer at Pro Bono Law Saskatchewan, who was able to bundle a number of cases together and marshal considerable case law, reports of scientific opinion, and expert witnesses from the Canadian Cancer Society and Lung Association.. As well, each of the tenants had sensitivities to second hand smoke, such as allergies, and could back this up with doctor's letters, and had taken pains to put the Housing Authority on notice of the problem. Cotter, A.M. for the Office of Residential Tenancies cited public health information from Health Canada, the US EPA and the World Health Organization as to the dangers of second hand smoke. Cotter also argued that the covenant of quiet enjoyment existed in common law and as such "explicit legislation is not necessary"[335]. Extensive rate abatements— to two thirds of the rent-- were granted for the duration of the tenant's time in the units.

In addition to smoke-related cases, the Northwest Territories has distinct clauses concerning a tenant's quiet enjoyment and landlords quiet enjoyment. In *Northwest Territories Housing Corporation v Porter*, 2015 CanLII 80110 (NWT RO) the rental officer found the tenant had breached the landlords quiet enjoyment by incorrectly using a fan leading to mould growth.

These cases suggest that proven health hazards, such as second hand smoke, radon, and mould conflict with quiet enjoyment.

4.6.4 Case law and limited review

In Canadian superior courts, judges are bound to follow common law principles and statutory interpretation laid down by prior decisions and higher courts—the principle of *stare decisis*.

[331] Lawrence v. Kaveh, 2010 BCSC 1403 (CanLII)
[332] TST-38271-13 (Re), 2013 CanLII 51007 (ON LTB),
[333] TNT-83545-16 (Re) 2016 CanLII 72018 (ON LTB) at para 11.
[334] Y.A., Y.E., S.A. & B.A. v Regina Housing Authority 2017 SKORT 75, upheld Regina Housing Authority v Y.A., 2018 SKQB 70
[335] Y.A., Y.E., S.A. & B.A. v Regina Housing Authority ibid. at para. 92)

However, Residential Tenancy Boards, Tribunals, Commissions and Officers do not necessarily work this way. Residential Tenancies tribunals are administrative tribunals, and unlike courts are not strictly bound by *stare decisis* (i.e., following legal precedents). In an effort to ensure ease of access for lay people, decisions rarely work through complex legal analysis. Further, only rarely do decisions draw on decisions from other provinces. Some tribunals, such as in Newfoundland, Nova Scotia, Alberta, do not even publish decisions, making it difficult for tenants or landlords to cite important past decisions.

Further, superior courts are wary of imposing their own standards on specialized tribunals. Since 2008, and the Supreme Court of Canada decision in *Dunsmuir*[336] courts outside of British Columbia apply a "reasonableness standard" to decisions of the Residential Tenancies Boards.[337] This means that courts will show considerable deference, and not overturn Board decisions unless "there is no line of analysis within the given reasons that could reasonably lead the tribunal from the evidence before it to the conclusion at which it arrived."[338] This means that in practice it is unlikely for a superior court to establish a principle (such as interpreting high radon concentrations as infringing on quiet enjoyment) and impose that on residential tenancy tribunals. In British Columbia, the courts look to the 'privative clause' in the RTA at section 84.1 that provides that "The director has exclusive jurisdiction to inquire into, hear and determine all those matters and questions of fact, law and discretion arising or required to be determined in a dispute resolution proceeding" and that "A decision or order of the director on a matter in respect of which the director has exclusive jurisdiction is final and conclusive and is not open to question or review in any court". The courts interpret this as imposed "patently unreasonable" standard[339]—i.e., only if a judgement is exercised arbitrarily or in bad faith, exercised for an improper purpose, based entirely or predominantly on irrelevant factors, or fails to take statutory requirements into account will courts intervene.[340]

Nonetheless, new decisions concerning radon can be expected to have some effect. Most Tribunals, Boards, and Commissions do hve publicly accessible databases of past decisions, and hearing officers will receive and use past decisions in forming their reasons. This is also a matter that has concerned the courts and is discussed at length by the Alberta Court of Appeal in *Altus Group Limited v. Calgary (City)*, 2015.[341] Strictly speaking, an administrative tribunal is not bound by its previous decisions or the decisions of its predecessor. Where numerous reasonable interpretations exist, the administrative tribunal may change its consensus or policy with respect to which one it will adopt. However, respect for prior arbitral decisions is not simply a nicety to be observed when convenient. Where arbitral consensus exists, it raises a presumption that subsequent arbitral decisions will follow those precedents. Consistent rules and decisions are

[336] Dunsmuir v. New Brunswick, 2008 SCC 9 (CanLII), [2008] 1 S.C.R. 190
[337] First Ontario Realty Corporation Ltd. v. Deng, 2011 ONCA 54 (CanLII), 330 D.L.R. (4th) 461, at para. 21, Onyskiw v. CJM Property Management Ltd., 2016 ONCA 477 (CanLII), 349 O.A.C. 253, at para. 31, Morguard Residential v Asboth, 2017 ONSC 387 para 33
[338] Law Society of New Brunswick v. Ryan, 2003 SCC 20 (CanLII), [2003] 1 S.C.R. 247, at para. 55; Dunsmuir v. New Brunswick, 2008 SCC 9 (CanLII), [2008] 1 SCR 190, North Avenue Road Corporation v Travares, 2015 ONSC 6986 at para 18
[339] by working of s. 58 (2) of the Administrative Tribunals Act, see Schaper v. Beachamp, 2011 BCSC 833 (CanLII), upheld on appeal at 2012 BCCA 208 (CanLII), see also Bennett v. Wamboldt, 2012 BCSC 1251
[340] s. 58 (3) of the Administrative Tribunals Act
[341] The following paraphrases Altus Group Limited v Calgary (City), 2015 ABCA 86 at para 16 to 18

fundamental to the rule of law. The demand of predictability, objectivity, and impersonality in arbitration require that rules which are established in earlier cases be followed unless they can be fairly distinguished or unless they appear to be unreasonable. Further, many residential tenancies processes have provisions for decisions to be made in provincial court or for appeals in court to involve new hearings and so findings of law.

4.6.5 Public health and housing regulation

In some cases, residential tenancies legislation contemplates or references a series of independent standards. These might be included in the legislation itself, as part of regulation enabled by the Act, or in Public Health legislation and its associated regulations. For instance, in Alberta, section 16 of the RTA states (in part) that premises will meet at least the minimum standards prescribed for housing premises under the *Public Health Act* and regulations. In turn, *The Housing Regulation* [342] contains a number of provisions covering rental housing. There are further *Minimum Housing and Health Standards*. Significantly, the *Housing Regulations* and the *Minimum Housing and Health Standards* are enforced by inspections of housing premises by Public Health Inspectors/Executive Officers of Regional Health Authorities on a systematic or complaint basis. The result is that in some cases, tenancy issues around habitability are handled as prosecutions for violation of the *Health Act* and *Regulations* in provincial court. [343] Moreover, the Court of Queen's Bench of Alberta has an inherent power to grant injunctive relief to prevent ongoing breaches of the *Health Act* and its regulations, providing renters and public health officials with a unique avenue of redress.[344] Actions may be taken by public health officials to address problems with standards, and subsequent procedures may be initiated by tenants under the RTA to seek abatement of rent, early termination and other issues relating to the landlord tenant relationship. [345]

Alberta Health Services has ordered radon mitigation and developed a guidance document on radon in rental accommodation. Inspectors can draw on general nuisance clauses in the *Public Health Act* (at s. 59 to 61) and the *Nuisance and General Sanitation Regulation*, Alta Reg 243/2003. "Nuisance" is 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)). In one case in Calgary, inspectors responded to a renter's complaint, worked with the renter to complete tests and ordered the landlord to mitigate. Out of this process a Standard Operating Procedure has been drafted, but remains unavailable to the public. Interviews with the public health official involved show this was made possible by the fact the official had taken specific radon mitigation training. While specific provisions in the *Housing Regulation* and *Minimum Health and Housing Standard* were contemplated none were felt specific enough to offer the requisite level of guidance. [346] Such general purpose 'nuisance

[342] Housing Regulation (Alberta Regulation 173/1999 under the Public Health Act) available at http://www.qp.alberta.ca/documents/Regs/1999_173.pdf
[343] c.f. R. v. Wannas, 2004 ABPC 85 (CanLII); Alberta (Health Services) v Bhanji, 2017 ABCA 126; R v George, 2018 ABPC 20
[344] Capital Health v. Gaida, 2004 ABQB 768—ordering reinstatement of electricity to a rental home
[345] Brown v. Libertas Property Management Inc., 2011 ABPC 148
[346] Interview with Ryan Lau, the inspector who oversaw the process, April 18, 2018

clauses' are not common in Canada. Similar provisions were found only in the Yukon,[347] in Newfoundland and Labrador[348], and Nova Scotia.[349]

Our review shows that while many provinces have some degree of public health standards current wording makes this unlikely to lead to significant action on radon. For instance, in British Columbia there are some provisions for rental accommodation in public health regulation, but they are extremely limited and there is no way to have them touch on radon. The *Health Hazards Regulation*, BC Reg 216/2011 at section 7 covers inadequate rental accommodation, and describes conditions that make up a health hazard. However, it is restricted to requiring potable water, minimum limits on air space per unit, and a window that can open. In other cases, such as New Brunswick, the *Public Health Act* enables regulation respecting rental accommodations but no regulations have been enacted.[350]

4.6.6 Investigative powers

One clear advantage of public health regulation directed at rental accommodation is that there are government agencies equipped to investigate and assess. With the right legislation and regulation, and with administrative and financial support from their organizations, inspectors and health officers can work with tenants directly to test for radon, and at times order mitigation. However, our reading of legislation shows at times such measures may also be available under residential tenancies statutes.

Residential tenancies branches or commissions typically have open ended investigative powers attached to processing complaints. Yukon's *Residential Landlord and Tenant Act*, SY 2012, c 20 s. 72(1) states, in part, for example that "Upon receiving an application for dispute resolution the director may conduct any investigation into the matter that the director considers necessary" Here there are seldom explicit provisions for warrants and searches, implying that the 'investigation' is mostly a matter of hearing evidence presented by the parties. Such provisions are found in Newfoundland and Labrador [351] Prince Edward Island [352] New Brunswick [353] Saskatchewan [354] Yukon[355] Northwest Territories[356] and Ontario.[357]

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[347] Public Health Regulations, YCO 1958/79 Section 5 states: "Except as provided by these regulations, no person shall accumulate, or permit to accumulate upon his premises or upon his land, anything that may endanger health, or is likely to become a public nuisance."
[348] Sanitation Regulations, CNLR 803/96 under the Health and Community Services Act, SNL 1995, c P-37.1 at s. 3
[349] Health Act, RSNS 1989, c 195. sec 51 prohibits nuisances, allows for removal by an inspector, deems a nuisance to be a wide swath of things "injurious to the health or indecent, or offensive to the sense, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property" and gives a judge or a medical health officer powers to make an order in writing for the removal, burial or destruction of any substance being or likely to become a nuisance.
[350] Public Health Act, RSPEI 1988, c P-30. s. 72 (tt.1)
[351] No independent powers but can be triggered by a complaint concerning landlord tenant conflicts and as part of a settlement —see Residential Tenancies Act, RSNS 1989, c. 401s. 16.
[352] Rental of Residential Property Act, RSPEI 1988 c. R-13.1 s. 8)
[353] NB Residential Tenancies Act, SNB 1975, c R-10.2 s.. 6
[354] Residential Tenancies Act, 2006, SS 2006, c R-22.0001 s. 70(1).
[355] Residential Landlord and Tenant Act, SY 2012, c 20 s. 72(1)
[356] Residential Tenancies Act, RSNWT 1988, c R-5 at s.74(1)
[357] Residential Tenancies Act, 2006, SO 2006, c 1 s. 76(2)(a)

In other cases, however, residential tenancies legislation does give explicit powers of investigation. BC's RTA, for instance, includes provisions whereby the Director of Residential Tenancies can conduct investigations, even where there is no application for dispute resolution.[358] They have general powers to investigate allegations of contraventions of the Act or the regulations and enter rental premises at any reasonable time, after giving reasonable notice, for the purpose of discharging his or her duties under this Act or the regulations.[359] We found similar provisions, or wording that allows for general powers of investigation, besides duties to investigate complaints, in Newfoundland[360] Manitoba, [361] and Saskatchewan.[362] In Alberta, Ontario, and Newfoundland there are explicit provisions for the Director of Residential Tenancies (or authorized persons such as inspectors) powers to apply to court for warrants to inspect concerning contraventions of the Act.[363] This power also at times is prescribes as part of Maintenance Standards. Ontario's RTA provides prescribed maintenance standards and a complaints process where there are no municipal property standards by-laws at play (because the residence is in unorganized territory, if there are no relevant bylaws or if they are excluded from applying to the resident (s. 224). There is a process of written complaints and investigations. Inspectors have the power to issue work orders (s. 225(1) to which landlords have a right of review (s. 226).

While we were unable to systematically interview residential tenancies staff across the country we did not see evidence or hear that these powers are commonly used. Concerning Newfoundland we were told that any health concerns related to rented or non-rented properties would be investigated by municipal building inspectors or a provincial health inspector rather than Service Newfoundland. Such concerns would only come to the attention of the Residential Tenancies Section if there was an application by a tenant for an order of repairs, or to terminate a tenancy.[364]

4.6.7 Government as landlord and occupier

In many cases governments and their agencies do act as landlords. Through the 1970s to the 1990s, a hybrid system was developed throughout Canada: The federal government was central in putting funds on the table for provincial partnerships, often with a split that was two-thirds federal money and one-third provincial. Key players were also non-profit community groups, such as church groups and co-operatives that applied for funds, and contributed land and other equity from fundraising as part of their applications. The result was considerable social housing

[358] Residential Tenancies Act, S.B.C. 2002, c.7 s. 87.1
[359] Residential Tenancies Act, 2006, SO 2006, c 1 s. 74(1).
[360] Residential Tenancies Act SNL 2000 c. R-14.1 s. 34).
[361] Residential Tenancies Act, CCSM, C. 11 s.152(2)
[362] Residential Tenancies Act, 2006, SS 2006, c R-22.0001 s. 87
[363] Residential Tenancies Act SNL 2000 c. R-14.1 s. 34., SA 2004, c R-17.1 s.64 and 65; Residential Tenancies Act, 2006, SO 2006, c. 1. s. 230
[364] Residential Tenancies Act SNL 2000 c. R-14.1 s. 34. Correspondence of Jean Bishop, Director, Director of Residential Tenancies. Department of ServiceNL April 18, 2018.

units built throughout Canada.[365] This has resulted in what we think of as 'social housing' to in fact be a mix. Some building sites are owned directly by the federal government and its agencies— such as Canada Mortgage and Housing Corporation, but with more owned by provincial governments or its agencies such as, through the British Columbia Housing Management Commission, commonly known as BC Housing. In some cases, municipal governments and regions are also housing providers, such as the Metro Vancouver Housing Corporation. Toronto Community Housing Corporation (TCHC) is one of the largest housing providers in North America, with about 110,000 tenants. For the TCHC 90% of tenants pay rent-geared-to-income and the remaining 10% pay market rent or affordable rent rates.[366] In Ontario, the oversight and funding responsibilities for social housing units was transferred to municipal governments in 2001 and there are now 47 distinct municipal "Service Managers" that administer social housing.

Once the state owns buildings, it must follow laws of general application— such as Building Codes, and Occupier's Liability. As such the state will be liable for claims in negligence or occupier's liability. Most provincial residential tenancies legislation state explicitly that the Crown is bound. They tend to have specific carve outs to make it easier for social housing to be administered, and to ensure rent can be geared to income rather than locked in through rent control. However, general laws of fitness and repair continue to apply. A significant percentage of housing financed by the federal and provincial governments is not owned by the state, but remains in the hands of non-profit housing providers (such as religious organizations) or housing cooperatives. For instance, in British Columbia, BC Housing generally leads the development, management and implementation of social housing in the province, but typically more recently with non-profit partners. This organization alone operates roughly 7,100 units of public housing but oversees a system of support for over 104,000 households.

We did a limited web-page based search for radon policies in state owned and non-profit social housing. We sampled more prominent housing authorities (such as BC Housing, the Toronto Community Housing Corporation, the Saskatoon Housing Authority, the Regina Housing Authority, as well as provincial and territorial websites) and found very little. At 4.3.5 above we noted that some governments have tested public buildings. We did find some interesting radon testing initiatives:

a. In 2014 the Quebec Housing Corporation (SQH) launched a pilot project in its social housing stock that sought to map radon levels and conduct mitigation in buildings with above-guideline levels. The study found 61 out of 380 dwellings with above-guideline levels and radon mitigation occurred within the 1 or 2 year time frames recommended by Health Canada. In the majority of the more severe cases, an active soil depressurization system was installed. Results of this project have prompted a request for radon testing of all social

[365] Lee, M. 2016. Getting Serious About Affordable Housing: Towards a Plan for Metro Vancouver. Centre for Policy Alternatives. https://www.policyalternatives.ca/sites/default/files/uploads/publications/BC%20Office/2016/05/CCPA-BC-Affordable-Housing.pdf at p. 26

[366] https: Toronto Community Housing Corporation 2016 Annual Review. //www.torontohousing.ca/about/annual-reports/Documents/AnnualReview2016_June16.pdf

housing to be completed by December 2018, with a total of 28,000 tests planned for Quebec as a whole.[367]

b. In 2015 Manitoba Housing and Renewal Corporation committed to proactively implementing a testing program to monitor levels of radon in government housing and use the results from this randomized testing to develop policy and guide decisions about further testing and mitigation.[368] Manitoba Housing's Design Guidelines for Multi-Unit Affordable and Social Housing (November, 2017) include provisions for radon control that, follow the National Building Code guidelines, but will be changed when the CAN/CGSB 149.11 is finalized.[369]

c. The Aboriginal Housing Society of Prince George is a not-for- profit housing provider of affordable housing for Aboriginal people. It participated in a broad radon testing program in Prince George in 2014. The housing society volunteered to test 136 of their individual housing units for radon. Testing took place for 3 months over the winter of 2013 and 2014, beginning in mid-December. Of the units tested, 28.28% (36 of 137) were above the Health Canada radon guideline of 200 Bq/m^3. Each of these units was subsequently scheduled for mitigation using active sub-slab depressurization system. Each home was left with a pro-series 3 continual radon monitor to measure the levels of radon post-mitigation. An estimated 85 – 90 per cent of houses reported levels below 100 Bq/m^3, with the highest post-mitigation level reported to be 129 Bq/m^3.[370]

The Yukon Housing Corporation acts both as a social housing provider and as a source of information and funder of diverse housing initiatives. Yukon Housing has facilitated radon testing/mapping of communities in the Yukon since 1989, and in particular in Whitehorse. Test kits are provided free of charge, and in total around 3,000 radon tests have occurred.[371] While the percentage of homes that have been tested remains low, high measurements can be seen. Yukon Housing Corporation has also partnered with Yukon Lung Association and has hosted Canada – National Radon Proficiency Program (C-NRPP) certified Radon Measurement and Radon Mitigation training, also bringing C-NRPP instructors to Yukon.[372]

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[367] tp://espacehabitat.gouv.qc.ca/societe/detection-radon-linitiative-de-societe-dhabitation-quebec-saluee-partout-pays-2/.

[368] Annual Report of the Department of Housing and Community Development for the Province of Manitoba for the year 2014/15.Available at http://www.gov.mb.ca/housing/pubs/2014-2015-annual-report-web.pdf accessed May 20, 2018.

[369] Manitoba Housing, 2017. Design Guidelines for Multi-Unit Affordable and Social Housing v. 1.4 Available at http://www.gov.mb.ca/housing/pubs/procurement/design-guidelines-for-multi-unit-affordable-and-social-housing.pdf accessed May 20, 2018

[370] Swoveland, B. 2016. A Model For Radon Testing and Mitigation in Affordable Housing. The Lung Association of British Columbia. available at http://www.radonaware.ca/database/files/library/BCLung_Radon_AHSCaseStudy_.pdf Accessed may 18, 2018.

[371] Personal communication, Government of Yukon, Yukon Housing Corporation, Research and Development Project Manager (July 6, 2018).

[372] Yukon Housing Corporation, 2018. Radon. Available at http://www.housing.yk.ca/radon.html. Accessed May 18, 2018. To access the Map using an online GIS Viewer, go here: http://www.arcgis.com/home/webmap/viewer.html?webmap=32f54a90ba514e46b03c99390064f046&extent=-135.5432,60.5582,-134.5166,60.8471 accessed May 18, 2018.

d. Toronto Community Housing, in conjunction with Health Canada, has embarked on an Assessment of Indoor Environmental Quality in some of its high rise buildings.[373]The first phase started in 2014 and determined the impact of energy retrofit measures (such as new windows, faucets, lighting and some heating) in high-rise social housing in Toronto on indoor environmental quality parameters (such as ozone, formaldehyde, VOCs, and including radon). A second stage in 2017 advanced to implementing and studying energy retrofits.

4.7 Child care and schools

Children are at greater risk of radon-induced lung cancer than adults—their little lungs and fast breathing mean they get a higher effective dose of radiation. As Dunn and Cooper (2014) record, education legislation generally contains some provisions relating to student health and safety but not indoor air quality. Schools are subject to laws of negligence and occupier's liability and there are broad fiduciary duties of school authorities to be careful and prudent with regards to students. A number of initiatives have sought to raise the awareness of childhood exposure to radon and to test radon in schools and childcares. However, initiatives such as the Vanguard Initiative of the Canadian Partnership for Children's Health and Environment (CPCHE) with the Canadian Child Care Federation (CCCF) in 2014 found staff had little previous knowledge about radon and felt that given their many other responsibilities, radon testing would be unlikely to occur unless it was mandatory.[374] Up to 2014, in some cases, public health officials in Ontario have closed day-cares for environmental health reasons such as mould on the basis it amounted to a health hazard.[375] As such, there is some basis to think radon in child care settings might be considered a 'health hazard' (but see section 4.8.1 below for more discussion). In contrast, a number of US states specifically include radon requirements in child care settings such as in Illinois, Iowa, New Jersey, and Rhode Island.[376]

[373] see Assessment of Indoor Environmental Quality in Toronto Community Housing Buildings REB 2014-0040, discused in Bush, K. and Bijlani, D. 2015. National Radon Program Update, Health Canada. For CARST 2015 Annual Conference. available here http://www.carst.ca/Resources/Documents/Conference2015/National%20Radon%20Program%20Update%20April2015.pdf; accessed May 22, 2018. and Falcomer, R. and Bush, K. 2017. Canadian National Radon Program Update Health Canada CARST 2017 Annual Conference. Available here http://www.carst.ca/resources/Conference%202017/Presentations%202017/CARST2017%20NRP%20Update%20FINAL.pdf accessed May 22, 2018.

[374] Phipps, E. 2014. Vanguard Initiative to promote radon awareness among child care/early childhood professionals and the families they serve. Canadian Partnership for Children's Health and Environment for Health Canada; see also 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.

[375] Jorgensen v. Halton (Regional Municipality), 2000 CarswellOnt 8510.

[376] .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.

4.7.1 Child care facilities

As noted in a March 2018 briefing note on policy measures to address radon in the child care sector, testing and mitigating radon in child care settings cuts across child care licensing, building codes, occupational health and safety, and public health law.[377]

Since 2014, we found some significant legislative and policy innovations across Canada are worth highlighting.

a. In Alberta, Bill 209 (*Radon Awareness and Testing Act*) was passed in 2017 as a private members bill and is waiting to be signed.[378] This is a straightforward and short piece of legislation that calls for the government to promote public awareness. As well at section 3, there are mandatory testing requirements for child care facilities.

> 3(1) Prior to a licence being issued or renewed for a child care program under section 4 of the *Child Care Licensing Act*, the director under that Act shall require an applicant to provide the director with the results of a radon test completed within one year immediately preceding the submission of the application within the premises where the child care program will be provided.

The Bill was designed to achieve cross party consensus in a climate in which Albertans were not highly aware of the radon issue and in which radon was not high on the current government legislative agenda. As well, given the vulnerability of children to radon and the importance of protecting them, the drafter, Robyn Luff, reasoned that the provisions relating to child care would be widely accepted. Luff also credited Dr. Aaron Goodarzi at the University of Calgary for having raised awareness through his widely publicized studies showing higher incidences of problematic radon in Alberta homes.[379] The bill has no budget attached, leaving it to individual ministries to find resources to implement it.[380]

b. In 2017 the Yukon government announced that it would test all schools over the 2017-2018 winter. This then prompted the New Democratic Party opposition to push for mandatory testing in all licensed facilities noting that child care and private day homes are not included.[381] In response, the government chose to mandate testing in child care facilities.[382]

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[377] Cooper, K. Giesbrecht, D., Phipps, E. 2018. Policy Measures to Address Radon in the Child Care Sector: Briefing Note for Child Care Sector Leaders. Available at http://www.cela.ca/sites/cela.ca/files/Policy-Radon-Child-Care-Sector-EN-Mar2018-Update.pdf Accessed May 20, 2018.

[378] The Bill is available here: http://www.assembly.ab.ca/ISYS/LADDAR_files/docs/bills/bill/legislature_29/session_3/20170302_bill-209.pdf.

[379] c.f. 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), p.E255.For media coverage see Wood, J. 2017. U of C researchers sound alarm over radon levels in Calgary homes November 14, 2017. Calgary Herald. available at at http://calgaryherald.com/health/u-of-c-researchers-sound-alarm-over-radon-levels. Accessed May 18, 2018; CBC News, 2017. Cancer expert urges Albertans to test homes for deadly radon gas. Nov 15, 2017 available at http://www.cbc.ca/news/canada/calgary/radon-gas-testing-health-canada-university-calgary-campaign-evict-1.4403648 accessed May 18, 2018.

[380] Robyn Luff, telephone interview, April 13, 2018)

[381] CBC News, 2017. Daycares should have mandatory radon testing, Yukon NDP says. Mar 09, 2017 available at http://www.cbc.ca/news/canada/north/radon-testing-yukon-daycares-schools-1.4017679 accessed May 18, 2018.

No draft bill is available, but a press release from October, 2017 states that "over the coming months, the government will be working with licensed child care facilities to determine how this requirement will be implemented."[383]

c. In British Columbia, the BC Interior Health Authority has had an ongoing program of working with child care providers, first with a program of mailing free test kits to 800 providers in 2014 followed with repeat contact to many.[384] The Health Authority also took the novel step of ordering child care facilities to test for radon in 2017.[385] However, rather than relying on the *Public Health Act*—which was felt to be too vague and uncertain, the Authority used the *Community Care and Assisted Living Act*, S.B.C. 2002, c. 75. This law 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).[386]

d. C-NRPP and CARST have developed some resources—brochures, posters, sample letters and tracking sheets— to help when it comes to testing child care centres.[387]

4.7.2 Schools

Some provinces, such as Saskatchewan and Prince Edward Island have long had a policy of testing schools, and PEI makes the results public online[388] as does Yukon.[389] In 2017 CAREX Canada completed a cross Canada survey of radon testing in schools.[390] Key findings from this investigation include:

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[382] CBC News, 2017. Radon testing will be mandatory for Yukon daycares, a 1st in Canada. October 17, 2018.http://www.cbc.ca/news/canada/north/radon-testing-daycares-mandatory-yukon-1.4361468 accessed May 18, 2018.

[383] Government of Yukon, 2017. October 18, 2017 Radon testing to become a requirement for child care centres and family day homes. Available at http://www.gov.yk.ca/news/17-221.html

[384] 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.

[385] Nicol, A-M, Ma, L, and Baytalan, G. 2017. Knowing leads to doing: The radon testing imperative. News for the Canadian Institute of Public Health Inspectors. Fall 2017. available at http://ciphi.bc.ca/downloadable/BC_Page/2017/BC%20Page%20-%20Fall%202017.pdf Accessed May 11, 2018. See also Interior Health, 2017. News and Resources from Licensing – May 2017. available at http://www.carst.ca/resources/Documents/May%20News%202017%20-%20Interior%20Health.pdf accessed May 11, 2018.

[386] interview with G. Baytalan April 11, 2018

[387] Canadian National Radon Profficiency Program, 2018. Testing Child Care Centres. available at https://c-nrpp.ca/professionals/testing-child-care-centres/ accessed May 20, 2018.

[388] PEI Department of Health. Radon Survey at Selected Sites Across Prince Edward Island. Project No. 7265 PEIGOV – RFP #526 Project No. 7108 Available at http://www.gov.pe.ca/photos/sites/infopei/7108%20Radon%20Final%20report%20(rev).pdf. Accessed May 20, 2018.

[389] Yukon, 2018. Radon Monitoring in Yukon Schools available at http://www.education.gov.yk.ca/radon-monitoring.html Accessed May 20, 2018.

[390] CAREX Canada, 2017. Radon in schools: A summary of testing efforts across Canada. available at https://www.carexcanada.ca/en/announcements/radon_in_schools/ Accessed May 20, 2018.

- All public schools in Saskatchewan, New Brunswick, Nova Scotia, Prince Edward Island, and Yukon have been tested for radon.
- British Columbia, Alberta, Manitoba, Ontario, and Newfoundland have low rates of radon testing in schools.
- Quebec has a collaborative approach to radon testing in schools led by the ministries of Education and Health, a product of the Inter-sectoral Committee on Radon.
- Over 500 schools across the country expressed interest or developed plans to test for radon in 2018.
- In some provinces, new schools are built to facilitate mitigation should they report elevated levels of radon.
- Some school buildings, such as those in some regions in the Northwest Territories and Nunavut, are constructed above ground on piles and therefore, may not require radon testing.

We have summarized key findings from that report by province in Appendix 5: Radon Testing in Child Cares and Schools by Province and Territory

4.8 Public health

4.8.1 General provisions promise but do not deliver

At both the federal and provincial/territorial levels, governments have enacted legislation that grants broad authority to promote and protect public health. Federal law is mainly concerned with health promotion and data collection. Authority to act in response to health hazards rests mainly with provinces/territories. The presence, or suspected presence, of a 'health hazard' is usually the trigger for an inspection and/or order by a public health official. 'Health hazards' are often broadly defined, including the conditions of premises, and the presence of a particular substance (in some cases specifying gases) which is, or is likely to be, a threat to public health.

In turn, public health agencies, often organized and empowered regionally or locally, are provided with inspection and enforcement powers and public health inspectors can respond to complaints regarding indoor air quality that may pose human health risks. Once right of access has been acquired, public health legislation generally confers powers to inspect the premises, including the powers, among others, to request information and documents and conduct tests on the premises. If, after inspection, there are grounds to believe that a health hazard exists, or that there has been a contravention of the legislation or related regulations, a public health inspector may issue an order. Orders are generally permitted to include conditions such as: requiring the building be vacated, closed, or its use regulated; declaring the building unfit for human habitation; requiring work to be done as specified in the order; and requiring the removal of anything that the order states causes a health hazard.

At first blush it would appear health officials could use these general powers to address radon. Powers of inspection and enforcement are generally drafted broadly enough to include hazards to health in indoor air, and public health agencies have the discretion to enforce the federal Radon

Guideline when assessing air quality complaints. Public health inspectors require a rationale in order to issue an order, but the courts are respectful of their expertise: They can draw on the solid scientific evidence that links radon exposure in indoor air to cancer risk. That said, the reality of public health legislation and administration has meant that, in fact there has traditionally not been considerable action. Dunn and Cooper (2014) thus note the following.

1. Most public health legislation so far lacks specificity in terms of application to indoor air, radiation or radon resulting in a lack of clarity that deters inspectors and health authorities from acting.
2. Public health agencies generally respond to complaints and can respond at times to complaints around radon. Yet few (if any) complaints about indoor radon are received by health units.
3. In most provinces, there are procedural obstacles to inspection that protect people's privacy in their home and businesses. That is, unless there is consent, a warrant is needed, but a warrant would require prior knowledge of radon levels that are hard to obtain. The result is that radon testing and orders for mitigation are often difficult to make.
4. Some provinces do have broader maintenance regulations that allow for inspections and orders concerning rental accommodation; however these continue to lack specificity with regards to radiation and radon.
5. Public health inspection and enforcement powers are intended to be case-specific, applying to particular buildings and businesses rather than promulgating new rules.

Follow up interviews were conducted for this report and these concerns resurfaced. We also heard that inspectors and medical officers of health who are interested in radon do not feel they have a strong mandate to act, radon is not prioritized, and they lack budgets to carry out radon research or investigations. Unlike litigation, where diverse actors have motivations to creatively interpret the law and push for change, public health inspectors and medical officers of health are not oriented towards pushing the envelope and are not rewarded for taking risks and expanding their mandate. Most inspectors do not have specific training in radon detection or mitigation.

One explanation for the impasse is that radon is a *chronic* hazard and so does not fit easily into public health regulation oriented towards acute or immediate hazards. Whether it is sanitation, food preparation, communicable diseases, or injuries, Canadian regulations tend not to be organized to address chronic hazards like radon.[391]

4.8.2 What's new

We looked for any changes to public Health laws since 2014 using the "compare" function at CANLII.org and did not find significant changes.[392] However, we did find that a number of provinces and local regions have been able to use general powers to take action.

[391] Cooper, K. Giesbrecht, D., Phipps, E. 2018. Policy Measures to Address Radon in the Child Care Sector: Briefing Note for Child Care Sector Leaders. Available at http://www.cela.ca/sites/cela.ca/files/Policy-Radon-Child-Care-Sector-EN-Mar2018-Update.pdf Accessed May 20, 2018. at p. 4

[392] Health and Community Services Act, SNL 1995, c P-37 went through two changes in 2015 and two in 2018 but nothing relevant to radon, hazards or inspectors powers was detected.
Health Protection Act, SNS 2004, c 4 was updated 2015 but no relevant changes were detected.

1. In Ontario, there has been a broad policy change enshrined in two documents— the *Ontario Public Health Standards* and *The Healthy Environments and Climate Change Guideline, 2018.* The *Public Health Standards* set out minimum expectations for public health programs and services to be delivered by Ontario's 36 boards of health. The Standards are published by the Minister of Health and Long-Term Care, and are enabled by the *Health Protection and Promotion Act* (at section 7). Boards of health are accountable for implementing the Standards including the protocols and guidelines that are referenced therein. The 2018 standards state, at section 7, that boards, shall as part of their strategy to reduce exposure to health hazards and promote healthy natural and built environments, effectively communicate with the public by addressing exposure to radiation, including UV light and radon.

2. The 2018 standards also reference the *Healthy Environments and Climate Change Guideline, 2018*. This document is intended to assist boards of health to develop approaches for promoting healthy built and natural environments to enhance population health and mitigate environmental health risks. The section concerned with Population Health Assessment asks boards of health to consider planning and implementing public awareness initiatives to address environmental exposures to radon. They are to develop and implement mitigation strategies for radon exposures. A recent survey of Ontario Public Health Units showed a majority had some kind of radon program started as a response to the new standards. The activities were, for the most part, testing of houses, child cares facilities, schools and apartment buildings, but not workplaces or public spaces. A number of health units gave out subsidized or free radon test kits, often as part of local studies.[393] Health units in Windsor Essex, Thunder Bay and Grey Bruce provided residents with free test kits during November to coincide with Radon Action Month.[394] In York Region during the winter of 2017-2018 the *Radon – Test Your Home Study* provided free kits to 550 homeowners to test their radon levels for a period of 91

Public Health Act, RSPEI 1988, c P-30.1 was updated in 2014, and 2016 but no relevant changes were detected.
Public Health Act, SNB 1998, c P-22.4 was updated in 2016, 2017 and three times in 2018. No relevant changes were detected.
Public Health Act, CQLR c S-2.2 was updated in 2015, 2016, and 2017 but no relevant changes were detected.
Health Protection and Promotion Act, RSO 1990, c H.7 We found no significant changes touching on radon issues through 5 updates.
The Public Health Act C.C.S.M.c. p210 was updated 2016, but no relevant changes were detected.
Public Health Act, 1994, SS 1994, c P-37.1 was updated in each of 2014, 2015, 2016, and 2017 but no relevant changes were detected.
Public Health Act, RSA 2000, c P-37 was updated in 2015, twice in 2016, and in 2017. No relevant changes were detected.
Public Health Act, SBC 2008, c 28 was updated 2016 and 2017 but no relevant changes were detected.
Public Health and Safety Act, RSY 2002, c 176 is unchanged since 2014.
Public Health Act, SNWT 2007, c 17 was updated in 2015 and 2017 but no relevant changes were detected.
Public Health Act, RSNWT (Nu) 1988, c P-12 remains unchanged.

[393] van Meer, R., MacIntyre, E, and Copes, R. 2018. Ontario Public Health Unit Radon Survey (winter 2017/2018) . Public Health Ontario.

[394]Nicol, A-M, Ma, L, and Baytalan, G. 2017. Knowing leads to doing: The radon testing imperative. News for the Canadian Institute of Public Health Inspectors. Fall 2017. available at http://ciphi.bc.ca/downloadable/BC_Page/2017/BC%20Page%20-%20Fall%202017.pdf Accessed May 11, 2018

days.[395] Results are not yet published. The City of Peterborough has also recently made free radon tests available to the public.[396] Windsor-Essex County, Ontario has also done radon testing[397] [398] [399] with data expected to form the basis for policy recommendations including municipal building code amendments.[400]

1. In Alberta, Alberta Health Services has ordered radon mitigation and developed a guidance document on radon in rental accommodation. Inspectors can draw on general nuisance clauses in the *Public Health Act* (at s. 59 to 61). "Nuisance" is 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)). The *Nuisance and General Sanitation Regulation*, Alta Reg 243/2003 under the *Public Health Act* has a general clause to the effect that (s. 2(1)) No person shall create, commit or maintain a nuisance. At s. 3 health officers who receive a complaint alleging the existence of a nuisance are to inquire into the complaint. In one case in Calgary, inspectors responded to a renter's complaint, worked with the renter to complete tests and ordered the landlord to mitigate. Interviews with the public health official involved show this was made possible by the fact the official had taken specific radon mitigation training. He was able to develop a Standard Operating Procedure for health inspectors and radon, but unfortunately this remains unavailable to the public.[401] (see also Section 4.6.5 above). We note that such general purpose 'nuisance clauses' are not common in Canada. Similar provisions were found only in the Yukon,[402] in Newfoundland and Labrador[403], and Nova Scotia.[404]

2. In British Columbia the BC Interior Health Authority initiated a radon awareness program in 2010 and through progressive, and precautionary action, funded through Health Canada grants, has been able to extend interventions. In early 2014, free test kits were mailed to 800 licensed child care providers, followed by repeat contact to many.

[395] http://www.york.ca/wps/portal/yorkhome/health/yr/environmentalhealth/radonhomestudy/.
[396] http://www.peterboroughpublichealth.ca/free-radon-test-kits-available-throughout-the-county-and-city-from-peterborough-public-health/.
[397] Indoor Radon Levels in Windsor-Essex County, Windsor-Essex County Health Unit, 2016, online: https://www.wechu.org/sites/default/files/reports-and-statistics/2015-2016-Radon-Report.pdf.
[398] Indoor Radon Levels in Windsor-Essex County: 2016-2017 Study Summary Report, Windsor-Essex County Health Unit, 2017, online: https://www.wechu.org/sites/default/files/reports-and-statistics/Radon_2016-2017_summary_doc-Accessible_MASTER.pdf.
[399] https://www.wechu.org/newsroom/news-release-health-unit-will-distribute-1000-free-radon-test-kits-area-residents-who.
[400] Personal Communication, Windsor-Essex County Health Unit, (June 6, 2018).
[401] Interview with Ryan Lau, the inspector who oversaw the process, April 18, 2018
[402] Public Health Regulations, YCO 1958/79 Section 5 states: " Except as provided by these regulations, no person shall accumulate, or permit to accumulate upon his premises or upon his land, anything that may endanger health, or is likely to become a public nuisance."
[403] Sanitation Regulations, CNLR 803/96 under the Health and Community Services Act, SNL 1995, c P-37.1 at s. 3
[404] Health Act, RSNS 1989, c 195. sec 51 prohibits nuisances, allows for removal by an inspector, deems a nuisance to be a wide swath of things "injurious to the health or indecent, or offensive to the sense, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property" and gives a judge or a medical health officer powers to make an order in writing for the removal, burial or destruction of any substance being or likely to become a nuisance.

Testing results showed nearly 11% (43) of the analyzed detectors recorded radon levels above the Canadian guideline, with 9 facilities (2.3%) measuring above 600 Bq/m^3, of which 5 (1.3%) were above 1,000 Bq/m^3.[405] The Health Authority also took the novel step of ordering child care facilities to test for radon in 2017.[406] However, rather than relying on the *Public Health Act*—which was felt to be too vague and uncertain, the Authority used the *Community Care and Assisted Living Act*, S.B.C. 2002, c. 75 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).[407]

3. Some health authorities have recently undertaken new radon studies, including the Cypress Health Region in Saskatchewan[408] and the Winnipeg Health Authority.[409]

4.8.3 Maintenance standards

In addition to powers with respect to health hazards, some provinces' health legislation also include minimum standards with respect to building maintenance and repair requirements for rental housing, including Prince Edward Island[410]Manitoba[411]Alberta [412] and British Columbia.[413] (As well, some provinces do have maintenance standards enabled under different legislation—see Newfoundland[414] and Ontario[415]). The possibilities and limits of such standards with regard to addressing radon turn on the wording of each provincial law and the related regulation-making powers.

British Columbia has provisions relating to potable water, windows and airspace only, leaving no room for action on radon, while Alberta's Housing Regulation [416] contains very general language concerning housing premises being in a safe condition. Alberta's *Minimum Housing and Health Standards* call for mechanical ventilation in conformance with the requirements of the *Alberta*

[405] 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.
[406] Nicol, A-M, Ma, L, and Baytalan, G. 2017. Knowing leads to doing: The radon testing imperative. News for the Canadian Institute of Public Health Inspectors. Fall 2017. available at http://ciphi.bc.ca/downloadable/BC_Page/2017/BC%20Page%20-%20Fall%202017.pdf Accessed May 11, 2018. See also Interior Health, 2017. News and Resources from Licensing – May 2017. available at http://www.carst.ca/resources/Documents/May%20News%202017%20-%20Interior%20Health.pdf accessed May 11, 2018.
[407] interview with G. Baytalan April 11, 2018
[408] https://cypresshealth.ca/news/testing-your-home-for-radon-exposure/, overseen by Dr. David Torr, Consulting Medical Health Officer . Cypress and Heartland Health Regions
[409] unpublished work of Davinder Singh, as relayed by Lisa Richards, Medical Officer of Health, Winnipeg Regional Health Authority, interview May 16, 2018
[410] Rental Accommodation Regulations, PEI Reg EC142/70
[411] Dwellings and Buildings Regulation, Regulation 322/88 R under the Public Health Act C.C.S.M. c. P210
[412] Alberta Housing Regulation (Alberta Regulation 173/1999 under the Public Health Act) available at http://www.qp.alberta.ca/documents/Regs/1999_173.pdf
[413] Health Hazards Regulation, BC Reg 216/2011
[414] Occupancy and Maintenance Regulations, CNLR 1021/96, under the Urban and Rural Planning Act (O.C. 96-201)
[415] Ontario Regulation 517/06, Maintenance Standards
[416] Housing Regulation (Alberta Regulation 173/1999 under the Public Health Act

Building Code.[417] The *Housing Regulation* and the *Minimum Housing and Health Standards* are enforced by inspections of housing premises by Public Health Inspectors/Executive Officers of Regional Health Authorities on a systematic or complaint basis.[418] Actions may be taken by public health officials to address problems with standards, and subsequent procedures may be initiated by tenants under the RTA to seek abatement of rent, early termination and other issues relating to the landlord tenant relationship.[419]

Public health authorities may also respond to complaints from tenants even where no such explicit regulations exist— that is, relying on general provisions in public health legislation. For instance, Saskatchewan has no particular public health regulation relating to rental housing, but the Saskatoon Health Region provides a guide to how tenants can lodge complaints and initiate public health inspections.[420] We found very little significant changes in regulations and practices since 2014, as they might pertain to radon, across all provinces and territories.

4.9 Incentive programs for mitigation

Advocates for mandatory requirements for radon face the problem that many people still do not know what radon is or don't care about something that presents an uncertain risk in the distant future. As such there is a lack of pressure on elected officials to resolve the problem and even potential backlash from people asked to do something against their will and the benefits of which they do not appreciate. In 2015 Statistics Canada's Households and Environment Survey found only 55% of all Canadian households indicated that they had heard of radon, although this was up from 45% in 2013. Of those who had heard of radon, 59% were able to correctly identify what it was when presented with a list of possible descriptions, which is an increase from 53% in 2013.[421]

Incentive programs could address this awareness problem through promoting certain actions without being coercive in the way that strong laws might be. As we will argue, there are good *prima facie* justifications for spending money to incentivize radon mitigation, and a range of available instruments.

We did not find current and comprehensive cost-effectiveness studies for Canada or provincial or regional levels and feel this should be done.[422] We note that economic modelling typically is

[417] Minimum Housing and Health StandardsM.O. 57/2012 available at https://banff.ca/DocumentCenter/View/2603 s. 4(b)
[418] c.f. R. v. Wannas, 2004 ABPC 85 (CanLII); Alberta (Health Services) v Bhanji, 2017 ABCA 126; R v George, 2018 ABPC 20
[419] Brown v. Libertas Property Management Inc., 2011 ABPC 148
[420] Saskatoon Health Authority. 2018 About Housing & Public Accommodations. available at https://www.saskatoonhealthregion.ca/locations_services/Services/Health-Inspection/Pages/HousingandPublicAccommodation.aspx accessed May 14, 2018
[421] Statistics Canada, 2016. Radon awareness in Canada. Environment, Energy and Transportation Statistics, Statistics Canada: Ottawa. Catalogue no. 16-508-X ISBN 978-0-660-06547-2 http://www.statcan.gc.ca/pub/16-508-x/16-508-x2016002-eng.pdf
[422] But see Létourneau, E.G., Krewski, D., Zielinski, J.M. and McGregor, R.G., 1992. Cost effectiveness of radon mitigation in Canada. Radiation Protection Dosimetry, 45(1-4), pp.593-598; Tracy, B.L., Krewski, D., Chen, J., Zielinski, J.M., Brand, K.P. and Meyerhof, D., 2006. Assessment and management of residential radon health risks: a report from the Health Canada radon

organized around specific goals, such as finding the most cost-effective way to reduce radon. However, the goals of modelling should not be simply to show where radon mitigation might be cost effective, because economic efficiency is not the only relevant goal. Modelling should show the effectiveness and costs of broad policy goals, such as achieving a low-radon built environment across Canada by 2050, including year over year building retrofits. Comparable exercises have been done for carbon mitigation in the built environment at the provincial level in British Columbia by the Pembina Institute and British Columbia Real Estate Foundation, estimating costs of a zero carbon building supply by 2050.[423] Such efforts could drive fiscal measures like tax credits or direct financing of radon registries, and awareness, testing and inspection through public health agencies.

4.9.1 Strong p*rima face* justifications

Dunn and Cooper (2014) made a simple estimation of health care savings. They reasoned that approximately 600,000 homes in Canada are above the Health Canada Guidelines. If all homes in Canada were at or under 200 Bq/m^3 927 lives would be saved per year and this would reduce health care costs by nearly $18 million. While such analyses help make the *prima facie* case it is important to also factor in the process of searching and finding suitable houses for mitigation and costs of mitigation. With an eye to comprehensive analysis, health economists tend to favour cost effectiveness studies that calculate the health benefits versus health care costs of mitigation and attempt to estimate costs per life year saved. The measure of QALY (quality adjusted life year) is used. For radon these are relatively complicated exercises because they depend on models for lung cancer incidence and calculations of risk from radon exposure and effective dose. The World Health Organization review of cost-effectiveness studies in 2009 found that most concluded that preventive measures in all new buildings are cost-effective in areas where more than 5% of the present housing stock is above 200 Bq/m.^{3} The WHO report includes a cost effectiveness calculation for the United Kingdom. The incremental cost per life year gained by radon mitigation was (at discounted rates) £ 9 824 for new construction and £ 32 614 for mitigating older buildings. The incremental cost per QALY gained - discounted was £12 526 for new construction and £ 41 584 for older buildings. In comparison, regulatory agencies in the United Kingdom, when evaluating National Health Service medical interventions, use thresholds of £25 000 to £30 000 for whether to accept or reject potential interventions on cost-effectiveness grounds.[424] Otherwise stated, radon mitigation is a relatively cheap public health intervention.

In addition, better mapping techniques (for finding high radon potential areas), internet based Radon Registries (that can more accurately tell people readings in their vicinity) and new radon measurement technologies all point to lowering overall costs by making it easier to identify

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workshop. *Journal of Toxicology and Environmental Health*, Part A, 69(7-8), pp.735-758. Janet Gaskin is completing a PhD in the area of Health gains of radon mitigation in Canada, combining epidemiological and economic modelling. She presented at the CARST 2018 Annual Conference in Ottawa, April 24, 2018, however her findings are not yet published.

[423] Frappé-Sénéclauze, T.-P., Heerema, D., Tam Wu, K. 2017. Deep Emissions Reduction in the Existing Building Stock: Key elements of a retrofit strategy for B.C. Pembina Institute and Real Estate Foundation of British Columbia.available at http://www.pembina.org/pub/building-retrofits accessed may 24, 2018

[424] 2009. WHO Handbook on Indoor Radon: A Public Health Perspective. eds. Zeeb, J. and Shannoun, F. World Health Organization. at p. 58

buildings in need of testing and mitigation. We did not find current and comprehensive cost-effectiveness studies for Canada or provincial or regional levels.[425] There are a variety of ways that state agencies can spend money to promote and encourage radon testing and mitigation.

There are also important equity considerations behind incentives. In the current Canadian housing system, homeowners with means can pay for testing and mitigation. Others may simply have more immediate financial needs for themselves and their families such as food, transport or paying debts. The result is that radon mitigation gets pushed into the future. In rental housing landlords are adverse to investing in mitigation that offers them no better returns on investments with small margins, while individual tenants either cannot make this happen if they want to put up the money (e.g. in multifamily residences) or have little incentive to fix something they may only stay in for a few years. Subsidies and incentives thus also work to share the costs of a collective good.

Radon mitigation is amenable to tax credits and subsidies in a vein similar to other housing upgrades such as energy retrofitting for which there is ample precedent. However, the cost of testing equipment and services is low enough that outright provision of testing devices to residents is possible. In the UK, areas such as Cornwall that have high levels of radon have had government programs offering free radon detection kits, with at least a million testing units distributed. Some jurisdictions, like Illinois and Maine have designed subsidy programs that are cost neutral for the state, using funds created by the payment of certification fees and penalties for noncompliance with testing and mitigation protocols.[426]

Subsidies and incentives can include direct incentive to individuals, but might also extend to offering financial support for programs that promote radon awareness (in the public or non-profit sector), research (in universities) or inspections and testing by public health agencies. Indeed, our interviews with public health inspectors and medical officers of health showed that even when inspectors or officers had an interest in radon, they lacked formal policies and the allocation of budgets to address the issue. As such, they could not justify allocating too much of their time to radon issues. A fully worked out cost-effectiveness analysis could show the importance of such funding and help direct funding to public health departments as well as radon testing and mitigation programs.

[425] But see Létourneau, E.G., Krewski, D., Zielinski, J.M. and McGregor, R.G., 1992. Cost effectiveness of radon mitigation in Canada. Radiation Protection Dosimetry, 45(1-4), pp.593-598; Tracy, B.L., Krewski, D., Chen, J., Zielinski, J.M., Brand, K.P. and Meyerhof, D., 2006. Assessment and management of residential radon health risks: a report from the health Canada radon workshop. Journal of Toxicology and Environmental Health, Part A, 69(7-8), pp.735-758. Janet Gaskin is completing a PhD in the area of Health gains of radon mitigation in Canada, combining epidemiological and economic modelling. She presented at the CARST 2018 Annual Conference in Ottawa, April 24, 2018, however her findings are not yet published.

[426] Miller, J. 2012. Regulating Exposure to Radon Gas in BC Homes: A Four Pillar Approach. University of Victoria Environmental Law Centre, for the Canadian Cancer Society, BC and Yukon Division. available at http://www.elc.uvic.ca/documents/2012-02-05-RegulatingRadonMemo.pdf accessed May 22, 2018.

4.9.2 Tax credits or grants

We found no federal or provincial programs that help offset mitigation costs. A proposal for amendment to the *Income Tax Act* has been included in submissions on Canada's federal budget by the Green Budget Coalition, for each of the 2015, 2016, 2017 and 2018 budget years. The Coalition called for a federal radon tax credit of up to $3,000 available to individual Canadians for radon mitigation by experts certified by the Canadian National Radon Proficiency Program. Using generalized calculations, anticipated costs of this measure were expected to reduce federal income tax revenues (from using the tax credit) that could be offset by increased tax revenue from businesses conducting radon mitigation. Supporters of this initiative included the Canadian Environmental Law Association (CELA), CARST, and the Take Action on Radon (TAoR) team.[427] For the 2018 Budget the proposal was modified to urge either a tax credit or a grant program with comparably neutral financial consequences for the federal government.[428]

At least one city— Victoriaville, Quebec— does provide subsidies for both new home construction and retrofits of existing homes. The Victoriaville program is fully discussed at s. 5.5 below.

4.9.3 Prizes

Prizes are a relatively low cost intervention in which participants are encouraged to participate by the chance of reward. They are often used in areas of innovation, such as green technology, where they are felt to drive competition amongst businesses or engineering teams.[429] In 2017 Take Action on Radon (TAOR) and CARST partnered to offer a total of $10,000 for a National Radon Reduction Sweepstakes. Homeowners that have tested their home for radon and taken action to reduce levels to below Health Canada's recommended guideline have a chance to receive a rebate for up to $1,000 towards the cost of the radon reduction method in their home. There will be 10 draws, each worth up to $1,000 with two prizes awarded per region.[430]

4.9.4 Loan programs

Loan programs can help homeowners (and others) cover the problem of large upfront costs for improvements that reap benefits over the long term. In the United States Property Assessed Clean Energy (PACE) has emerged as a prime means for financing energy efficiency upgrades or renewable energy installations. Depending on state legislation, PACE can be used to finance building envelope energy efficiency improvements like insulation and air sealing, cool roofs,

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[427] Take Action on Radon, 2016.: Guidance Document: Recommended Strategic Direction for Supporting Radon Mitigation. At https://www.takeactiononradon.ca/file/take-action/pdf-radon/pdf-radon-updated/White-Paper-_Recommended-Strategic-Direction-for-Supporting-Radon-Mitigation.pdf accessed May 22, 2018. Cooper, K. 2016. A Tax Credit for Radon Remediation: Logical Next Step for Feds. Canadian Environmental Law Association, January 18, 2016. Available at http://www.cela.ca/blog/2016-01-18/tax-credit-for-radon-remediation-logical-next-step-for-feds accessed May 22, 2018. Green Budget Coalition, 2016. Recommendations for Budget 2016— Indoor Air: Tax Credit for Radon Remediation. Available at http://greenbudget.ca/wp-content/uploads/2016/01/GBC-Radon.pdf accessed May 22, 2018

[428] Green Budget Coalition, 2017. Recommendations for Budget 2018. Available at http://greenbudget.ca/past-recommendations/ accessed July 31, 2018.

[429] See for example the The Clean Tech Open in Sillicon Valley. https://www.cleantechopen.com/app.cgi/content/competition/ideas/index accessed May 22, 2018.

[430] (see https://www.takeactiononradon.ca/radon-reduction-sweepstakes-2017.

water efficiency products, seismic retrofits, and hurricane preparedness measures. Governments can offer a specific bond to provide financing to the building owners to put towards an energy retrofit. The loans are repaid over the selected term (over the course of somewhere between 5 and 25 years) via an annual assessment on their property tax bill. The loan is attached to the property rather than an individual. PACE helps home and business owners pay for the upfront costs of green initiatives. This form of on-bill financing allows property owners to begin saving on energy costs while they are paying for their upgrades. Governments and other institutions can also provide modest subsidies through allocating funds to backstop financing or offer low or zero interest loans.[431]

So far Canada has seen very few such programs. Yukon Housing Corporation has a Home Repair Loan program available to Yukon residents that includes radon mitigation. It provides financing to address building components in need of repair, energy efficiency upgrades, overcrowding and accessibility issues. It allows for borrowing up to $50,000, at interest rates of prime + 1%, amortized over 15 years. Eligible clients can receive a forgivable loan and subsidy program (max $30,000). Properties on rented or leased land are eligible for up to $20,000 in financing.[432]

Manitoba Hydro has developed an Energy Finance Plan that allows for upgrades to gas and electrical systems, but also includes radon mitigation if done through a C-NRPP certified mitigator. It is available to Manitoba Hydro residential, commercial, farm, and seasonal customers. It allows financing up to $5,000.00 per residence for a maximum term of 5 years. Instalments are applied to energy bills. However, the interest rate is too high to be much of an encouragement— currently 6.75%, which, as of May 22, 2018 was 3.3% over the prime lending rate of 3.45%.[433] By comparison, Vancouver City Savings Credit Union provides the Vancity Home Energy™ Loan at prime+1% rate for up to 15 years, with borrowing as little as $3,500 or a maximum of $50,000.[434]

4.9.5 Landlord and tenant cost sharing

Manitoba's *Residential Tenancies Act*, C.C.S.M. c. R119 at section 137 provides a unique mechanism whereby tenants and landlords might share the cost of repairs. We have not heard that this has been used for radon. The Act provides that a tenant can request an improvement to a unit, and the landlord may apply to the director for an order fixing the value of the improvement, alteration, service, facility, privilege, accommodation or thing. The director may make an order fixing the value to the tenant of the improvement and specifying how this could be paid for. This mechanism potentially allows a tenant to request radon mitigation but only pay for it pro-rated to the time they rent their unit. Such a mechanism may make sense in jurisdictions where it proves to be politically unfeasible to pass laws requiring landlords to bear the cost of mitigation.

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[431] There is a large literature on this, for example see Speer, B. and Koenig, R. 2009. "Property-Assessed Clean Energy (PACE) Financing of Renewables and Efficiency" National Renewable Energy Lab. at https://www.nrel.gov/docs/fy10osti/47097.pdf accessed May 22, 2018.
[432] Yukon Housing Corporation, 2018. Loan Programs. at http://www.housing.yk.ca/loans-programs.html#Home%20Repair accessed May 22, 2018.
[433] Canadian Prime Rate available at https://www.ratehub.ca/prime-rate accessed May 22, 2018.
[434] Vancouver City Savings Credit Union, 2018. Home Energy Loans. at https://www.vancity.com/Loans/TypesOfLoans/HomeEnergyLoan/ accessed May 22, 2018.

Part 5 - Municipal leadership

5.1 The role of municipalities

. Municipalities tend to be delegated the responsibility for public services such as water supply, sewage and garbage disposal, public health, roads, sidewalks, building codes, and parks. Having jurisdiction over issues such as land use planning and approvals, municipalities are responsible for passing zoning by-laws, and issuing building permits. Municipal building by-laws generally include property maintenance standards, as well as requirements for the approval of building permits prior to construction, the authorization of building inspections, and include powers to issue orders necessary to direct compliance with the applicable (provincial/territorial) code. Municipalities can have significant powers to regulate radon:

- Municipalities are creatures of statute, and derive their powers from provincial enabling legislation. However, over time, that legislation has expanded the range of powers of municipalities, and enabled municipal action through broad general purpose provisions. The courts, in turn, have adopted a deferential stance to reviewing municipal bylaws, and afforded municipalities a liberal interpretation of their powers.[435] This deference extends to powers to pass by-laws in respect of health and general welfare. To the extent that local government and province/territory or federal government attempt to regulate the same subject matter, the local government's by-law will not be found to be inoperative unless it conflicts with, or frustrates the purposes of, legislation enacted by a more senior level of government.[436]
- Public health authorities can influence municipalities through declaring matters to be health hazards, leading municipal governments to take action[437]
- Whether municipalities can adopt building codes depends on provincial or territorial legislation. As described in more detail in Section 4.2 above, provinces and territories with uniform Codes include Nova Scotia, Manitoba, Saskatchewan, Alberta, British Columbia (with the exception of the City of Vancouver), Yukon, and Northwest Territories. Other provinces in some case do allow distinct municipal codes. In Newfoundland and Labrador, municipalities can pass regulations that address building code requirements and many cities have their own building code regulations such as St. John's,[438] Mount Pearl, [439] Paradise, [440] Conception Bay South, [441] Corner Brook, [442] Gander, [443] and Grand Falls-Windsor.[444] In

[435] United Taxi Drivers' Fellowship of Southern Alberta v. Calgary (City) (2004), 2004 SCC 19). Catalyst Paper Corp v North Cowichan (District), [2012] 1 SCR 5.
[436] 114957 Canada Ltée (Spraytech, Société d'arrosage) v. Hudson (Town), [2001] 2 SCR 241
[437] Croplife Canada v. Toronto (City), 2005 CanLII 15709 (ON CA)
[438] Building By-Law, By-Law no. 1438 (as last amended by By-Law no. 1610, May 14, 2018), Section 46, online: http://www.stjohns.ca/bylaws.nsf/nwByLawNum/1438.
[439] https://www.robertmiller.ca/node/8.
[440] Town Of Paradise Development Regulations, 2016, online: http://www.paradise.ca/en/town-hall/resources/Municipal-Plan/Municipal-Plan-Final/Paradise-Development-Regulations.pdf
[441] Building Regulations, Town of Conception Bay South, 2017, Section 15, online: https://www.conceptionbaysouth.ca/mdocs-posts/018-building-regulations/
[442] City of Corner Brook, online: http://www.cornerbrook.com/wp-content/uploads/2016/05/Building-By-Law1.pdf
[443] http://gandercanada.com/wp-content/uploads/2017/03/Residential.pdf.

Prince Edward Island, municipally-incorporated areas have jurisdiction over issuing building /development permits and three municipalities (Charlottetown, Summerside and Cornwall) were early adopters of the National Building Code[445] In New Brunswick, the City of Fredericton applies additional requirements that go beyond the National Building Code, and requires that sub-slab venting be extended all the way to the roof in all new buildings.[446] In Quebec, the Régie du bâtiment du Québec empowers municipalities to establish by-laws with stricter radon requirements and several municipalities have done so or are planning to do so including Ascension, Chelsea, Oka, Notre-Dame de Pont Main, La Pocatière, Saint-André-d'Argenteuil, Saint-Colomban, Saint-Hilaire, Saint-Pierre Île d'Orléans and Vallée-de-la-Gatineau.[447,448] In Ontario several Ontario municipalities have moved ahead with stronger standards, including the City of Guelph, Central Elgin, St. Thomas, Thunder Bay, Southgate and Grey Highlands.[449] In Nunavu**t**, the town of Iqaluit has a distinct Building bylaw[450]

- Radon protection has been incorporated into some municipal by-laws, including: Elliot Lake, Ontario, and Oka, St-André d'Argenteuil, Mont Saint-Hilaire in Quebec. (Below we discuss new initiatives in Calgary, Guelph, Thunder Bay and Victoriaville.)
- Municipalities can use approval processes such as permitting to drive radon mitigation.[451]
- Municipalities can enact property standards bylaws that protection renters and this can extend to radon.

Municipalities are charged with enforcing building codes, but they also have considerable leeway as to when to enforce them. Once they take on enforcement, they have a duty to do this properly— courts will find municipalities liable for negligent inspection. One a city makes a policy decision to inspect building plans and construction it should expect people to rely on this approach.[452] To avoid liability, the government agency must exercise the standard of care in its inspection that would be expected of an ordinary, reasonable and prudent person in the same circumstances. It is possible that as radon regulation expands municipalities will need to ensure that inspectors are trained concerning radon mitigation

5.1.1 Municipal leadership – Victoriaville, Quebec

Victoriaville is a small city in Central Quebec with a population a bit over 45,000 people, and lying southeast of Trois-Rivières. Along with well known summer festivals, such as the Festival

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[444] Development Regulations 2012-2022, Town of Grand Falls-Windsor, 2012, at p. 19, online: http://grandfallswindsor.com/images/GF-W_Development_Regs_2012-2022_JAN-13_edit_Full_Report_Single_Sided.pdf
[445] Personal communication, Health Canada Regional Radiation Specialist, Atlantic Canada (June 25-28, 2018).
[446] Personal communication, Health Canada Regional Radiation Specialist, Atlantic Canada (June 25-28, 2018).
[447] https://www.apchq.com/documentation/technique/questions-et-reponses/le-radon.
[448] Personal Communication, Health Canada Regional Radiation Specialist, Quebec (June 12, 2018).
[449] https://www.publichealthgreybruce.on.ca/Portals/0/Documents/Publications/General%20Reports/Radon%20Policy%20Statement.pdf
[450] Iqaluit Building By-law #710, 2010, online: https://www.city.iqaluit.nu.ca/content/building-law-710.
[451] Bonaire Highlands Ltd. v. Fergus (Town) (2008 CarswellOnt 874).
[452] *Rothfield v. Manolakos* [1989] 2 SCR 1259; *Ingles v. Tutkaluk Construction Ltd.* [2000] 1 SCR 298

International de Musique Actuelle de Victoriaville [453] it has long cultivated sustainability policies (in areas of recycling and composting) gaining a reputation as the 'cradle of sustainable development.' As part of a broader sustainable buildings program— Victoria Sustainable Habitation (VSH) it has provided a system of incentives for new construction and, more recently, new regulations covering radon.[454] It works together with companies that provide technical knowledge and appraisal, such as Ecohome[455] and Hydro- Quebec's Renoclimat Program.[456]

The VSH program provides for homeowners to make a series of 'gestures' that, if taken together would transform local buildings to be healthier, more energy efficient and ecological. This program allows choices between more than a hundred building options that homeowners can take, ranging from putting in south facing windows (to capture passive solar energy), water efficient taps, to recycled materials in home additions. Participants were given points for each action, which add up to 3, 4, or 5 "stars" which then become hard money incentives up to 8,000 dollars. The program started in 2011. By 2014 radon mitigation systems were added. Participants were encouraged to install a radon exhaust system in line with the National Building Code, 2010, e.g. aggregate under slub, a sunction point and a PVC pipe equipped with a sealed screw cap inside the house in anticipation of the installation of a sub-slab depressurization system. In September 2016 the City moved to add this has a formal requirement in the local building code.

VSH included a separate renovation component involving homeowner grants for building retrofits. These were available in areas of greenhouse gas emissions, and ecology, and guiding values included sustainable material use, local procurement, reduced water consumption; improved waste management, universal accessibility, and air quality.[457] After 2013 up to 2017, radon was included as an "eco-action" which would be subsidized— 35 dollars for radon testing and 150 dollars for mitigation. Information pamphlets made it clear to homeowners the risks of radon, and that results over 200 bq/m^3 pointed to the need to mitigate. IN 2018 the "VSH Plus" program was established, and gave 45 dollars for radon testing and 150 dollars of mitigation works.

5.1.2 Municipal leadership - Thunder Bay, Ontario

Thunder Bay took an early lead with the Thunder Bay District Health Unit initiating a program in 2014, giving out 500 free test kits and paying for analysis. They found that 16% of the houses tested had radon levels higher than Health Canada guidelines. This result is well above the Canadian average of 6.9% and the Ontario average of 4.6%.The complete report was released in

[453] Festival International de Musique Actuelle de Victoriaville at http://www.fimav.qc.ca/en/
[454] Cyr, S. 2018. Minimizing Exposition to Radon. Municipal Bylaws. http://www.carst.ca/resources/Conference%202018/Presentations2018/Radon%20-%20réduction%20de%20l'exposition%20(anglais)%20Victoriaville.pdf Presented as Victoriaville-A Unique Approach to Municipal Grant Programs. at CARST 2008, April 24, 2018.
[455] https://www.ecohome.net
[456] http://www.transitionenergetique.gouv.qc.ca/en/my-home/renoclimat/#.Wvz_oy8ZNSw
[457] http://www.habitationdurable.com/victoriaville/images/pdf/formulaire-ecogestes-2014.pdf

November 2015.[458] The Health Unit has gone on to do further testing (and distributing free kits in neighbouring towns of Oliver Paipoonge and Marathon.[459]

Action on Radon was then integrated into the City's EarthCare Sustainability Plan 2014-2020 (published 2015). The plan draws on extensive citizen and stakeholder engagement through 11 working groups in thematic areas of energy, green building, land use planning, climate adaptation, education, food, mobility (active transportation, transit, walkability), waste, air, community greening and water. This document states goals, objectives, and proposed actions leading to greater community sustainability, resilience, and reduced greenhouse gas emissions. It aims to lead the community in securing the environmental health of the region, and thereby improve the social, cultural, and economic wellbeing of future generations. It builds on successive sustainability plans (such as the EarthWise Thunder Bay Community Environmental Action Plan, 2008). Special attention is given to air quality, including indoor air—and to this end radon mitigation is stated as important (section 8.0). For Air quality, Objectives include having by 2020 Thunder Bay citizens with the air quality and noise resources they need to make environmentally responsible decisions. To this end, actions for community are recommended, and radon is given a central role. Citizens are to be educated and informed about air quality and noise by means of educational initiatives and community resources including a website highlighting ideal resources and links. Radon is one such topic. The City is to promote, within the existing building permit process, the requirement for radon mitigation "rough-ins" to be included in new housing construction. [460]

The city has subsequently hosted public talks and workshops by mitigators.[461] The police station was tested and was well below Health Canada guidelines.[462] In 2017 the Building Services Division has fully implemented radon testing and mitigation requirements for new residential buildings within the City of Thunder Bay. Results from mandatory testing of these projects may determine radon mitigation beyond basement slab and/or foundation wall sealing. This may include a sub-slab exhaust system.[463]

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[458]Sieswerda L, Czinkota G, Edwards K. 2015. The prevalence of high residential radon in Thunder Bay, Ontario. Thunder Bay, Ontario: Thunder Bay District Health Unit. : Availabe at The Prevalence of High Residential Radon in Thunder Bay accessed May 20 2018.

[459] Thunder Bay District Health Unit, undated. Free Radon Kits for Oliver Paipoonge and Marathon. https://www.tbdhu.com/news/free-radon-kits-for-oliver-paipoonge-and-marathon-1

[460] City of Thunder Bay, 2015. EarthCare Sustainability Plan 2014-2020. http://www.thunderbay.ca/Assets/Living/Environment/images/2014-2020+EarthCare+Sustainability+Plan.pdf

[461] City of Thunder Bay, 2016. Everything You Need to Know About RADON: Healthy Get Together. available at http://www.thunderbay.ca/Assets/Health+Get+Together_Oct+2016_Public_FINAL.pdf; City of Thunder Bay, 2016. Radon 101 Workshop. http://www.thunderbay.ca/Living/Environment/EarthCare_Thunder_Bay/Resources/Community_Events/Radon_101_Workshop_s_p23371.htm?EventMode=View&EventOccurrence=0

[462] Thunder Bay Police Services, 2017. Agenda Material for the Thunder Bay Police Services Board. Tuesday, July 25, 2017 http://www.thunderbay.ca/Assets/City+Government/Council+Meetings/docs/Thunder+Bay+Police+Services+Mtg+July+25$!2c+2017.pdf

[463] City of Thunder Bay, 2017. Building Services Division/Ontario Building Code Updates for 2017 http://www.thunderbay.ca/City_Government/News_and_Strategic_Initiatives/News_Releases/Building_Services_Division_Ontario_Building_Code_Updates_for_2017_s_p23925.htm?EventMode=View&EventOccurrence=0

5.1.3 Municipal leadership - Guelph, Ontario

The 2012 Health Canada radon studies showed the Wellington-Dufferin-Guelph had much higher than average radon levels: 18 per cent of homes were above the Health Canada Guidelines. One of the Guelph homes tested showed radon levels of 984 Bq/m^3.[464] In the face of a policy vacuum created by poor provincial radon regulation, in 2015 Guelph adopted a Radon Gas Mitigation Program requiring new-build homes to contain rough-ins for radon mitigation systems and offered free testing in new homes for the first two winters of the program.[465]

Guelph's Radon Gas Mitigation Program requires that all new low-rise residential dwellings (and +20 m^2 additions to existing buildings) must include radon gas mitigation measures. One of the following mitigation methods is required:

1. Rough-in soil gas pipe *and* mandatory radon gas testing.[466]
2. Soil gas barrier on the foundation walls, soil gas barrier under the basement floor slab.
3. Soil gas barrier on the foundation walls, active sub-slab depressurization system.

Where the builder opts for a simple radon rough-in, the home is subject to a mandatory long-term (minimum 91 days) radon gas testing and where a test result is over 200 Bq/m^3 the builder must conduct the radon mitigation. To ensure that testing occurs in new homes, or voluntary testing occurs in existing homes, residents that move into new homes are contacted by the city each fall to do radon testing and confirm that levels are below the 200 Bq/m^3 level.[467]

Beyond these requirements for low-rise residential buildings, the Guelph program requires all new industrial, commercial, institutional and non-low-rise multi-residential additions that exceed 50 m² to implement radon controls.

Even still, in 2016 officials from Wellington-Dufferin-Guelph Public Health (WDGPH) told journalists that enough people were getting their homes tested: "Generally we feel like there isn't a lot of awareness on this important issue," said Shawn Zentner, Manager of Health Protection for WDGPH.[468] The result was an educational campaign with presentations and subsidized radon kits. [469]

Commentators suggest most builders building in Guelph are going with option 1. While the rough in is in itself insufficient, it has led to a large increase in testing. The city sends letters to

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[464] Ponciano, C. 2016. Radon gas: Invisible problem, invisible issue, says Guelph Health. CBC News. Nov 06, 2016 http://www.cbc.ca/news/canada/kitchener-waterloo/radon-gas-issue-guelph-public-health-1.3837337

[465] City of Guelph, 2015. Radon Gas Mitigation Program http://guelph.ca/city-hall/building-permits-inspections/residential-building-permits/radon/ (accessed February 14, 2018)

[466] According to one Real Estate Brokerage, it would appear that this option is most commonly selected by builders: http://talk.trilliumwest.com/2017/02/02/radon-gas-in-guelph-what-you-need-to-know/.

[467] http://www.cbc.ca/news/canada/kitchener-waterloo/radon-gas-issue-guelph-public-health-1.3837337.

[468] Ponciano, C. 2016. Radon gas: Invisible problem, invisible issue, says Guelph Health. CBC News. Nov 06, 2016 http://www.cbc.ca/news/canada/kitchener-waterloo/radon-gas-issue-guelph-public-health-1.3837337

[469] Coxson, D. 2016. Radon testing and awareness growing in Guelph. Guelph Tribune, January 16, 2016. availabe at https://www.guelphmercury.com/news-story/6234783-radon-testing-and-awareness-growing-in-guelph/ Accessed May 21, 2018

new homeowners reminding them of the mandatory or voluntary radon gas testing, with contact information for the testing company that the City of Guelph is working with.[470]

[470] Walker, R. 2017. Radon Gas in Guelph – What you need to know. http://talk.trilliumwest.com/2017/02/02/radon-gas-in-guelph-what-you-need-to-know/

Appendix 1: Scan of Radon Regulations, Policies and Initiatives in Europe

Contents

1. European Union

On December 5, 2013, the Basic Safety Standards Directive[1] (BSS-Directive) was approved by the European Council, and entered into force not long after. The BSS-Directive (Art. 106.1) gave the Member States a significant period of time to implement its various provisions. The Member States were thus required, no later than February 6, 2018, to bring into force the laws, regulations and administrative provisions necessary to comply with the Directive. While the Directive has been in existence for a while, the implementation deadline has thus only recently been passed.

The BSS-Directive contains a number of provisions that help address the issue of radon in private and public buildings. These provisions, which can be expected to have an impact on radon requirements and policies in the EU-member states, are briefly examined below.

1.1. Radon in Workplaces

According to art. 54.1, Member States are required to set a national reference level for indoor radon concentrations in workplaces. The reference level must not be higher than 300 Bq/m^3, unless a higher level is warranted by so-called *national prevailing circumstances*.

While this exception opens the door to deviating from the otherwise clear requirement in art. 54.1, Recital 24 of the directive adds that, where this exception is invoked and a Member State establishes a higher reference level, it should submit information on this issue to the Commission, thus allowing for a review of the deviation.

1.2. Indoor Radon Exposure in General

Art. 74.1 requires that Member States establish a generally applicable annual average reference level for indoor radon concentrations. Like art. 54, art. 74 also requires that this reference level be no higher than 300 Bq/m^3. Unlike workplaces, art. 74 does not allow exceptions to this requirement. Notably, art. 74.1 anticipates that several different reference levels may be set, e.g. different levels for new and existing buildings.

Art. 74.2 ties the requirement in art. 74.1 to the Radon Action Plan described in art. 103, by making it a requirement that member states, through this Action Plan, promote action to identify dwellings where reference levels are exceeded, as well as encourage radon reducing measures in dwellings. While this provision is highly discretionary, it does bring focus to the need for both radon mapping and the promotion of radon mitigation.

Art. 74.3 requires that Member States ensure that both local and national information on indoor radon exposure and associated health risks is made available, alongside the importance of radon

1 Council Directive 2013/59/Euratom of 5 December 2013, online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013L0059.

measurements and radon mitigation. As will be seen from some of the national examples below, information and awareness are essential tools when working to reduce radon exposure, and art. 74.3, while again being highly discretionary brings this need into focus at the EU-level.

1.3. Radon Action Plan

Art. 103.1 requires that each Member State establish a Radon Action Plan. The goal of the Action Plan must be to address long-term risks from radon exposures. It must cover dwellings, buildings with public access and workplaces, and must deal with all sources of radon (soil, building materials and water).

It is also required that the Action Plan be updated on a regular basis, although no specific requirements are set out in terms of how often.

Art. 103.1 refers to Annex XVIII of the BSS-Directive, which contains a list of 14 key items to consider when preparing the action plan. Three examples of suggested items for inclusion are:

- (1) Strategy for conducting surveys of indoor radon concentrations or soil gas concentrations for the purpose of estimating the distribution of indoor radon concentrations, for the management of measurement data and for the establishment of other relevant parameters (such as soil and rock types, permeability and radium-226 content of rock or soil).
- (3) Identification of types of workplaces and buildings with public access, such as schools, underground workplaces, and those in certain areas, where measurements are required, on the basis of a risk assessment, considering for instance occupancy hours.
- (5) Assignment of responsibilities (governmental and non-governmental), coordination mechanisms and available resources for implementation of the action plan.

In addition, art. 103.1 also refers to art. 100.1, which requires, *inter alia*, that Member States take action, if they find evidence or indications of exposures that cannot be disregarded from a radiation protection point of view. This requirement supplements the above-mentioned reference levels and places on Member States a duty to act when confronted with radon risks, and requires that duty be reflected in the Action Plan. Read together with the general provisions of art. 103.1 this duty to act could be taken as setting a reasonably high bar in terms of what is actually required under the Radon Action Plans. Art. 103.1 provides for a number of different actions that are likely to uncover information about elevated radon levels, which then trigger the duty to act in art. 100.1. Exactly what the Commission will require of Member States may become clearer once their Radon Action Plans have been reviewed by the Commission.

Art.103.2 requires that appropriate measures be put in place to prevent radon from entering new buildings. The provision thus aims to ensure that new buildings constructed after the BSS-Directive's implementation deadline (February 6, 2018) will have acceptable radon levels – a requirement that applies in general, and not just to areas with elevated radon levels. While this requirement may be implemented through building code requirements, it is left up to the Member States to decide how best to implement art. 103.2. As this requirement is included in art. 103 it must be implemented as part of the Radon Action Plan.

According to art. 103.3, Member States are required to identify areas where the annual average radon level is expected to exceed national reference levels in a significant number of buildings. This provision requires that testing and mapping efforts be carried out. While the extent of such efforts may vary, they need to be sufficient to identify high radon areas. Again, this requirement is included in art. 103 and must therefore be implemented as part of the Radon Action Plan.

1.4. Enforcement Provisions

And finally, art. 104 requires a *system of enforcement*, which covers, but is not limited to, radon related issues. The requirements placed on the Member States are as follows:

- Establish a system or systems of inspection to enforce the provisions put in place to implement the Directive and initiate surveillance and corrective action where necessary.
- Ensure that the competent authority establishes an inspection programme.
- Record and communicate findings from each inspection to the business or employer concerned.
- Ensure that outlines of the inspection programmes and their main findings are available to the public.
- Ensure timely dissemination to relevant parties of protection and safety information concerning significant lessons learned from inspections, reported incidents and accidents.

Art. 105 in turn requires that a competent authority in each Member State must be given "*the power to require any individual or legal person to take action to remedy deficiencies and prevent their recurrence or to withdraw, where appropriate, authorisation when the results of a regulatory inspection or another regulatory assessment indicate that the exposure situation is not in compliance with the [law]*".

Again, the requirements in Sections 104 and 105 are broadly worded, but do provide a solid basic framework, which is likely to help improve enforcement of the rules put in place as a result of the BSS-Directive. As with many other EU-directives, each individual Member State is given a fair degree of freedom in terms of how ambitious it intends to be, while the Commission will step in, if it finds that a Member State is not living up to the basic requirements of the BSS-Directive in question or fails to explain what steps it has taken and how it expects those steps to fulfill the requirements of the Directive.

1.5. A Promising EU-Framework

In general, the directive is a significant step forward for EU-wide radon policy and requirements as evidenced by its expansive requirements as well as its demand for a Radon Action Plan, which is intended to tie the various radon requirements together in a comprehensive strategy, while ensuring adherence to the radon reference levels.

The directive provides flexibility by allowing Member States freedom in choosing how to implement its requirements. Some of this flexibility is ensured by the fact that individual Member States are free to choose what exact measures to take in order to achieve the various objectives set out in the Directive, while other provisions provide flexibility in terms of how stringent to apply the more specific radon-related requirements.

1.5.1. Still early days for the implementation of the directive

With that being said, only two of the four EU Member States examined below have so far prepared a Radon Action plan. While not particularly impressive, all four countries have taken steps to implement the directive. The delay may be due to a lack of clarity in terms of when the Action Plans must be completed, and may also be a result of these countries having worked on radon issues for several decades and having already developed certain strategies to deal with the radon issue, and thus not prioritizing this new requirement.

Article 106.1 of the Directive merely asserts that "Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive by 6 February 2018" as such it does not set a clear review timeline. At this point, it is unclear what action the Commission intends to take to ensure that all Member States prepare compliant Radon Action Plans. In what follows we provide examples of individual state action, including the ways that they incorporate Action Plans for complying with the EU Directive.

2. Denmark

2.1. Radon Limits for New Buildings – Recommendations for Existing Buildings

The 1995-Building Code (BR95) incorporated radon measures for larger buildings, including schools and commercial buildings. The 1998-Building Code (BR-S 98) then moved to introduce radon requirements for small buildings such as detached homes and townhouses. However, rather than firm radon limits, the Codes called for buildings to have impermeable membranes where in contact with the subsoil.[2] [3] BR-S 98 recommended that mitigation measures be taken when indoor radon levels were between 200 Bq/m^3 and 600 Bq/m^3. It furthermore recommended that simple and inexpensive improvements be made to existing buildings when levels were between 200 Bq/m^3 and 400 Bq/m^3 and that more effective improvements be made when the radon levels exceed 400 Bq/m^3. For new construction it was recommended that radon levels should not exceed 200 Bq/m^3.[4] BR-S 98 and BR95 were combined into one single Building Code in 2008, which carried over the existing radon requirements.

The 2010 version of the Building Code (BR10) saw the introduction of the current requirement that new buildings must be constructed to ensure that radon levels in indoor air remain below 100 Bq/m^3. BR10 also added that the reduction of radon levels can be achieved in any number of ways, so long as the approach taken is effective at ensuring that the parts of a building that are in contact with the subsoil are airtight.[5] This requirement thus allows for a broad range of radon reduction methods to be used, so long as it can be demonstrated that they achieve at least the same level of protection against radon as the existing requirements, and so long as radon levels do not exceed 100 Bq/m^3. These requirements are carried over into the 2018 version of the

[2] Bygningsreglement for erhvervs- og etagebyggeri (BR95), Chapter 11.4.2 Radon, online: http://historisk.bygningsreglementet.dk/br95_00/0/42.
[3] Bygningsreglement for småhuse (BR-S 98), Chapter 6.5.2 Radon, online: http://historisk.bygningsreglementet.dk/brs98_00/0/42.
[4] Ibid.
[5] Bekendtgørelse nr. 810 af 28. juni 2010 om bygningsreglement 2010 (BR10), Section 6.3.3.2(2), online: https://www.retsinformation.dk/Forms/R0710.aspx?id=132697.

Building Code (BR18), and in the guidance document to BR18 it is emphasized that the radon prevention requirements apply throughout the life of the building.[6]

For existing buildings, the guidance document to BR18 recommends, but does not require, that simple and cheap improvements be made when the radon level is between 100 Bq/m^3 and 200 Bq/m^3, and that more effective measures be taken when the radon level exceeds 200 Bq/m^3.[7]

In general, three main methods of reducing radon levels are suggested, namely creating an airtight barrier against the subsoil, active ventilation inside the building and sub-slab suction systems.[8]

2.1.1. Enforcement of the Building Code

Failure to comply with the Building Code, including failure to ensure radon levels below 100 Bq/m^3, may lead to the imposition of fines.[9] Overall responsibility for approvals and inspections under, and enforcement of, the Building Code is placed on Denmark's 98 municipalities.[10] The enforcement and possible imposition of fines is thus highly contingent on the ability and willingness of each municipality to carry out inspections and enforce the building code.

2.1.2. 10-year new home warranty covers radon

The Building Act[11] and the Building Insurance Regulation,[12] state that the builder must ensure that a new home is covered by a 10-year warranty (premium must be paid by the builder). This warranty covers a wide variety of deficient work and materials and structural defects, including elevated radon levels, and includes mandatory inspections after 1 year and after 5 years to be paid for and initiated by the insurance company that is providing the home warranty. The inspection includes a visual inspection of radon mitigation efforts to the extent possible (barriers may be impossible to inspect visually), but could conceivably also include a radon test. For houses constructed after the 2010 Building Code revisions, this insurance may be relied upon if testing shows that annual average radon levels exceed the 100 Bq/m^3 limit, as this would constitute a violation of the Building Code.[13]

2.1.3. Status Reports for Real Estate Transactions

A status report is a highly common (but not legally required) document used in Denmark as part of real-estate transactions. The report is prepared by a professional building inspector and

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[6] Bygningsreglementets vejledning om forureninger (§ 329 - § 333), 1.2. Forureninger fra undergrunden, Bygningsreglementet 2018, online: http://bygningsreglementet.dk/Tekniske-bestemmelser/13/Vejledninger/Generel_vejledning.

[7] Ibid.

[8] Ibid.

[9] Bekendtgørelse nr. 1615 af 13. december 2017 om bygningsreglement 2018 (BR18), Section 564.1, online: https://www.retsinformation.dk/Forms/R0710.aspx?id=196435.

[10] Ibid., Section 3.

[11] Byggeloven, jf. Lovbekendtgørelse nr. 1178 af 23. september 2016, Chapter 4 A, online: https://www.retsinformation.dk/Forms/r0710.aspx?id=183662#id84f68ced-fc5b-4677-bd59-3427fbe44c1a.

[12] Bekendtgørelse nr. 1292 af 24. oktober 2007 om byggeskadeforsikring, online: https://www.retsinformation.dk/forms/r0710.aspx?id=113467.

[13] Betænkning 1520 - Huseftersynsordningen afgivet af Justitsministeriets udvalg om huseftersynsordningen, appendix 7, online: http://jm.schultzboghandel.dk/upload/microsites/jm/ebooks/bet1520/index.html.

contains information about the property in question. [14] These reports are important for a distinct system in Denmark of change of ownership-insurance, which covers latent defects on real estate transactions. The main purposes of the report are to: Inform the buyer about the property and its potential deficiencies; set a baseline for the application *of change of ownership insurance; and* provide the seller with an opportunity to disclose issues with the property and avoid potentially being held responsible for latent defects later. At this point radon measurement is not required. However, the status report should include the average radon levels in the area where the house is located as well as general information on radon issues, measurements and remediation. [15] [16] Radon is not (yet) covered by the change of ownership-insurance.

2.2. Schools and Preschools

While all buildings are covered by generally worded ventilation and indoor air quality requirements in the building code, schools and preschools built after 1995 are covered by a specific and relatively demanding set of ventilation requirements, which result in the air in a room being exchanged several times per hour.

Fresh air supply to and extraction from schools and preschools must be no less than 3 liters of air per second per child [5 liters per second per child in schools] and no less than 5 liters per second per adult, plus 0.35 liters per second per m² floor area. [17]

The responsible ministries estimate that these mechanical ventilation requirements have significantly reduced the risk that radon levels exceed the 100 Bq/m^3 limit in schools and preschools built after 1995. [18]

Schools and preschools built after 1995 are furthermore governed by the above-mentioned requirement that any parts of the building in contact with the soil must be airtight, while schools built after 2010 must adhere to the clear 100 Bq/m3 limit introduced with the 2010 Building Code (BR10).

Thus, while schools and preschools built after 1995 (and in particular after 2010) can be expected to have low radon levels, in the case of schools and preschools built before 1995, and which have not been substantially modified, the above-mentioned requirements do not apply. These older schools and preschools thus have a greater risk of elevated radon levels. The problem appears to remain somewhat unresolved, and while the individual municipalities are

[14] Boligejer - Tilstandsrapport, Erhvervsstyrelsen, online: https://boligejer.dk/tilstandsrapport.
[15] Nye krav til tilstandsrapporten, Idenyt, May 1, 2012, online: http://www.idenyt.dk/huset/boligoekonomi-forsikring/nye-krav-til-tilstandsrapporten/.
[16] Huseftersyn – Tilstandsrapport for ejendommen, Sikkerhedsstyrelsen, September 28, 2017, online: http://naturstyrelsen.dk/media/223917/tilstandsrapport-og-allonge.pdf.
[17] Bekendtgørelse nr. 1615 af 13. december 2017 om bygningsreglement 2018 (BR18), Section 447, online: https://www.retsinformation.dk/Forms/R0710.aspx?id=196435.
[18] Klima-, Energi- og Bygningsudvalget 2013-14, KEB Alm.del Bilag 239, December 18, 2012, online: http://www.ft.dk/samling/20131/almdel/KEB/bilag/239/1357635.pdf.

responsible for ensuring a healthy environment in municipal schools, only some municipalities have so far taken sufficient steps to measure radon in all schools.[19]

2.3. Workplaces

Workplaces are governed by the general Building Code radon requirements. The comments made regarding schools and preschools thus apply equally here, with the exception of the more onerous ventilation requirements, which are specific to schools and preschools.

2.4. Mapping Efforts

The results of a key Danish radon survey were released in January 2001. The survey, which consisted of living-room measurements averaging 12 months in length,[20] looked at radon levels in 3019 single-family homes (includes detached and semi-detached houses as well as townhouses) and 101 multi-story buildings.[21]

For the country as a whole, 4.6% of single-family homes had radon levels above 200 Bq/m^3. Significant regional variation was found, with some regions having less than 1% of houses above 200 Bq/m^3, while other regions saw more than 10% of single family houses above 200 Bq/m^3.[22]

The survey found that, on average, single-family houses had radon levels of 77 Bq/m^3, while 15 single-family houses had levels above 400 Bq/m^3. Comparatively, the average for multi-story buildings was 18 Bq/m^3 with no findings above 200 Bq/m^3. In total, the average for all homes was estimated at 53 Bq/m^3.[23]

These results are likely to have played some part in Denmark deciding to implement a stricter 100 Bq/m^3 limit for new homes in 2010 – in particular when compared to the average levels found in neighbouring Nordic countries, which are significantly higher than the Danish average of 53 Bq/m^3, but have imposed somewhat less ambitious radon limits.

The survey also found no significant links between radon levels and the use of different types of building materials, although single-family homes with wooden walls tended to have lower radon levels than corresponding homes with outer brick or concrete walls.[24]

2.4.1. Follow-up surveys

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[19] Kommuner har ikke overblik over radon i skoler og daginstitutioner, Danmarks Radio, April 20, 2018, online: https://www.dr.dk/nyheder/indland/kommuner-har-ikke-overblik-over-radon-i-skoler-og-daginstitutioner.

[20] Radon i danske boliger, Kortlægning af lands-, amts- og kommuneværdier, Sundhedsstyrelsen, Statens Institut for Stralehygiejne, January 2001, at p. 70, online: https://www.sst.dk/da/straalebeskyttelse/radioaktivitet/radon/boliger/~/media/A8388BCBB6324490BE8E71549223AE62.ashx.

[21] Ibid., at p. 1.

[22] Ibid.

[23] Ibid., at pp. 60-61.

[24] Radon i danske boliger, Kortlægning af lands-, amts- og kommuneværdier, Sundhedsstyrelsen, Statens Institut for Stralehygiejne, January 2001, at p. 73, online: https://www.sst.dk/da/straalebeskyttelse/radioaktivitet/radon/boliger/~/media/A8388BCBB6324490BE8E71549223AE62.ashx.

While no national surveys have been conducted since the 2001 survey, a 2008 survey looked at improvements since the 1998-changes to the Building Code for small buildings (airtight-requirement introduced).[25]

In the period from July to September 2007, radon levels were measured in 200 detached homes built in the years 2005-2007. To compensate for the seasonal variation, the results were multiplied by a factor 1.5 to calculate estimated annual averages. The average radon concentration in the 200 homes was calculated at 35 Bq/m^3, with 1% of the homes having a radon concentration above 200 Bq/m^3.[26]

The survey only looked at houses located in areas, where higher radon-levels had been found in 2001. The average annual radon level in 2001 for these particular areas was 106 Bq/m^3. In the homes built in 2005-2007, the levels were thus reduced by roughly two thirds, suggesting that the requirements in the 1998-Building Code have been working as intended.[27]

Finally, the below-mentioned radon awareness campaign spearheaded by Realdania will collect results from the many radon tests carried out as a result of its campaigns. Results will be shared with public entities and researchers alike[28] providing for a significant update to existing radon mapping data. So far, initial results from Realdania's campaign show that one in three houses built after 2000 and measured as part of the campaign have radon levels that exceed the recommended limits.[29] [30] However, it should be noted that these are not representative numbers, as the campaign has targeted particularly radon prone areas.[31] Once the results are in, it may be worth reviewing these to see whether the gradually increasing requirements in the Danish Building Code have had the intended effect on radon levels.

2.5. Public Awareness Campaigns, Guidance etc.

Similar to the experience in Sweden (see below), outreach efforts that involve local municipalities seem to lead to an improved impact in terms of motivating home-owners to test for radon. A three-year national 40 million DKK ($ 8 million) awareness campaign, financed by the Realdania non-profit foundation,[32] provides a telling example. In Denmark's second largest municipality (Aarhus), the national radon awareness campaign led to 155 home-owners paying to have radon levels measured during its first year (2015). When the campaign resumed for its

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[25] SBi 2008:12, Radonkoncentrationen i nye Enfamiliehuse, Statens Byggeforskningsinstitut, Aalborg Universitet, 2008, online: https://sbi.dk/Assets/Radonkoncentrationen-i-nye-enfamiliehuse/sbi-2008-12-pdf.pdf.
[26] Ibid., at p. 17.
[27] Ibid., at pp. 17 and 19.
[28] Kommunerne er en vigtig partner i at få nedbragt radon i vores boliger, Danske Kommuner, January 25, 2017, online: http://www.danskekommuner.dk/Blog/Jesper-Nygard/Kommunerne-er-en-vigtig-partner-i-at-fa-nedbragt-radon-i-vores-boliger/.
[29] Københavnske husejere opfordres til at få tjekket for radon , Københavns Kommune, January 22, 2018, online: https://www.kk.dk/nyheder/koebenhavnske-husejere-opfordres-til-faa-tjekket-radon.
[30] Sidste chance for radonmåling denne vinter, Realdania, February 7, 2017, online: https://realdania.dk/projekter/radonfrithjem/nyheder/sidste-chance-for-at-maale_07022017.
[31] Ibid.
[32] www.realdania.org. Realdania's mission is "to improve the quality of life and benefit the common good by improving the built environment."

second year, complemented by a letter (e-mail[33]) sent by the local municipality to 45.000 home-owners, 1.825 home-owners were motivated by the campaign to have radon testing done.[34] [35] This significant difference in success highlights the potential impact of having a local municipality play a central role in such campaigns. The importance of including local municipalities is also linked to the fact that the individual municipalities are responsible for the enforcement of the building code.

2.5.1. Radon-websites

Realdania has also prepared a website with useful guidance on radon mitigation.[36] The website includes a mailing-list, which allows visitors to add their email address. Realdania then sends out notifications and guidance on ordering radon-testing in the fall when radon measurements should be commenced.

A radon-guide[37] has been prepared by the Danish Business Authority, which based on the three simple questions (the municipality you live in, the year your house was built (pre or post 1998), and whether your house has a basement/crawlspace or not) provides a rough assessment of a building's radon risk. Based on this information, the website determines the building's risk category – ranging from 1 to 4 based on past radon measurements carried out in the local municipality.

The Danish Health Authority also has a website with information on radon. [38] The website contains a number of radon resource documents, a list of businesses that carry out radon measurements, as well as links to numerous other radon resources, including the radon-guide described above. Overall, the website is not particularly user friendly or inviting, and looks like a "typical" text-heavy government website, rather than a website aimed at motivating individual to measure and mitigate radon.

All in all, radon information appears spread out over several websites, making it harder to distinguish between official, government-provided information, and private websites that deal in providing radon measurement and mitigation services.

2.6. Incentive Programs

2.6.1. Free radon test kits?

[33] The municipality sent the letters via e-mail. Denmark has set up a secure electronic (e-mail) communication system that replaces conventional mail services: https://www.e-boks.com/danmark/en. This system allows for reduced costs when communicating with home-owners.
[34] Kommunerne er en vigtig partner i at få nedbragt radon i vores boliger, Danske Kommuner, January 25, 2017, online: http://www.danskekommuner.dk/Blog/Jesper-Nygard/Kommunerne-er-en-vigtig-partner-i-at-fa-nedbragt-radon-i-vores-boliger/.
[35] 1825 huse målt: For meget radon i næsten halvdelen, Århus Stiftstidende, October 15, 2017, online: https://stiften.dk/aarhus/1825-huse-maalt-For-meget-radon-i-naesten-halvdelen/artikel/479008.
[36] For meget radon? – Kom godt i gang med din radonsikring, Realdania, online: www.radonfrithjem.dk.
[37] Boliger – Radonguiden, Erhvervsstyrelsen, online: https://boligejer.dk/guide-radon/0/26.
[38] Strålebeskyttelse – Radioaktivitet - Radon, Sundhedsstyrelsen, January 3, 2017, online: https://www.sst.dk/da/straalebeskyttelse/radioaktivitet/radon.

We did not find any indication that public authorities in Denmark are distributing free test kits.

2.6.2. Tax credit for home renovations/improvement

A 27% tax credit of up to 12,000 DKK ($ 2,400) is provided for work carried out by craftsmen, including the installation of radon mitigation measures. The tax credit only applies to the labour portion, not the materials used. [39] To give an example, a radon mitigation project amounting to a total of $ 2,000 worth of materials and $ 1,500 worth of labour would result in a total tax credit of $ 1,500 x 0.27 = $ 405. The Danish Government has thus opted to provide some relief in the form of a permanent tax credit.

2.7. Review of Radon Mitigation Methods

A study of various radon mitigation methods were carried out in 1995, as part of the *Radon-95* project.[40] The research included radon reductions in 21 single family homes with an annual average radon concentration above 200 Bq/m^3.[41] The results showed that active suction under terrain deck resulted in an 85% reduction; mechanical ventilation of uninhabited basements resulted in a 51% reduction; membrane coverage of floor resulted in a 27% reduction; passive suction under the terrain deck resulted in a 23% reduction; while installation of air valves in order to improved natural ventilation resulted in an 11% reduction.[42] These results mirror those seen in other countries, namely that active measures such as sub-slab depressurization and to a lesser extent mechanical ventilation of basements yield much greater radon reductions than more passive measures. Given the relatively small sample size and the age of the survey, it is unclear whether the results are indicative of current mitigation efforts in Denmark.

A more recent study looked at passive radon mitigation measures (passive room ventilation and passive sub slab ventilation).[43] The study examined the use of such measures throughout the year to determine seasonal variations in their efficiency, and found that the radon reduction was greater during the colder months where the temperature difference between indoors and outdoors was the greatest.[44]

A cost benefit analysis was carried out in 2003, looking at the impact of reducing radon levels in existing homes.[45] It concluded that implementing mitigation measures recommended in building code guidance was more likely than not to be beneficial judged purely from a financial perspective.[46] These findings clearly support implementing radon mitigation in older homes and

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[39] Håndværkerfradrag 2018 (servicefradrag), Skatteforvaltningen, online: http://skat.dk/skat.aspx?oid=2234759.
[40] Claus E. Andersen et al., Radon-95: En undersøgelse af metoder til reduction af radonkoncentrationen I danske enfamiliehuse, Forskningscenter Risø, 1995, online: http://orbit.dtu.dk/fedora/objects/orbit:87912/datastreams/file_7753635/content.
[41] Ibid., at p. 2.
[42] Ibid., at. pp. 4-5.
[43] Britt Haker Høegh et al., Effektivitet af naturligt drevne radontiltag året rundt, InnoBYG, 2016, online: https://www.innobyg.dk/media/74936/slutrapport-radon_spireprojekt_rev.pdf.
[44] Ibid., at p. 4.
[45] Reduktion af radon, En samfundsøkonomisk cost benefit analyse, Institutt for Miljøvurdering, August 2003, online: https://www.dors.dk/files/media/graphics/Synkron-Library/Publikationer/IMV/2003/reduktion_af_radon.pdf.
[46] Ibid., at pp. 5-6.

despite the fact that the radon provisions in the Danish Building code are not mandatory for existing buildings.

Although the overall impression left when examining the Danish radon mitigation efforts is that the regulatory framework for new buildings is very ambitious with a limit set at 100 Bq/m^3, and that remedies such as fines are available to help ensure compliance, it is unclear whether the new requirements are actually properly enforced, as no requirement exists to test for radon post-construction. Research has not revealed any systematic government efforts in ensuring compliance, with press coverage suggesting the opposite.[47]

The experiences from recent public/private-partnership awareness campaigns in Denmark suggest that involving local municipalities is an important part of motivating home-owners to carry out testing. It would seem that having municipalities send out information is more convincing, presumably by making it clear that radon has been identified as a risk within the local community and not simply at the regional or countrywide level.

2.8. Radon Action Plan

Denmark has prepared a Radon Action Plan[48] as required in the BSS-Directive. The action plan summarizes the existing efforts aimed at radon mitigation, while providing an overall framework for future radon mitigation work, including the following 10 initiatives, which it aims to implement in 2018-2019:

- Correct measurement and determination of radon levels.
- Unification of measurement and calculation of radon at European level.
- Guidelines for the radon measurement industry on communication of measurement results.
- Assessment of whether the provisions of the Building Code are being followed and have effect.
- Assessment of targeted/selected buildings.
- One consolidated (online) portal with knowledge about radon.
- Information and guidance packages to relevant target groups, including homeowners and other building owners.
- Catalogue of radon solutions.
- Concept for annual information on the start of the radon measurement season.
- Assessment of radon exposure in at-risk workplaces (above 100 Bq/m^3).[49]

As the action plan was published in January 2018, and the full results of the action plan, including these initiatives, are unlikely to be made available before 2020 at the earliest, future review of the results is advisable alongside a review of similar results in other EU-countries.

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[47] Kronik: Krav om radonsikring i nybyggeri skaber falsk tryghed, Mads Leerbech Jensen, Ingeniøren, April 3, 2014, online: https://ing.dk/artikel/kronik-krav-om-radonsikring-i-nybyggeri-skaber-falsk-tryghed-167442.
[48] Radonhandlingsplan, Trafik-, Bygge- og Boligstyrelsen, 2018, online: https://www.trafikstyrelsen.dk/~/media/Dokumenter/09%20Byggeri/Sikre%20og%20sunde%20bygninger/Radonhandlingsplan.pdf.
[49] Ibid., at p. 17.

3. Finland

3.1. General Radon Limits – New and Existing Buildings

The Building Code of Finland (Part D2 Ventilation and indoor climate) and in decision 944/92 by the Ministry of Social Affairs and Health, require that new buildings are designed and constructed to ensure indoor radon levels below 200 Bq/m^3 – a requirement that has been in place since 2004. If radon is not taken into account in the design of a building, a written explanation for this choice (e.g. where local radon surveys clearly show that the radon concentration inside residential buildings is consistently below the permitted maximum value) must be included in the design documents of the building project. [50] [51] [52]

3.1.1. New Home Warranty.

If radon levels in a new building exceed 200 Bq/m^3, the occupant may demand that the radon levels are reduced, with the necessary mitigation efforts covered by the new home warranty. For this reason, it is recommended that radon levels be measured as soon as possible, and during the warranty period.[53] There is, however, no requirement in the Building Code that radon measurements be carried out, although some local authorities require or recommend such measurements.[54]

3.1.2. Non-binding levels for existing buildings

In existing buildings, decision 944/92 of the Ministry of Social Affairs and Health merely states that indoor radon levels should not exceed 200 Bq/m^3.[55] There is thus a significant difference between new and existing buildings, with only non-binding levels for existing buildings other than workplaces, as further examined below.

3.2. Schools, Preschools, Other Public Premises and Workplaces

Radon mapping of houses in Finland is used to predict whether other buildings such as workplaces may have elevated radon levels (similar to the UK). In municipalities known to have high radon levels (average annual radon levels above 400 Bq/m^3 in more than 10 % of low-rise residential buildings) radon must be measured in all schools, preschools, public premises, and permanent workplaces. This requirement does not apply where it can be assumed that the radon levels do not exceed 400 Bq/m^3, due to reasons such as the design of the building or its lack of contact with the soil (e.g. on the second floor or higher). Radon levels must also be measured in

[50] Miljöministeriets förordning om byggnaders inomhusklimat och ventilation, D2, 2011, Section 2.3, online: https://www.edilex.fi/data/rakentamismaaraykset/D2-2012_Svenska.pdf.
[51] Regulations and guidelines for new buildings, Radiation and Nuclear Safety Authority, online: http://www.stuk.fi/web/en/topics/radon/radon-in-new-buildings/regulations-and-guidelines-for-new-buildings.
[52] Olli Holmgren, Radon remediation and prevention in new construction, Radiation and Nuclear Safety Authority, 2016, at p. 5, online: https://www.envir.ee/sites/default/files/radoon_3._remediationprevention.pdf.
[53] Maximum levels and regulations concerning radon in dwellings, Radiation and Nuclear Safety Authority, online: http://www.stuk.fi/web/en/topics/radon/maximum-levels-and-regulations-concerning-radon-in-dwellings.
[54] Olli Holmgren, Radon remediation and prevention in new construction, Radiation and Nuclear Safety Authority, 2016, at p. 6, online: https://www.envir.ee/sites/default/files/radoon_3._remediationprevention.pdf
[55] Maximum levels and regulations concerning radon in dwellings, Radiation and Nuclear Safety Authority, online: http://www.stuk.fi/web/en/topics/radon/maximum-levels-and-regulations-concerning-radon-in-dwellings.

all workplaces located on ridges or very air-permeable gravel or sand formations, as well as all regularly used workplaces located underground. [56] [57]

The Radiation and Nuclear Safety Authority (STUK) shall be notified of measurement results if radon levels exceed 400 Bq/m^3, or if STUK ordered the measurement. STUK may then order additional investigations or mitigation actions, depending on the outcome. The mitigation method is determined individually in each case, expert advice being usually required, and is selected in part on the basis of radon levels, the design of the building in question and the soil type (permeability). It is not clear if the mitigation method is selected by the party responsible for the building or by STUK, although the wording of the provision suggests that STUK may include such selection, or requirements narrowing this selection, as part of its orders. The party responsible for the building is required to inform workers of the measurements and the investigation.[58]

In addition to this more specific set of rules and procedures for radon investigation and mitigation, an overarching requirement applies for the party responsible for a workplace to take all warranted measures to limit exposure of workers to indoor radon (and other natural forms of radiation) if an investigation indicates that the annual average radon levels exceed 400 Bq/m^3 during working hours.[59]

3.3. Mapping Efforts in Finland

The Radiation and Nuclear Safety Authority (STUK) has been measuring radon levels since 1986, and so far a total of 113,000 dwellings have been measured, mostly by STUK.[60] [61] STUK has also prepared measurement plans for all municipalities, the aim of which is to describe the radon situation in each municipality's prevailing housing stock, locate houses with high indoor radon levels and ensure that further measurements are carried out in areas where high indoor radon levels (>400 Bq/m^3) are likely to be found.[62] [63]

So far, mapping has showed that the average radon level in Finland is 96 Bq/m3, with low-rise buildings averaging 121 Bq/m^3, and an overall estimated 10.4% of all buildings exceeding 200 Bq/m^3.[64]

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[56] Municipalities requiring radon measurements in workplaces, Radiation and Nuclear Safety Authority, online: http://www.stuk.fi/web/en/stuk-supervises/practice-that-causes-exposure-to-natural-radiation/radon-at-the-workplace/municipalities-requiring-radon-measurements-in-workplaces.
[57] Directive ST 12.1, Radiation safety in practices causing exposure to natural radiation, 2011, Sections 2.1 and 2.2, online: https://www.stuklex.fi/en/ohje/ST12-1.
[58] Ibid., Section 2.2.3.
[59] Radiation Decree 1512, 1991/1512, Section 27, online: https://www.stuklex.fi/en/ls/19911512/P27.
[60] http://www.stuk.fi/web/en/topics/radon/radon-in-finland/radon-maps-of-finland.
[61] Olli Holmgren et al., Risk communication, The Radiation And Nuclear Safety Authority, 2016, at p. 23, online: https://www.envir.ee/sites/default/files/radoon_8._risk_communication.pdf.
[62] Ibid., at p. 24.
[63] Anne Voutilainen et al., Indoor Radon Mapping In Finland, Radiation and Nuclear Safety Authority, 1999, at p. 514, online: http://www.inive.org/members_area/medias/pdf/Inive%5CRadon1999%5C058.pdf.
[64] Radon in Finland, Radiation and Nuclear Safety Authority, online: http://www.stuk.fi/web/en/topics/radon/radon-in-finland.

The radon mapping has revealed areas with particularly high probability of radon levels exceeding 400 Bq/m^3. For these areas, STUK recommends radon testing in all low-rise buildings, ground floor apartments and workplaces.[65] This focus is reflected in the number of radon measurements carried out in such radon-prone areas. In 2008 10-18% of all houses in radon-prone areas had been tested with 13 (out of 336) municipalities having tested as many as 20-41% of low-rise residential houses, whereas the national average in 2008 showed that 6% of low-rise residential buildings had been measured throughout Finland.[66] [67] These numbers suggest a relatively targeted approach to radon measurements.

3.4. Effectiveness of Mitigation Methods

In Finland, a number of radon prevention and mitigation techniques are used. These have been evaluated by STUK for their effectiveness.

In a study of the impact of the 2004-updates to the building code and associated guidance on radon prevention, which was conducted in 2009 and included 1561 dwellings, a number of preventative measures were considered. The study resulted in the following findings:

> The average radon concentration of all the houses measured, which were completed in 2006–2008, was 95 Bq m^{-3}, the median being 58 Bq m^{-3}. The average was 33% lower than in houses completed in 2000–2005. The decrease was 47% in provinces with the highest indoor radon concentration and 26% elsewhere in the country. In houses with a slab-on-ground foundation that had both passive radon piping and sealing measures carried out using a strip of bitumen felt in the joint between the foundation wall and floor slab, the radon concentration was on average reduced by 57% compared with houses with no preventive measures. Preventive measures were taken nationwide in 54% of detached houses and in provinces with the highest radon concentration in 92% of houses.[68]

In addition to suggesting that the 2004-changes to the building code have likely had a significant impact on radon levels, these results also highlight the likely beneficial impact of focusing on areas with high radon levels. These results furthermore show that even passive measures may have a significant impact on radon levels.

Nonetheless, as stated by STUK, other measures such as sub-slab suction and radon wells are likely to have significantly greater impact on radon levels:[69]

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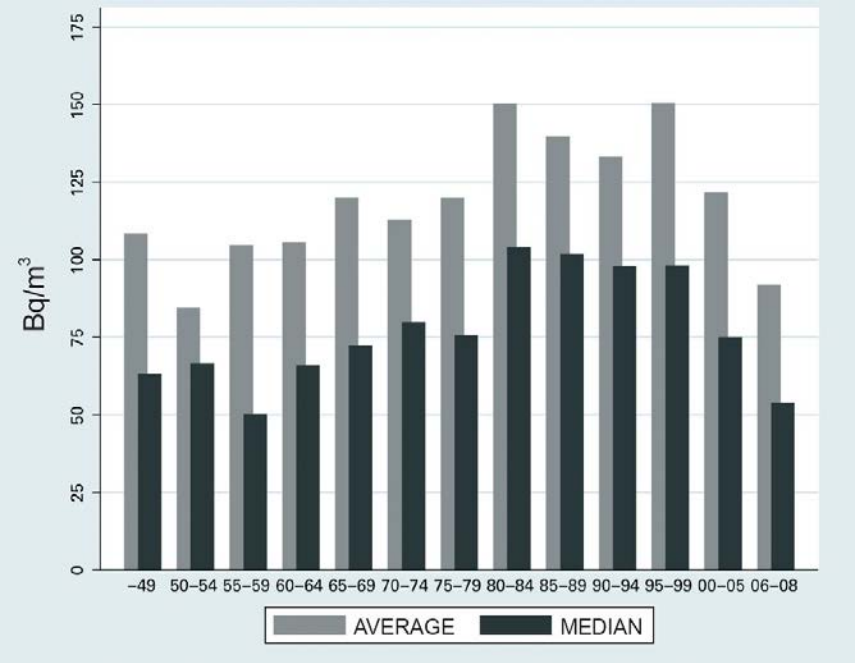
[65] Ibid.
[66] Olli Holmgren et al., Risk communication, The Radiation And Nuclear Safety Authority, 2016, at p. 24, online: https://www.envir.ee/sites/default/files/radoon_8._risk_communication.pdf.
[67] Tuomas Valmari et al., Radon Atlas of Finland 2010, Radiation and Nuclear Safety Authority, 2010, at p. 55, online: http://www.julkari.fi/bitstream/handle/10024/124319/stuk-a245.pdf?sequence=1&isAllowed=y.
[68] Arvela H. et al., Radon prevention in new construction in Finland: a nationwide sample survey in 2009, Radiation Protection Dosimetry vol. 148, 2012, at pp. 465-474, online: https://pdfs.semanticscholar.org/3b7c/061ef9b51ef405edd2a44a362d9dbf8de572.pdf.
[69] Radon mitigation, Radiation and Nuclear Safety Authority, online: http://www.stuk.fi/web/en/topics/radon/radon-mitigation.

Mitigation method	Reduction of radon concentration, %
Sub-slab suction	65–90
Radon well	75–95
Crawl space ventilation	30–80
Improvement of ventilation in cellar	20–60
Improvement of efficiency of ventilation	10–50
New exhaust air ventilation system	10–40
Replacement of supply/exhaust air system	20–50
Sealing of leaks, wooden walls	10–35
Sealing of leaks, concrete element walls	30–55
Sealing of leaks, blocks of flats	*30–65*

As can be seen, one of the most effective radon prevention and mitigation options in Finland is the use of a radon well. Such wells are placed a few metres away from the dwelling in question, and are intended for houses built on coarse sand or gravel.[70] This method is also used in Norway and Sweden.

That the Building Code revisions appear to be having the intended effect is also reflected in the following graph of average radon levels in buildings organized according to year of construction, which reveals a clear downward trend in radon levels in recent years:[71]

[70] Ibid.
[71] Olli Holmgren, Radon remediation and prevention in new construction, Radiation and Nuclear Safety Authority, 2016, at p. 22, online: https://www.envir.ee/sites/default/files/radoon_3._remediationprevention.pdf.



3.5. Tax Credits, Grants, Free/Reduced Cost Tests

3.5.1. 50% tax credit for residential radon mitigation work

Tax credits are available for so-called domestic expenses, which includes costs related to maintenance, upkeep and major improvements of year round dwellings and summer homes. The credit amounts to 50% of the costs incurred up to € 2,400 per taxpayer ($ 3,600) or € 4,800 ($ 7,200) for two spouses.[72] [73] This is credit covers a number of different expenses, including the cost of radon mitigation.[74].

3.5.2. Radon mitigation subsidy

The Housing Finance and Development Centre of Finland provides subsidies for the elimination of health hazards, but that such subsidies are only provided in highly exceptional circumstances, and that the cost of radon mitigation rarely exceeds the minimum cost limit associated with such assistance.[75] While this may be the case, this does appear to complement the generous 50% tax credit, in cases of serious radon issues where costs are likely to be unusually high.

3.5.3. Radon tests

[72] Checklist - Tax credit for domestic expenses, Finnish Tax Administration, online: https://www.vero.fi/contentassets/e7f46f1b30ed4a9a858b784a51ef7bc4/checklist-tax-credit-for-domestic-expenses.pdf.
[73] Household Employers, Finnish Tax Administration, February 1, 2017, online: http://vero.fi/en-US/Individuals/Household_employers.
[74] Radon mitigation, Radiation and Nuclear Safety Authority, online: http://www.stuk.fi/web/en/topics/radon/radon-mitigation.
[75] Ibid.

While free radon tests do not appear to be offered in Finland, it appears that STUK has provided a number of radon tests free of charge through its nationwide radon surveys in 1991, 2006-2007 and 2009.[76] STUK has also carried out radon measurement campaigns where radon measurement kits were offered at a 25% discount.[77] In January 2017 a radon measurement campaign was carried out in the Åland-municipality, where a mere 3% of buildings had so far been tested. To improve on this percentage, STUK and two participating radon service providers were offering tests at reduced prices ranging from € 35 to € 43.40 (C$ 55 to C$ 67).[78] Currently, radon tests are provided by STUK at a price of € 57.04 (C$ 88).[79]

3.6. Awareness/Information Campaigns

In 2015-2016 STUK carried out a questionnaire survey on public radon awareness.[80] Of the 807 respondents, 93% had heard about radon. Of the several possible answers, it is worth nothing that 584 had heard of radon through media outlets, while 252 had heard of radon through STUK and 104 through building inspection authorities (respondents could choose more than one answer).[81] 96% of respondents agreed that radon presents a health risk, with 706 identifying lung cancer as a risk, while other answers were also provided, such as headache (235) asthma (214), blocked nose (149) and eye problems (108).[82]

These results highlight the importance of regular media outlets in radon communications. Furthermore, while a not insignificant number of incorrect answers were provided, these results show that most of the people surveyed had understood that radon causes lung cancer, suggesting that media outlets in Finland have been reasonably successful in communicating about lung cancer. At the same time, it should be noted that the survey took place over the internet, which may have skewed the results by mainly targeting people who can be reached through online means of communication and where the ability to achieve appropriately randomized samples for statistical accuracy is not possible.

On the perceived importance of radon measurements, the questionnaire results are slightly less encouraging and seem to suggest that an understanding of the cancer risk is not clearly linked to an understanding of the need to measure radon levels. The answers were as follows:

- Measuring has not occurred to me before (125)
- I have not yet decided whether to measure or not (145)
- I have decided not to measure (28)
- I want to measure (213)

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[76] Olli Holmgren et al., Risk communication, Radiation and Nuclear Safety Authority, 2016, at p. 23, online: https://www.envir.ee/sites/default/files/radoon_8._risk_communication.pdf.
[77] Ibid., at p. 27.
[78] Kampanjen Fritt från radon på Åland, Radiation and Nuclear Safety Authority, online: http://www.stuk.fi/web/sv/teman/radon/kampanjen-fritt-fran-radon/kampanjen-fritt-fran-radon-pa-aland.
[79] Beställning av radonmätning, Radiation and Nuclear Safety Authority, online: http://www.stuk.fi/web/sv/tjanster/radonmatningar-i-bostader/bestallning-av-radonmatning.
[80] Olli Holmgren et al., Risk communication, Radiation and Nuclear Safety Authority, 2016, at p. 10, online: https://www.envir.ee/sites/default/files/radoon_8._risk_communication.pdf.
[81] Ibid., at p. 11.
[82] Ibid., at p. 12.

- I have already measured radon (147)
- I have started the measurement (82)
- Don't know (59)[83]

In part to overcome this barrier, STUK recommends clearly linking the problem and the solution when communicating about radon, and provides the following example:

> Radon may be a risk in area xx especially in houses built in the 70s and 80s. However, measuring radon is simple and cheap and radon mitigation is not very expensive, on average 2500 euros [C$ 3900].[84]

Statistics are also collected about the use of STUK's website (www.stuk.fi). The results show that radon is the second most popular topic. It also shows that people tend to spend 1-2 minutes on each topic found in the radon section of the website, leading STUK to suggest that the length of the text on each topic should reflect this, while links may be provided for those seeking more detailed information.[85]

STUK has conducted direct-mail advertising since 2008 (and before 2008 through newspaper advertisements) in its radon measurement campaigns. The average participation rate following such campaigns is around 4-5%.[86] STUK regularly hosts a two-day course on radiation (including but not limited to radon), which is aimed at journalists. So far approximately 100 journalists have attended.[87] STUK also conducts a one-day radon mitigation training every year, aimed at professionals (construction companies, building managers, health inspectors), which focuses on construction techniques, while also providing a valuable forum for dialogue and information sharing between professionals and STUK on a range of radon-related issues.[88]

3.7. Real Estate Transactions – Radon Bond

In general, STUK recommends, but does not require that radon measurements be carried out, before or after the sale of a house.

Where radon levels are unknown at the time of transfer of the property, a portion of the sale proceeds may be set aside to cover potential radon mitigation. This approach appears similar to the radon bond that is used in the United Kingdom.[89] Unfortunately, it has not been possible to find readily available information about this Finnish radon bond system.

3.8. Radon Action Plan – BSS-Directive

It would seem that, while a National Radon Action Plan is yet to be published, Finland is apparently in the process of amending its legislation to meet the requirements of the BSS-Directive – including a new Radiation Act with a proposed entry into force on July 1, 2018. It

[83] Ibid., at p. 18.
[84] Ibid., at p. 21.
[85] Ibid., at p. 16.
[86] Ibid., at p. 27.
[87] Ibid., at p. 14.
[88] Ibid., at pp. 29-30.
[89] Ibid., at p. 22.

may therefore be worth following up on these and other initiatives brought about by the BSS-Directive at a later date.[90]

4. Norway

4.1. Building Code Requirements for New Buildings

The current Norwegian Building Code (TEK17) sets a limit of 200 Bq/m3 for radon in new buildings. [91] This binding requirement was first introduced in amendments to the Norwegian Building Code in 2010 (the now out-dated TEK10),[92] and thus covers buildings from 2010 and onwards.

The building code requires that a radon barrier or membrane be installed in the foundation of all new buildings intended for human occupation, and that the building be prepared for depressurisation measures (radon sump or a network of perforated pipes) in the ground under the building, which can be activated should the radon concentration in the indoor air exceed 100 Bq/m^3.[93] The radon barrier and the depressurisation measures are not required if it can be demonstrated that the measures are unnecessary, such as where the home is located above a parking garage, or where the home is otherwise elevated above the ground.[94]

4.2. Schools, Preschools and Rental Units

In addition to the above requirements for new buildings, existing schools, preschools and rental units, be they private or public, are covered by Section 6 of the Norwegian Radiation Protection Regulation. Section 6 requires that mitigation must be initiated if radon levels exceed 100 Bq/m^3, and that radon levels must not exceed 200 Bq/m^3, and must always be as low as practically achievable.[95]

This requirement means that radon levels must be reduced even if the levels are below the 100 Bq/m^3 action level, where such reductions can be achieved without significant disadvantages. If radon levels exceed 200 Bq/m^3, then mitigation is required until the level is reduced to as low as practically achievable, and in any case always below 200 Bq/m^3.[96]

Landlords responsible for rental units are also required to measure radon levels. New requirements were introduced in 2011, following which all landlords were required to measure

[90] Government proposal for the new Radiation Act submitted to Parliament, Ministry of Social Affairs and Health, March 28, 2018, online: http://stm.fi/en/artikkeli/-/asset_publisher/hallituksen-esitys-uudeksi-sateilylaiksi-eduskuntaan.
[91] Byggteknisk forskrift (TEK17), Section 13-5. (1), online: https://dibk.no/byggereglene/byggteknisk-forskrift-tek17/13/iii/13-5/.
[92] Byggteknisk forskrift (TEK10), Section 13-5. (1), online: https://dibk.no/byggeregler/tek/3/13/iii/13-5/.
[93] Byggteknisk forskrift (TEK17), Section 13-5. (2), online: https://dibk.no/byggereglene/byggteknisk-forskrift-tek17/13/iii/13-5/.
[94] Ibid., Section 13-5. (3).
[95] Forskrift 16. desember 2016 nr. 1659 om strålevern og bruk av stråling, Section 6 and the explanatory notes to Section 6, online: https://lovdata.no/dokument/SF/forskrift/2016-12-16-1659.
[96] Ibid.

radon levels before January 1, 2014, when the new requirements entered into force, and risked fines if they did not meet this deadline. As a consequence of Section 6 in the Radiation Protection Regulations, a tenant can demand that radon measurement be carried out. [97]

If measurements reveal radon levels above the 200 Bq/m^3 limit, the landlord is required to carry out radon mitigation. If the landlord refuses, this may constitute a deficiency covered by the Residential Tenancies Act, Sections 2.2 and 5.1. If there is such a deficiency and the landlord fails to address this problem, the tenant may initiate sufficiently cost-effective steps at the landlord's expense.[98]

4.3. Workplaces

While the above-described Building Code requirements apply to all buildings constructed after 2010, including new workplaces, they do not apply to existing workplaces.

The Norwegian Working Environment Act,[99] however, contains provisions that require employers to protect employees against radon exposure. Section 4.1 requires that the working environment be safe (fully satisfactory), based on an individual and collective consideration of all factors in the working environment that may influence the employees' physical and mental health and welfare. Section 3.1 places a duty on the employer to survey, assess risks, draft plans and take action to ensure compliance with the law's requirements.

It is furthermore required that the employer be able to document in writing that an assessment of all risks (including radon measurements), has been carried out.[100] Radon is covered due to being a source of radiation exposure.[101] It is required that all workers receiving a dose of more than 6 mSv per year be subjected to a medical examination every 3 years.[102] There are general recommendations that to achieve such exposure limits, employers abide by the 100 Bq/m^3 action level and 200 Bq/m^3 limit. It is furthermore recommended that employers keep records of all workers exposed to radon at values above 400 Bq/m^3. This is based on the assumption that 400 Bq/m^3 for 1800 hours per year (an average work year in Norway) amounts to an effective dose of 6 mSv per year.[103]

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[97] Utleieboliger skal radonmåles - men alle må ikke, Din Side, March 4, 2013, online: https://www.dinside.no/bolig/utleieboliger-skal-radonmales---men-alle-ma-ikke/61293748.
[98] Radon i utleieboliger, Leieboforeningen, online: https://www.leieboerforeningen.no/Rettigheter/tabid/304/ID/2284/Radon-i-utleieboliger.aspx.
[99] Lov om arbeidsmiljø, arbeidstid og stillingsvern mv. (arbeidsmiljøloven) av 17. juni 2005 nr. 62, online: https://lovdata.no/dokument/NL/lov/2005-06-17-62.
[100] Forskrift om systematisk helse-, miljø- og sikkerhetsarbeid i virksomheter (Internkontrollforskriften), av 6. Desember 1996, Section 5.6, online: https://lovdata.no/dokument/SF/forskrift/1996-12-06-1127.
[101] Tema – Stråling – Radon, Arbeidstilsynet, online: https://www.arbeidstilsynet.no/tema/straling/radon/.
[102] Forskrift om utførelse av arbeid, bruk av arbeidsutstyr og tilhørende tekniske krav (forskrift om utførelse av arbeid), av 6. desember 2011 nr. 1357, Section 15.4, online: https://lovdata.no/dokument/SF/forskrift/2011-12-06-1357.
[103] Tema – Stråling – Radon, Arbeidstilsynet, online: https://www.arbeidstilsynet.no/tema/straling/radon/.

4.4. Role of Municipalities

While the Norwegian Radiation Protection Authority may carry out inspections under the Radiation Protection Act, the bulk of the work is done by the municipalities.[104] As such, municipalities are tasked with ensuring compliance with radon concentrations in indoor air in all private and public properties including residential rental units, but not owner-occupied residential units,[105] as well as in school and preschools.[106]

Schools and preschools are required to carry out self-monitoring, and are required to establish a self-monitoring program to ensure compliance with, among other things, indoor air quality. As part of their compliance efforts, municipalities may carry out investigations, make corrections, stop ongoing activities, and make orders to ensure compliance with radon requirements.[107] Similar rules apply to private and public properties in general, except that residential rental units are not required to carry out self-monitoring.[108]

It is evident from a survey of individuals who have carried radon testing that the municipalities in Norway have embraced their role in dealing with radon issues. When asked why they decided to carry out radon measurements, 58% of respondent replied that they decided to carry out radon measurements as result of the local municipality encouraging them to do so.[109] In the same survey 16% responded that measured high radon levels in their neighbourhood had led to the decision, while only 5% answered that they had tested because radon is dangerous. While one might have hoped for a greater percentage of respondents referring to the dangers of radon as their primary motivation, it is encouraging to see that municipalities can have such an impact on the choice to measure radon.

4.4.1. Environmental web-portal for municipalities

To assist municipalities with environmental administrative tasks, including enforcement of radon requirements,[110] the Norwegian Environment Agency has set up a website, which provides comprehensive regulatory guidance.[111] The website is managed by the Environment Agency in collaboration with the Radiation Protection Authority and the Directorate for Cultural Heritage, while another 13 government agencies contribute to the contents on this website.

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[104] Bård Olsen, Radon, Kilder – Helse – Regelverk – Arealplanlegging, 2013, at p.26, online: https://www.fylkesmannen.no/Documents/Dokument%20FMNT/Kommunalavdelingen/Samfunnssikkerhet/Samling%20Sn%C3%A5sa2013/Radon%20B%C3%A5rd%20Olsen%20NRPA.pdf.
[105] Forskrift 25. april 2003 nr. 486 om miljørettet helsevern, Sections 7 and 10a, online: https://lovdata.no/dokument/SF/forskrift/2003-04-25-486.
[106] Forskrift 1. desember 1995 nr. 928 om miljørettet helsevern i skoler og barnehager, Sections 19 and 25, online: https://lovdata.no/dokument/SF/forskrift/1995-12-01-928.
[107] Ibid., Sections 4, 19 and 26.
[108] Forskrift 25. april 2003 nr. 486 om miljørettet helsevern, Sections 4 and 12, online: https://lovdata.no/dokument/SF/forskrift/2003-04-25-486.
[109] Bård Olsen, Radon, Kilder – Helse – Regelverk – Arealplanlegging, 2013, at p. 42, online: https://www.fylkesmannen.no/Documents/Dokument%20FMNT/Kommunalavdelingen/Samfunnssikkerhet/Samling%20Sn%C3%A5sa2013/Radon%20B%C3%A5rd%20Olsen%20NRPA.pdf.
[110] Forurening – Radon, Veiviser i Kommunal Miljøforvaltning, Miljødirektoratet, online: http://www.miljokommune.no/Temaoversikt/Forurensing/Radon/.
[111] Veiviser i Kommunal Miljøforvaltning, Miljødirektoratet, online: http://www.miljokommune.no.

4.5. Existing Owner-occupied Properties

Generally speaking, existing private homes, other than rental units, are not covered by mandatory rules on radon levels. Instead, where radon levels exceed 100 Bq/m^3, it is recommended to take appropriate measures to reduce the levels. It is furthermore recommended that radon level should be kept as low as practically achievable and always below 200 Bq/m^3.[112]

While private dwellings are generally excluded from the municipalities' above-described enforcement tools, the Norwegian Directorate of Health is of the view that municipalities may use these tools where extreme radon levels are discovered.[113] This, however, appears to be a rather limited power, and thus not an effective way of addressing radon in owner-occupied properties.

4.6. Radon in Aggregate

In Norway, there have been cases of aggregate used under houses causing elevated indoor radon levels in areas without otherwise known radon issues. As a result, the Radiation Protection Authority has introduced a guideline limit for radium concentration in aggregate of 150 Bq/kg (equivalent to a uranium concentration of 12ppm).[114]

4.7. Real Estate Transactions

According to the Real-estate Sales Act, if a seller of a property is aware of high radon levels, but fails to inform a buyer of this, or if the seller gives false or misleading information regarding radon levels, the buyer may be entitled to compensation. Case-law has shown that a buyer may furthermore be entitled to rescind the agreement where the seller withholds information regarding high radon test results.[115] [116]

4.8. Evaluation of Building Code Requirements

A report commissioned by the Norwegian Radiation Protection Authority examined the impact of the current, stricter, radon mitigation requirements for new buildings that were introduced with the 2010 changes to the Building Code (TEK10).[117] The report, which was based on

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[112] Tiltak mot radon i inneluft, Norwegian Radiation Protection Authority, June 20, 2017, online: https://www.nrpa.no/temaartikler/90032/tiltak-mot-radon-i-inneluft.

[113] Strategi for å redusere radoneksponering i Norge, Arbeidsgruppen for samordnet innsats mot radon, 2009, at p. 40, online: https://www.regjeringen.no/globalassets/upload/hod/dokumenter20info/strategi-radon.pdf.

[114] Radon fra tilkjørte masser under bygg – anbefalt grenseverdi, Stråleverninfo, Norwegian Radiation Protection Authority, June 25, 2015, online: https://www.nrpa.no/filer/6f312fa358.pdf. The following document contains further information regarding this guideline, including sampling: Radon fra Pukk – grenseverdier og prøvetaking, Norwegian Radiation Protection Authority and Geological Survey of Norway, online: http://www.ngu.no/sites/default/files/radonfrapukk.pdf.

[115] Lov om avhending av fast eigedom (avhendingslova), 1992, Sections 3.7 and 3.8, online: https://lovdata.no/dokument/NL/lov/1992-07-03-93.

[116] Strategi for å redusere radoneksponering i Norge, Arbeidsgruppen for samordnet innsats mot radon, 2009, at pp. 50-51, online: https://www.regjeringen.no/globalassets/upload/hod/dokumenter20info/strategi-radon.pdf.

[117] Finne IE, Kolstad T, Olsen B, Larsson M, Prendergast J, Rudjord AL. Radon i nybygg. Kartlegging i 2008 og 2016. StrålevernRapport 2017:3. Østerås: Norwegian Radiation Protection Authority, 2017, online: https://www.researchgate.net/profile/Anne_Rudjord/publication/316033007_Radon_i_nybygg_Kartlegging_i_2008_og_2016/links/58edcb6aa6fdcc61cc109e40/Radon-i-nybygg-Kartlegging-i-2008-og-2016.pdf?origin=publication_detail.

surveys of randomly selected properties, compared radon measurements in buildings constructed in the years 2004-2007 under the previous Building Code (TEK97), and buildings constructed in the years 2012-2015. For each property, the surveys included measurements of the living room and a bedroom, but only included the higher of those two measurements in the survey.[118]

The results showed much lower average radon levels in the more recently built homes. For detached homes, a 47% reduction in radon levels was observed, from an average level of 76 Bq/m^3 in the 2004-2007 buildings to an average of 40 Bq/m^3 for the 2012-2015 buildings.[119]

The report also highlighted that the number of detached homes with a radon concentration above the Upper Limit Value (200 Bq/m^3) had been reduced by 67% (from 7.6% to 2.5% of houses surveyed), while the number of homes with a concentration above the Action Level (100 Bq/m^3) had been reduced by 73% (from 23.9% to 6.4% of houses surveyed).[120]

It was also found that in townhouses, including stacked townhouses, built between 2012 and 2015, no results above the 200 Bq/m^3 limit were observed, while a mere 3.2% of these buildings exceeded the 100 Bq/m^3 limit. The report notes that this difference between detached homes and townhouses has not been determined with certainty, and would therefore be worth examining further.[121]

The report furthermore noted that depressurization and ventilation measures, such as radon wells outside homes and radon ventilation systems inside/under homes, have been found to be highly effective resulting in a reduction of radon levels in the range of 70 to 95%.[122]

Finally, the report noted that in the survey of homes built in 2012-2015, a mere 3.5% of home-owners responded that radon levels had been measured in their home, while the remaining either replied “no” (79.6%), “don’t know” (14.7%) or failed to respond (2.1%).[123] This suggests that radon mitigation efforts have not been accompanied by a corresponding level of information campaigns aimed at home-owners.

4.9. Mapping Efforts

In Norway, a detailed map has been developed, which shows estimated radon risk levels covering the entire country at a resolution of 1/50.000. The map is based on actual measurements of indoor radon levels as well as geological survey data concerning bedrock type. It also takes into account the distribution of permeable drift deposits such as sand and gravel, which can permit the transport of radon from large ground volumes into aggregate used under new dwellings.[124]

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[118] Ibid. at p. 10.
[119] Ibid. at p. 11.
[120] Ibid. at p. 11.
[121] Ibid. at p. 12.
[122] Ibid. at p. 13.
[123] Ibid. at p. 14.
[124] Produktark: Nasjonalt aktsomhetskart for radon, Norwegian Radiation Protection Authority, Geological Survey of Norway and Norge Digitalt, September 2016, online: http://www.ngu.no/upload/Aktuelt/Produktark_RadonAktsomhet.pdf.

The map is made available online by Geological Survey of Norway, and provides municipalities and individuals with extensive data regarding radon levels, soil composition (various types of rock, clay, gravel, marine sediments, river bed etc.), topography and all existing infrastructure, including the location of all buildings in Norway.[125]

For parts of the country where uranium rich alum shale formations are found, more detailed maps have been developed, which incorporate data from aerial measurements (plane and helicopter) of natural background radiation from uranium. These more detailed maps cover an area of 10,000 km^2, which is home to nearly 2 million people.[126]

Field studies appear to show that such aerial measurements provide results that mirror average actual measured radon levels, suggesting that this type of mapping can be a valuable tool in providing more detailed predictions of radon levels across large areas, including the likely number of buildings expected to exceed regulatory radon limits.[127]

Overall, the average radon level in Norwegian homes is estimated to be 88 Bq/m^3.[128] Furthermore, the radon mapping of Norway suggests that radon concentrations in indoor air exceed the recommended action limit of 100 Bq/m3 in as many 9% of all dwellings (175,000).[129]

4.9.1. 2000-2001 national survey of 30,000 homes

Starting in 2000, a national radon mapping project was carried out in collaboration with roughly 20% of Norway's over 400 municipalities. In all, 30,000 measurements were carried out. While the measurements were paid for by the Norwegian Government, the individual municipalities were tasked with ensuring that the measurements were carried out. Depending on the size of each municipality, between 50 and 600 radon measurements were carried out in randomly selected homes.[130]

The survey found higher radon levels compared to a previous survey of 7.500 randomly selected homes carried out in 1987-1989. While the previous study had estimated the average radon level to be somewhere between 55 and 65 Bq/m^3,[131] the 2000-200 1 study arrived at a higher average level of 88 Bq/m^3.[132]

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[125] Radon aktsomhet, Geologic Survey of Norway, online: http://geo.ngu.no/kart/radon/.
[126] https://www.ngu.no/en/topic/radon-hazards.
[127] Guri v. Ganerød et al., Geologiske bakgrunnsdata for kartlegging av radonfare i Norge, Geologic Survey of Norway, 2013, at p. 12, online: http://www.ngu.no/upload/Publikasjoner/Rapporter/2012/2012_067.pdf.
[128] Radon, Miljøinformasjon fra offentlige myndigheter, Norwegian Radiation Protection Authority, February 2, 2018, online: http://www.miljostatus.no/tema/straling/radon/.
[129] Radon Hazards, Geological Survey of Norway, August 15, 2017, online: https://www.ngu.no/en/topic/radon-hazards.
[130] Strålevernsrapport 2001:6, Kartlegging av radon i 114 kommuner, Norwegian Radiation Protection Authority, 2001, at p. 4, online: https://www.nrpa.no/filer/6970f488d4.pdf.
[131] Ibid., at p. 5.
[132] Ibid., at p. 10.

In stating that radon levels can vary over time, the Norwegian Radiation Protection Authority currently recommends that radon measurements be repeated every 10 years in buildings where measurements have shown consistently low radon levels; every 5 years in new and mitigated buildings with a risk of high radon levels; and after major renovations.[133]

4.9.2. Survey of schools

In 2016-2017, 103 municipalities carried out radon measurements in over 470 schools, amounting to more than a third of all 1403 schools in Norway. Of these, 18% did not meet one or several legal requirements with regard to radon (half had radon levels above the legal limit), while another 18% were told that, while all requirements had been met, certain improvements should be made. The remaining 64% were fully compliant. It is noted that these numbers should be not be seen as representative of the situation in Norway as a whole, as schools suspected of having radon issues tend to be overrepresented in such inspections.[134]

4.10. Incentives

It does not appear that free radon tests are provided at the national level in Norway.

The Radiation Protection Authority used to keep a list of radon measurement and mitigation service providers on its website. The list was, however, sometimes erroneously considered as a list of approved radon service providers. With this in mind, and as the prevalence of such firms has increased significantly, the Radiation Protection Authority has opted to no longer provide such a list.[135] It thus appears that the radon service provider industry is now doing sufficiently well in Norway, with less need for national authorities providing assistance of this kind. This may be linked to the stricter requirements outlined above.

In Norway, some municipalities have opted to sell radon tests, in one example at a cost of 330.00 NOK ($ 52) plus VAT.[136] Other municipalities have instead entered into an agreement with Eurofins' accredited Radon Laboratory to provide radon tests at a cost of 225.00 NOK ($36) plus VAT.[137]

4.10.1. Grants

Norway previously offered grants up to 40,000.00 NOK (C$6300) to aid with radon mitigation, from 1999 to 2003. This program is, however, no longer in place.[138] [139]

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[133] Hvor ofte trenger jeg måle radon?, Norwegian Radiation Protection Authority, online: https://www.nrpa.no/radon?p=1.
[134] Tilsyn med radon i skoler, Stråleverninfo 4-17, Norwegian Radiation Protection Authority, May 15, 2017, online: https://www.nrpa.no/filer/99f4e84615.pdf.
[135] Har Strålevernet lister over firmaer som tilbyr radonmålinger og tiltak mot radon?, Norwegian Radiation Protection Authority, online: https://www.nrpa.no/radon?p=1.
[136] Radon – Pris, Frederikstand Kommune, October 18, 2016, online: https://www.fredrikstad.kommune.no/radon#pris.
[137] Tilbud på radonmålinger i norske kommuner, Eurofins Radonlab, online: http://radonlab.com/tilbud-kommuner.
[138] Støtten til radon-tiltak forsvinner, Aftenposten October 27, 2003, online: https://www.aftenposten.no/norge/i/jQbmL/Stotten-til-radon-tiltak-forsvinner.
[139] Strategi for å redusere radoneksponering i Norge, Arbeidsgruppen for samordnet innsats mot radon, 2009, at p. 78, online: https://www.regjeringen.no/globalassets/upload/hod/dokumenter20info/strategi-radon.pdf.

During the first years of this program, it was found that insufficient information about the program was available, which led to low public interest in the first years of the program. This lack of interest was countered by improved information campaigns, which then unfortunately resulted in the grant program creating greater demand for radon mitigation than the market could provide, and ultimately resulted in rising costs of radon mitigation towards the end of the grant program.[140] Where grant or tax credits are considered, this experience points to the need to ensure available capacity of radon mitigation service providers, or alternatively, the need for gradual efforts that also monitor costs, to ensure the best use of funds allocated to such grant programs.

Based in part on a review of past radon efforts in Norway, including the experiences from the 1999-2003 grant program, the working group preparing the current Norwegian Radon Strategy (see below)[141] concluded that a grant program was a prerequisite to achieving health improvements. Past experiences had thus shown that information campaigns on their own failed to lead to significant mitigation efforts, while a grant program without sufficient information campaigns also led to unsatisfactory mitigation levels.[142]

Only when an information campaign, a grant program and municipal radon measurement campaigns were combined, were satisfactory results achieved. The working group on the Norwegian Radon Strategy therefore recommended that a grant program be reintroduced in Norway.[143] This recommendation, however, does not appear to have led to a new grant program, despite the success of the previous program.

4.11. Radon Strategy

With Norway not being a member of the European Union, but rather of the European Economic Area Agreement, Norway does not appear to have any plans to implement the BSS-Directive.

Instead, as mentioned above, Norway has its own radon strategy[144] adopted in 2009 for the years 2010-2014. This strategy has been extended to cover the years 2015-2020.[145] The key goals of this strategy are to work to ensure that radon levels in buildings are below the current radon limits, and to contribute to reducing radon exposure in Norway as far as practicable.[146] The following goals have been set:

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[140] Ibid., at pp. 78-79.
[141] Strategi for å redusere radoneksponeringen i Norge, Departementerne, 2009, online: https://www.regjeringen.no/globalassets/upload/hod/dokumenter-fha/strategi-for-a-redusere-radoneksponeringen-i-norge.pdf.
[142] Strategi for å redusere radoneksponering i Norge, Arbeidsgruppen for samordnet innsats mot radon, 2009, at pp. 78-79, online: https://www.regjeringen.no/globalassets/upload/hod/dokumenter20info/strategi-radon.pdf.
[143] Ibid.
[144] Strategi for å redusere radoneksponeringen i Norge, Departementerne, 2009, online: https://www.regjeringen.no/globalassets/upload/hod/dokumenter-fha/strategi-for-a-redusere-radoneksponeringen-i-norge.pdf.
[145] Radonstrategien forlenges til 2020, Norwegian Radiation Protection Authority, April 22, 2015, online: https://www.nrpa.no/nyheter/92316/radonstrategien-forlenges-til-2020.
[146] Strategi for å redusere radoneksponeringen i Norge, Departementerne, 2009, at p. 7, online: https://www.regjeringen.no/globalassets/upload/hod/dokumenter-fha/strategi-for-a-redusere-radoneksponeringen-i-norge.pdf.

- *Radon in land use planning:* Radon must be given sufficient and systematic consideration in all land use planning.

- *Radon and the construction of new buildings:* Radon levels in new buildings must be as low as practically achievable and always below 200 Bq/m^3.

- *Radon in existing homes:* The proportion of homes with radon levels above 200 Bq/m^3 will be significantly reduced by 2020. Average radon levels must be reduced considerably by 2020, and a significant portion of the housing stock must have achieved radon levels that are as low as practically achievable.

- *Local communities in Norway with particularly serious radon problems:* All Norwegian communities in extremely high radon levels must be mapped. Safe health conditions for the inhabitants of such local communities must be secured through necessary measures.

- *Radon in buildings and premises:* The proportion of buildings with radon levels above the current limits must be significantly reduced by 2020. Average radon levels must be significantly reduced by 2020, and a large portion of all buildings must have achieved radon levels that are as low as practically achievable. All schools and preschools must have radon levels below the given maximum limit value.

- *Radon in workplaces:* Norwegian workplaces must have radon levels that ensure a sound working environment when considering the health, environment and safety of workers.

While the strategy has been extended, unfortunately no detailed information evaluating its success so far appears to be publicly available. Still, media coverage suggests that the strategy has been an important tool for radon work in Norway, with the authorities in charge of health, construction and labour working together to reduce radon exposure. The strategy has furthermore resulted in new or updated legislation covering new buildings, schools, preschools and rental units, while an increase in radon measurements in private homes has been observed. The evaluation has apparently also highlighted the importance of coordination and cross-sectoral cooperation.[147]

5. Sweden

5.1. General Radon Limits for New Buildings

For all new buildings, the Swedish Building Code sets a binding radon limit at 200 Bq/m^3.[148] This limit was introduced in 2004, and covers both private and public buildings.[149] The new limit

[147] https://www.byggfakta.no/regjeringen-fortsetter-kampen-mot-radon-86868/nyhet.html.
[148] Boverkets byggregler (föreskrifter och allmänna råd), BFS 2011:6 BBR 18, Section 6:23, online: https://rinfo.boverket.se/BBR/PDF/BFS2011-6-BBR18.pdf. The Swedish Building Code has been amended several times. All amendments to the Building Code can be accessed online at: http://www.boverket.se/sv/lag--ratt/forfattningssamling/gallande/bbr---bfs-20116/.

was tied to the Swedish government's original goal of ensuring radon levels below 200 Bq/m^3 in all schools and preschools by the year 2010 and in all private homes by 2020.[150] However, these ambitious goals do not appear to be reflected in the recently released Swedish Radon Action Plan.[151]

In Sweden, municipalities are tasked with ensuring that new buildings live up to the 200 Bq/m^3 limit. During construction of a new building, the local municipality has the authority to impose a variety of inspection requirements, which have to be met as the work progresses. Post-construction radon testing is one such inspection requirement, which may be included in the inspection plan for a new building, if the local municipality so decides.[152]

5.2. Existing Buildings

For existing buildings a *recommended* level is set at 200 Bq/m^3.[153] While there is no requirement to mitigate existing buildings, local municipalities may, as part of their building and environmental inspections duties, issue mitigation orders for health reasons (further discussed below). They may also carry out radon testing to ensure that completed mitigation work has actually led to reduced radon levels. There is, however, a significant degree of variation in terms of the inspection work carried out by the individual municipalities.[154] [155]

Radon is covered by Section 9, Chapter 9 of the Swedish Environmental Protection Act (Swedish EPA),[156] which states as follows:

> **Section 9** Dwellings and public premises shall be used in such a way as to prevent detriment to human health and shall be kept free of vermin and other pests.
>
> The owners or leaseholders of the property in question shall take any measures that may be reasonably required to prevent or eliminate detriment to human health.

The Swedish EPA Chapter 26, Section 3, places the primary responsibility for the enforcement of Chapter 9, Section 9, on the local municipalities, and provides them with the power to issue

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[149] Radon i inomhusluft, Socialstyrelsen, 2004, at p. 6, online: https://www.folkhalsomyndigheten.se/contentassets/38e175d1681242219db4575648aeda1e/radon-inomhusluft.pdf.
[150] Ibid.
[151] Nationell handlingsplan för radon, Arbetsmiljöverket, Boverket, Folkhälsomyndigheten, Livsmedelsverket, Sveriges geologiska undersökning, Swedac, Strålsäkerhetsmyndigheten, 2018, online: https://www.stralsakerhetsmyndigheten.se/globalassets/radon/nationell-handlingsplan-for-radon.pdf.
[152] Ibid., at pp. 7 and 30.
[153] Regulation FoHMFS 2014:16 on Indoor Radon, online: https://www.folkhalsomyndigheten.se/contentassets/4673dd9bd1054478a8dcadfdbb96c5e4/fohmfs-2014-16.pdf.
[154] Susanna Skogsberg, et al., "Utredningen om radon i bostäder - Del 2: Radon Fakta och lägesrapport om radon", Statens offentliga utredningar 2001:7, January 31, 2001, online: https://www.regeringen.se/contentassets/992ff2aa54bc4d4dac489177318e7fcf/del-2-radon-fakta-och-lagesrapport-om-radon.
[155] Myndighetens uppdrag inom radon, Swedish Radiation Safety Authority, July 27, 2017, online: https://www.stralsakerhetsmyndigheten.se/omraden/radon/myndighetens-uppdrag/.
[156] Miljöbalk (1998:808), online: http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/_sfs-1998-808/.

such injunctions or prohibitions as are necessary to ensure compliance with the Chapter 9 Section 9.

This power is what allows the local municipality to order radon measurements and, if needed, radon mitigation as radon levels above 200 Bq/$m^3$are considered detrimental to human health thus triggering the provisions of the Swedish EPA.[157]

The powers bestowed upon the municipalities are broadly defined and cover dwellings and public premises. They can be used to issue radon measurement and mitigation orders covering single family homes,[158] rental buildings,[159] schools and preschools as well as any publicly accessible building where people stay more than temporarily.[160]

5.2.1. Municipal efforts

Leaving it up to the local municipalities has led to variation in the approach taken, with some but not all municipalities mandating testing and mitigation.[161] This issue is one of the areas that the Swedish Radon Action Plan intends to improve upon, following a 2014 survey, which found that 15% of municipalities were taking little to no action to address the radon-issue. The recommendation involves an initiative, which will see the so-called Regional Authorities[162] tasked with supervising and reporting on the radon-related work carried out by the individual municipalities, starting with a pilot project covering a few municipalities.[163]

Here, it is also worth mentioning a 2017-survey of municipal authorities, conducted by the Swedish Radiation Safety Authority. The survey found, among other things that local governments would like to receive further assistance and guidance to assist them in dealing with radon issues, as well as assistance with information initiatives and with national coordination.[164] This result suggests that the lack of action by some municipalities may be linked to insufficient knowledge, expertise and/or resources to manage the potentially significant task of enforcing radon requirements in all buildings in a municipality.

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[157] Radon om du är villaägare, Boverket, October 1, 2015, online: https://www.boverket.se/sv/byggande/halsa-och-inomhusmiljo/radon/villaagare/.
[158] Ibid.
[159] Hyresvärdens ansvar, Boverket, May 20, 2014, online: http://www.boverket.se/sv/byggande/halsa-och-inomhusmiljo/radon/hyresvardens-ansvar/.
[160] Nationell handlingsplan för radon, Arbetsmiljöverket, Boverket, Folkhälsomyndigheten, Livsmedelsverket, Sveriges geologiska undersökning, Swedac, Strålsäkerhetsmyndigheten, 2018, at p. 7, online: https://www.stralsakerhetsmyndigheten.se/globalassets/radon/nationell-handlingsplan-for-radon.pdf.
[161] Vill att alla ska mäta radon, Sakaborgs Allehanda, July 17, 2017, online: https://sla.se/skovde/2017/07/17/vill-att-alla-ska-mata-radon.
[162] These authorities make up the regional representation of the national government, and are divided into 21 regions covering all of Sweden.
[163] Nationell handlingsplan för radon, Arbetsmiljöverket, Boverket, Folkhälsomyndigheten, Livsmedelsverket, Sveriges geologiska undersökning, Swedac, Strålsäkerhetsmyndigheten, 2018, at p. 13, online: https://www.stralsakerhetsmyndigheten.se/globalassets/radon/nationell-handlingsplan-for-radon.pdf.
[164] New Swedish action plan for reducing the health effects of radon, Swedish Radiation Safety Authority, April 9, 2018, online: https://www.stralsakerhetsmyndigheten.se/en/press/news/2018/new-swedish-action-plan-for-reducing-the-health-effects-of-radon/.

An interesting example of municipal action is a group of smaller municipalities that are collaborating on environmental protection. The group has set up a joint website that includes detailed radon information for the particular municipalities.[165] They have also prepared a radon plan spanning 2011-2020 setting a target of 2020 for when all buildings are supposed to have radon levels below 200 Bq/m^3.[166] This target appears to be in line with the overall 2020-target set by the Swedish Government which may, however, have been abandoned as mentioned above.

The group also provides their own regional radon mapping, which is updated twice yearly.[167] Their tracking of radon measurements show that exceedance of the 200 Bq/m^3 has been steadily decreasing, from 23% in 2015, to 21% in 2016 and most recently18% in 2017, suggesting that their efforts are having a gradual, yet significant effect on radon levels.[168]

Given the target of having all buildings measure below 200 Bq/m^3 by 2020, these municipalities intend to demand that all remaining property owners test for radon, if they have not already done this, and that mitigation be carried out in all buildings that exceed the 200 Bq/m^3 limit.[169] If these demands are not followed, the municipalities state that they intend to consider whether any further measures need to be taken.[170]

5.2.2. Radon in existing workplaces

Workplace safety legislation applies to all workplaces, other than those located underground. Radon limits are determined on the basis of a work-year totalling 1800 hours, and is roughly equivalent to a 200 Bq/m^3 radon level.[171] There are plans to divide responsibility for radon enforcement between the Swedish Work Environment Authority and the Swedish Radiation Safety Authority. The Work Environment Authority will be given the primary responsibility for workplaces where radon measurements have not yet been carried out, while the Radiation Safety Authority will be responsible for workplaces where measurements have shown levels above 200 Bq/m^3.[172]

5.2.3. Reasons behind the 200 Bq/m3 limit

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[165] Miljönämnden östra Skaraborg, online: https://www.miljoskaraborg.se/Organisation/ and https://www.miljoskaraborg.se/Bostadsmiljo1/Radon/.

[166] Radonplan för kommunerna Falköping, Hjo, Skövde, Tibro 2011 —2020, Miljönämnden östra Skaraborg, June 15, 2011, online: https://www.miljoskaraborg.se/globalassets/dokument/halsoskydd/beslutad-radonplan-2011-2020.pdf.

[167] Resultat av mätningar av radonhalt i flerbostadshus, Miljönämnden östra Skaraborg, April 19, 2018, online: https://www.miljoskaraborg.se/Bostadsmiljo1/Radon/resultat-av-matingar-av-radonhalt-i-flerbostadshus/.

[168] Granskning av radonmätningar i flerbostadshus under 2017, Miljönämnden östra Skaraborg, online: https://www.miljoskaraborg.se/globalassets/projektrapporter/halsoskydd/2018/h_granskning_radon_flerbostadshus_feb_2018.pdf.

[169] Ibid.

[170] Ibid.

[171] Arbetsmiljöverkets föreskrifter och allmänna råd om hygieniska gränsvärden, AFS 2015:7, at note 41, online: https://www.av.se/globalassets/filer/publikationer/foreskrifter/hygieniska-gransvarden-afs-2015-7.pdf.

[172] Nationell handlingsplan för radon, Arbetsmiljöverket, Boverket, Folkhälsomyndigheten, Livsmedelsverket, Sveriges geologiska undersökning, Swedac, Strålsäkerhetsmyndigheten, 2018, at p. 32, online: https://www.stralsakerhetsmyndigheten.se/globalassets/radon/nationell-handlingsplan-for-radon.pdf.

Based on a socio-economic analysis, Sweden in 2010 decided to maintain its radon limit at 200 Bq/m^3 for new construction based on an assessment that the cost of reducing radon to levels under 100 Bq/m^3 for new construction homes would be too high (130 million SEK per year) and would only lead to 0.15 fewer cases of lung cancer each year. It is claimed that, to make this cost acceptable, the reduction would have to be at least 0.45 fewer cases of lung cancer per year.[173] This analysis, however, appears somewhat challenged by the more recent results of the study referenced below, which found that 93.2% of building constructed 2010 and 2015 already have levels below 100 Bq/m^3. This suggests that radon measures may not be needed to the extent presumed in this analysis, or that the requirements found in existing legislation already go a long way towards reaching a 100 Bq/m^3 level.

For existing homes, the cost was also estimated to be too high (a one-time expense of 14-19 billion SEK ($ 2.10-2.85 billion) and an annual expense of 500 million SEK ($ 75 million)) to warrant a reduction of the limit to 100 Bq/m^3. The analysis found that a reduction to 100 Bq/m^3 was expected to lead to 40 fewer cases of lung cancer per year caused by radon in existing homes. It was, however, suggested that 65-85 fewer cases of lung cancer per year would be required to make these investments reasonable from a socio-economic perspective.[174] One issue mentioned in particular is a type of low-density concrete made from rock with high uranium content. This rock has been used for decades in Sweden, and releases significant amounts of radon thus making mitigation more difficult.[175]

These socio-economic conclusions are mentioned in Sweden's Radon Action Plan without further discussion, suggesting that updated socio-economic assessments have not been carried out. It is furthermore reiterated that the above-mentioned concrete makes it more difficult to reduce radon levels below 100 Bq/m3 in buildings where this material has been used,[176] which suggests that this particular structural issue has played a role in Sweden's decision to maintain its radon limit at 200 Bq/m^3.

5.3. Mapping Efforts

According to the Swedish Radon Action Plan, a comprehensive survey and analysis of indoor radon levels was carried out by the National Board of Housing, Building and Planning in a 2009-study that measured radon levels in 1400 homes selected to be statistically representative. In the study it was estimated that 250,000 single-family houses had radon levels above the 200 Bq/m^3 limit. The uncertainty range for this estimate was 125,000 to 375,000 single-family houses. Similarly, 75,000 apartments were estimated to exceed the target value, with an uncertainty range set at 29,000 to 120,000 apartments. [177]

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[173] Radon i inomhusmiljön, Boverket, 2010, at p. 7, online: https://www.boverket.se/globalassets/publikationer/dokument/2011/radon-i-inomhusmiljon.pdf.
[174] Ibid., at pp. 35-36.
[175] Ibid., at pp. 7 and 9.
[176] Nationell handlingsplan för radon, Arbetsmiljöverket, Boverket, Folkhälsomyndigheten, Livsmedelsverket, Sveriges geologiska undersökning, Swedac, Strålsäkerhetsmyndigheten, 2018, at p. 10, online: https://www.stralsakerhetsmyndigheten.se/globalassets/radon/nationell-handlingsplan-for-radon.pdf.
[177] Ibid., at p. 19.

Based on this study, the average indoor radon levels in Sweden were estimated to be 124 Bq/m^3 in single family homes and 68 Bq/m^3 in apartments. The annual number of homes likely in need of radon mitigation was estimated to be around 5,600 houses and 6,700 apartments.[178]

A higher estimate was found in an environmental health report released in 2017. In this report it was found that approximately 400,000 homes (cottages and apartments) exceeded the benchmark 200 Bq/m^3. [179]

Given this discrepancy, the Swedish Radon Action Plan concludes that the data on the number of homes above the target value and estimation of the mean radon content of different types of housing in Sweden is quite uncertain.[180] This may in part be a result of the more limited number of properties that appear to be included in the national surveys in Sweden.

5.3.1. Proposals for better radon data collection

Given the limited nationwide mapping that appears to have been carried out in Sweden, and issues such as the lack of a central database containing data from both national radon surveys and from the individual municipalities' own radon measurements, the Swedish Radon Action Plan proposes a number of actions be taken to improve data collection, including the following:

- Increase the number of radon measurements in indoor air and thereby help enable increased radon mitigation rates.

- Evaluate whether any of the following methods can be recommended as a means of providing a national overview of radon levels in indoor air in homes and other buildings:
    - Collection of measurement data in a central database.
    - Requirement that, if measured, radon levels be included in declarations on home energy use.
    - Compilation of radon statistics from municipalities.
    - Statistical health surveys (last study in 2015 included 37,000 people, and already includes questions regarding radon exposure, which could be amended to include specific questions about radon measurement results).

- Update methodology for radon measurements at workplaces, public premises and homes.

- Develop comprehensive nationwide risk map for ground radon.[181]

These and other related suggestions in the Action Plan may or may not lead to novel solutions in terms of improving radon data collection and mapping, and it would be worthwhile to review the possible developments in the coming years.

5.3.2. Mapping of newer buildings constructed between 2010 and 2015

[178] Ibid.
[179] Ibid.
[180] Ibid., at p. 20.
[181] Ibid., at p. 24.

In addition to the above-mentioned study from 2009, a more targeted radon study was recently carried out in 1,680 buildings constructed between 2010 and 2015 have been carried out. In 99.2% of the tested buildings radon levels were below 200 Bq/m^3, while 93.2% had levels below 100 Bq/m^3, and 77.2% had levels below 50 Bq/m^3.

Current Building Code requirements in Sweden thus appear sufficient to ensure compliance with the country's current 200 Bq/m^3 radon limits in all but a few instances, while a lower limit of 100 Bq/m^3 also appears to be largely attainable. Not surprisingly, the conclusion in the Action Plan is that further changes to the Building Code need not be given a high priority, given these results.[182]

5.4. Environmental Certification of Sustainable Buildings – Includes Radon

"Miljöbyggnad" is a Swedish voluntary certification system developed by the construction industry. It provides for three tiers of environmental certification for sustainable buildings that provide good indoor environments at home and at work. It is based on the Swedish Building Code and other regulatory requirements as well as Swedish construction practices. It covers housing, offices, schools and others building types, and can be applied to both new construction and changes to existing buildings.[183]

When a building is considered, 16 requirements are applied in the categories of indoor environment, energy efficiency and building materials. One of the factors to be considered is radon.[184] For new construction, the three certification tiers for radon levels in indoor air are:

- Gold: ≤ 60 Bq/m^3.
- Silver: ≤ 100 Bq/m^3.
- Bronze: ≤ 200 Bq/m^3. [185]

Certification can also be applied to existing buildings, with the same three levels being applied in such cases.[186]

Compliance with the certification criteria, including radon levels, is verified by independent specialists, two years after occupation of a *new* building.[187] Similar compliance verification is

[182] Ibid., at p. 31.
[183] Nordisk Miljömärkning, "089 Småhus, flerbostadshus och byggnader för skola och förskola", version 3.5, March 26 2018, at p. 15, online: http://www.svanen.se/PageFiles/22844/Bakgrundsdokument_089_Smahus_flerbostadshus_och_byggnader_for_forskola_och_skola_3_Svenska.pdf.
[184] Sweden Green Building Council, Miljöbyggnad 3.0 Metodik Version 170510 Rättelser tom 170915, September 17, 2015, at p. 5, online: https://www.sgbc.se/docman/miljobyggnad-2017/950-3-0-mb-metodik-170510-vers-170915-1/file.
[185] Sweden Green Building Council, Miljöbyggnad 3.0 Bedömningskriterier för nyproducerade byggnader Version 170510 Rättelser tom 170915, September 17, 2015, at p. 31, online: https://www.sgbc.se/docman/bgo-2014/947-3-0-mb-nyproduktion-170510-vers-170915/file.
[186] Ibid., at p. 27.
[187] Sweden Green Building Council "Miljöbyggnad 3.0 Metodik Version 170510 Rättelser tom 170915", September 17, 2015, at p. 5, online: https://www.sgbc.se/docman/miljobyggnad-2017/950-3-0-mb-metodik-170510-vers-170915-1/file.

carried out when certifying *existing* buildings, although the certification is done right away by measuring whether the performance of the building meets the rating criteria.[188] The environmental building certificate is valid as long as the building's environmental performance is maintained. Reporting on this performance is provided to the Sweden Green Building Council every 5 years.[189]

5.5. Incentives and Campaigns

While free radon testing does not appear to be part of the national radon initiative, Sweden has had a radon grant program for several years. The program subsidizes measures aimed at reducing radon levels in private houses. While the program was discontinued at the beginning of 2015, it was reintroduced in 2018, with funds set aside specifically for public information campaigns.[190]

Starting July 1, 2018, the Swedish government will provide funding to home owners for radon mitigation measures where testing shows homes exceed radon concentrations of 200 Bq/m^3. Funding is approved before the measures are put in place, and subsequently paid out once the measures have been completed. Grants will cover 50% of the cost of the proposed measures up to a total of 25,000.00 SEK (C$3,700).[191]

Apart from a previous radon information campaign by the National Board of Housing, Swedish authorities do not appear to have engaged in any continuous national coordination or communication strategies for radon. In its evaluations of the grant program, the National Board of Housing found that a lack of information concerning the health risks of radon and the possibility of reducing radon levels was part of the reason for the declining success of the previous radon grant program. [192]

It concluded that information campaigns carried out by individual municipalities, with the support of central authorities, were particularly effective. In the evaluation of both the information campaign and the grant program it was found that a continuous and centrally unified communication strategy is an important factor in achieving good results.[193]

5.6. Mitigation Methods

The following general categories of mitigation are used in Sweden:

- Seal building envelope to prevent radon from the ground leaking into the building.
- Improvement of the existing indoor ventilation system.

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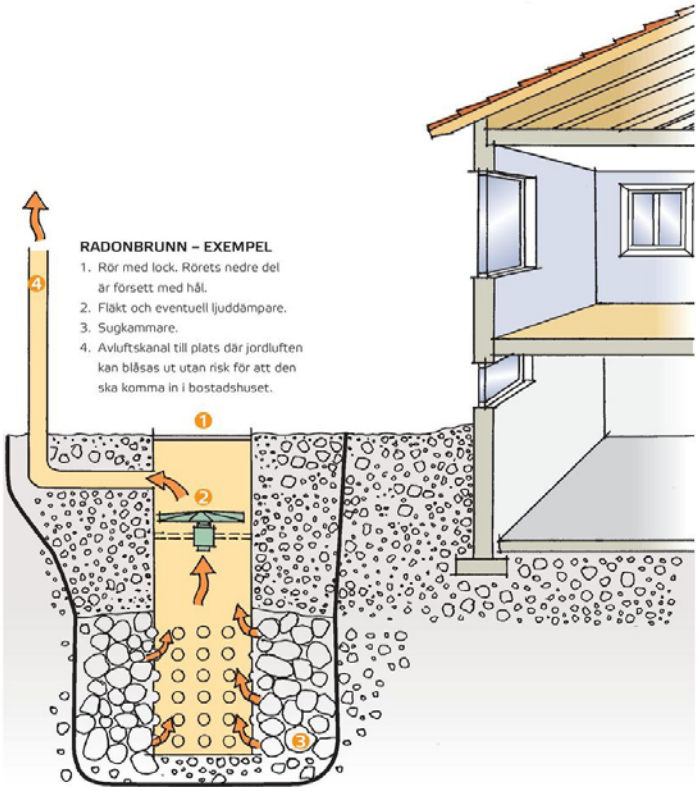
[188] Ibid., at p. 6.
[189] Ibid.
[190] Nationell handlingsplan för radon, Arbetsmiljöverket, Boverket, Folkhälsomyndigheten, Livsmedelsverket, Sveriges geologiska undersökning, Swedac, Strålsäkerhetsmyndigheten, 2018, at p. 7, online: https://www.stralsakerhetsmyndigheten.se/globalassets/radon/nationell-handlingsplan-for-radon.pdf.
[191] Förordning (2018:158) om bidrag till åtgärder mot radon i småhus, online: http://rkrattsbaser.gov.se/sfst?bet=2018:158.
[192] Nationell handlingsplan för radon, Arbetsmiljöverket, Boverket, Folkhälsomyndigheten, Livsmedelsverket, Sveriges geologiska undersökning, Swedac, Strålsäkerhetsmyndigheten, 2018, at p. 15, online: https://www.stralsakerhetsmyndigheten.se/globalassets/radon/nationell-handlingsplan-for-radon.pdf.
[193] Ibid.

- Installation of mechanical exhaust or mechanical exhaust and supply air.
- Measures that lower the air pressure in the ground under the house, such as radon sump or radon well.
- Improvement of ventilation in the crawl space.
- Replacement of radon-releasing building materials.[194]

Many of these measures are similar to what is seen in other countries, with the exception perhaps of replacement of building materials that release radon. Unfortunately, no official government-provided estimates of the effectiveness of the different radon mitigation measures in use in Sweden were found during the preparation of this report.

As in Finland and Norway, we also see the use of radon wells being suggested. The following illustration shows how such a radon well system is constructed in Sweden:[195]



5.7. Radon Action Plan – BSS-Directive

As may already be evident from the references to the Swedish Radon Action Plan above, Sweden appears to have put good efforts into preparing an action plan as required by the BSS-Directive. The result is a comprehensive document, which addresses radon health effects in general (including choice of reference levels); organization of involved authorities; communication

[194] Åtgärder mot radon i bostäder, National Board of Housing, Building and Planning, 2015, at p. 7, online: https://www.boverket.se/globalassets/publikationer/dokument/2015/atgarder-mot-radon-i-bostader-2015.pdf.
[195] Ibid., at p. 14.

strategies; radon measurements; radon mitigation; radon in new buildings; radon in workplaces; and radon in drinking water, as well as numerous sub-topics. Of the many recommendations made, the following are highlighted as key recommendations:

- Organize a formalized cooperation on radon between the relevant authorities under the guidance of the Radiation Safety Authority with the task of planning and following up on efforts to implement the strategies and activities identified in the Action Plan.

- Implement a radon campaign as part of long-term communication efforts to stimulate the measurement of radon and the implementation of measures to reduce radon levels.

- Coordinate government information on radon and make sure that comprehensive information about radon is readily available.

- Determine the distribution of radon levels in homes and workplaces.

- Ensure that all homes meet the long-term goal of a maximum radon level of 200 Bq/m^3.

- Investigate workplaces with the highest risk of high radon levels and exercise supervision and carry out follow-up radon measurements at workplaces.

- Ensure that the county administrative boards are given a time-limited task of monitoring and reporting on the municipality's work with radon in order to ensure good and equitable supervision of radon across the country.

- Investigate the possibility of improving follow-up on radon reduction methods.

- Develop a comprehensive nationwide risk map for radon in the ground by combining aerial measurements of gamma radiation and geological maps. If possible, housing measurements of radon content in the indoor air will also be used to improve the radon mapping.

- Improve information on the measurements of radon in private wells and store measurements results in a database.

- Collaborate with mainly the Nordic countries, but also in other international contexts.[196]

This list makes it clear that with the Swedish Action Plan, the Government intends to address a wide variety of issues that have an impact on the radon problem, which in turn means that this plan has the potential to significantly change the management of the radon issue in Sweden.

[196] Nationell handlingsplan för radon, Arbetsmiljöverket, Boverket, Folkhälsomyndigheten, Livsmedelsverket, Sveriges geologiska undersökning, Swedac, Strålsäkerhetsmyndigheten, 2018, at p. 2, online: https://www.stralsakerhetsmyndigheten.se/globalassets/radon/nationell-handlingsplan-for-radon.pdf.

We find that Sweden's Action Plan, despite its less than optimal radon reference levels, is a particularly good example of national coordination, which merits more in depth study.

6. United Kingdom[197]

6.1. General Radon Rules

In the UK, Public Health England (PHE) has made recommendations for an "ideal" or Target Level of 100 Bq/m^3 and an Action Level of 200 Bq/m^3.[198] While both of these levels have been endorsed by the Government,[199] it is not clear whether this changed the legal status of these recommendations. The Action Level is based on a three-month test using two detectors.[200] The Target Level is considered the ideal radon level for post-mitigation in existing buildings and a protective level in new buildings. Where testing reveals a radon level between these two levels action is recommended especially if there is a smoker or ex-smoker in the home.[201]

Since 1988, radon has been covered by the Building Regulations' definition of contaminants,[202] but this does not include mandatory radon limits. Instead, guidance document BR211 to the Building Regulations provides advice on how to ensure that radon levels do not exceed the Action Level recommended by PHE.[203]

It is worth keeping in mind that since guidance documents such as BR211 are not binding, individuals may opt for an approach that differs from advice and examples given in such guidance documents. Following non-binding guidance such as installing a radon barrier and/or a radon sump will, however, normally be sufficient to comply with the binding, but more generally worded, contaminant requirements in the Building Regulations. Inspection authorities may refer to such guidance documents as illustrating good practice when they seek to secure compliance with the Regulations. The result of this system appears to be wide acceptance of the non-binding radon mitigation approach suggested in the guidance documents.

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[197] While the information provided below aims to cover all of the UK, some aspects of this information may only apply to England, and not the UK as a whole. To limit the research required, and for sake of simplicity, any variations in the handling of radon within the United Kingdom will not be reflected below, and the information given below will be presented as though it applies throughout the United Kingdom, although some elements, such as building regulations, may only relate to England.

[198] Limitation of Human Exposure to Radon RCE 15, Health Protection Agency, July 2010, online: http://webarchive.nationalarchives.gov.uk/20101108170107/http://www.hpa.org.uk/Publications/Radiation/DocumentsOfTheHPA/RCE15LimitationofHumanExposuretoRadon/.

[199] Radon Action Level and Target Level, Public Health England, online: http://www.ukradon.org/information/level.

[200] Ibid.

[201] Ibid.

[202] Department for Communities and Local Government, Revision of building regulation policy on radon, Impact Assessment, 2013, at p. 7, online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/225640/Radon_IA.pdf.

[203] Ministry of Housing, Communities & Local Government, Approved Document C –Site preparation and resistance to contaminants and moisture, 2013, section 2.40, online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/431943/BR_PDF_AD_C_2013.pdf.

This impact is evidenced by the fact that the National House Builders Council (NHBC) has included sub-floor ventilation in the requirements for its 10 Year new home Warranty:

> In areas where there is a high radon potential, full radon protection is required. This should comprise a radon barrier across the ground floor supplemented by provision for subfloor depressurisation or ventilation (either a radon sump or a ventilated subfloor void).[204]

This requirement has apparently been in place since 1988, suggesting that the 1988 changes to the Building Regulations have had a significant impact, including through home warranty requirements making explicit reference to radon protection.[205]

Finally it should be noted that a new regulation concerning radon entered into force on May 8, 2018.[206] According to Section 8(1) of this regulation *"The Secretary of State must set a reference level for the exposure of members of the public to indoor radon concentrations. The reference level for the annual average radon activity concentration in air must not exceed 300 becquerels per cubic metre."* It does not appear that this has had any impact on the existing reference (action) level, which appears to remain at 200 Bq/m^3, despite the possibility of increasing this to 300 Bq/m^3. More importantly, this means that the setting of a *binding* reference level has now become an explicit regulatory requirement,[207] as required by the BSS-Directive. Whether the reference level will remain at 200 Bq/m^3 remains to be seen. This regulation is also briefly mentioned below in regards to the UK's (yet to be released) Radon Action Plan.

6.2. Review of Mitigation Measures

There is some evidence that the radon mitigation methods outlined in the 1988 amendments to the building regulations and associated guidance documents aid in lowering radon levels in the long-term. In one study it was shown that the radon protective measures such as installation of a radon barrier continue to ensure lower radon levels even 10 years after their installation:

> A sample of 73 houses monitored for radon shortly after construction were contacted ten years later to see whether radon level remain low and check for signs of any construction defects. The results of the study have confirmed that the protective measures continue to provide adequate radon protection, without causing any adverse side effects. This offers confidence that the measures will continue to provide protection over the life time of the buildings.[208]

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[204] Technical Guidance - Radon protection – provision of sump, National House Builders Council, 2008, online: http://www.nhbc.co.uk/Builders/Technicaladviceandsupport/TechnicalGuidance/52/filedownload,37176,en.pdf.

[205] What Has Radon Gas Got To Do With Conveyancing?, Clutton Cox Conveyancing, May 22, 2017, online: http://www.cluttoncox.co.uk/site/blog/conveyancing-questions-answered-blog/radon_gas_conveyancing.html.

[206] The Ionising Radiation (Basic Safety Standards) (Miscellaneous Provisions) Regulations 2018, online: http://www.legislation.gov.uk/uksi/2018/482/made.

[207] Response to the consultation on revised requirements for radiological protection: regulation of public exposures and the justification of practices – Transposition of the Basic Safety Standards Directive (2013/59/EURATOM), Department for Business, Energy & Industrial Strategy, 2018, at p. 26, online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/695558/Government_Consultation_Response_Document_FINAL.pdf.

[208] Scnyer, Chris et al., The long Term durability of radon protective measures used in new UK dwellings, International Radon Symposium, 2000, at p. 1, online: https://pdfs.semanticscholar.org/7739/79ea0825d4afa6dc297ee542850bb679266d.pdf.

Given its limited scope and sample size, this study is, unfortunately, insufficient to make any conclusions as to the actual impact of the 1988-amendments to the Building Regulations across the UK.

In another interesting example from the UK, which is not related to the 1988-amendments to the building regulations, a single sump pump was installed outside a number of homes (townhouses) with the aim of mitigating radon in all the adjacent homes. The sump pump led to a reduction in radon levels in all the targeted homes,[209] suggesting a cost effective solution for townhouses, including those governed by a condominium corporation – where the soil conditions permit. Installation of a single system for several houses likely requires (at least) an agreement between the homeowners to ensure its continued functioning.

6.3. Mapping Efforts

The UK has developed radon maps, which show average estimated radon levels at a 1 km^2 level of detail across the country.

A total of just over 595,700 radon measurements have been carried out in homes in the UK between 1980 and 2015. The average radon levels in homes are estimated at an arithmetic average of 101 Bq/m^3 or a geometric average of 53 Bq/m^3, while the population weighted average is 20 Bq/m^3. Of the measured homes, a total of 69,500 were at or above the 200 Bq/m^3 action level – corresponding to an average of 11.7% of all measured homes.[210]

These mapping efforts have resulted in designation of certain areas as so-called *radon affected areas*, i.e. areas where 1% or more of all homes have radon levels above the 200 Bq/m^3 action level.[211] Areas where the risk of surpassing the action level is under 1% are deemed *low* risk areas, while areas with 1-10% risk are deemed *medium* risk areas and those with over 10% are deemed *high* risk areas.[212] This classification helps suggest what type of mitigation should be used in existing buildings.[213]

To supplement the existing maps, PHE is currently promoting radon awareness in homes built after 2000, in areas where the risk of having radon levels above 200 Bq/m^3 is greater than 10%, with the goal of encouraging homeowners to measure if their radon protection is working

[209] Communal externally excavated mini-sump system,World Radon Solutions Database, Federal Office of Public Health, June 22, 2009, online: https://www.worldradonsolutions.info/sites/worldradonsolutions.info/files/ERSD_cs_UK_003.pdf.
[210] Radon in Homes in England: 2016 Data Report, 2017, Public Health England, at p. 6, online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/602516/England_data_report_2016.pdf.
[211] Indicative Atlas of Radon in England and Wales, Health Protection Agency and British Geological Survey, 2007, at p. 1, online: http://www.ukradon.org/cms/assets/gfx/content/resource_2687cs573eec40e4.pdf.
[212] Radon searches, Public Health England, online: http://www.ukradon.org/information/radonsearches.
[213] Radon and Building Regulations, Public Health England, online: http://www.ukradon.org/information/buildingregs.

effectively.[214] It may be worth checking up on this effort to determine whether more recent radon protection efforts have worked as intended.

6.4. Workplaces – Including Schools and Preschools

Radon in workplaces is governed by the *Ionising Radiation Regulations 2017* (IRR17),[215] which covers all workplaces.

IRR17 replaced the previous IRR99 as of January 1, 2018, and is aligned with the 300 Bq/m^3 limit in the European Union's BSS-Directive. Regulation 3(1)(b) states that IRR17 applies to "*any work […] carried on in an atmosphere containing radon 222 gas at an annual average activity concentration in air exceeding 300 Bq m^{-3}*", except for the types of work defined in regulation 2(1), which involve radioactive substances or radiation devices.

The broad application to any workplace with radon concentrations above 300 Bq/m^3 means that it includes schools and preschools as well as workplace buildings where members of the public are present. A recent campaign in the UK took advantage of this in encouraging parents to ask if radon risk assessments had been carried out in their children's schools and preschools. [216]

Where radon concentration levels exceed an annual average of 300 Bq/m^3, IRR17, regulation 5(2), requires that the employer notify the appropriate authority of the exceedance, before allowing work to be carried out in the atmosphere containing elevated radon levels.

In general, employers are required to carry out risk assessments in accordance with the Management of Health and Safety at Work Regulations 1999. Such assessments should include radon measurements if the workplace is located in an area that has been determined to be a *radon affected area* in the UK radon mapping. As noted above, radon levels above 300 Bq/m^3 trigger the IRR17 notification duty. For workplaces located below ground measurements should be carried out if the workplace is occupied more than an hour per week, or 52 hours per year. [217]

Under IRR17, regulation 9(1), employers are required to "*take all necessary steps to restrict so far as is reasonably practicable the extent to which its employees and other persons are exposed to ionising radiation*", and under regulation 9(2) it is required that employers use "*engineering controls*" to reduce exposure. In guidance to regulation 9(2) it is stated that high radon levels "*can be reduced in buildings by use of continuous engineering controls, such as a radon sump and pump system or positive ventilation.*"

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[214] Public Health England, Radon programme 2018 – recently built homes, at p. 1, online: http://www.ukradon.org/cms/assets/gfx/content/resource_4079cs9c9f1366ed.pdf.
[215] The Ionising Radiations Regulations, no. 1075, 2017, online: http://www.legislation.gov.uk/uksi/2017/1075/pdfs/uksi_20171075_en.pdf.
[216] Workers lungs need protection too, UK Radon Awareness Week Campaign, online: https://radonweek.co.uk/2017/11/09/workers-lungs-need-protecting-too/.
[217] Radon in the workplace - What is radon?, Health and Safety Executive, online: http://www.hse.gov.uk/radiation/ionising/radon.htm#whatisradon.

In regulation 14(1), it is furthermore required that employers "*must consult […] radiation protection advisers […] for the purpose of advising the employer on the observance of these Regulations […]*".

Failure to abide by the requirements may lead to one or several enforcement actions:

- Providing published information and verbal advice.
- Providing written information regarding breaches of law.
- Requiring improvements in the way risks are managed.
- Stopping certain activities where they create serious risks.
- Recommending and bringing, prosecutions where there has been a serious breach of law.[218]

All in all, these provisions provide for a relatively strong protection of workplaces, schools and preschools as well as public places – a protection which can likely be triggered by employees or those using schools or other public buildings asking for a radon test.

PHE has produced a brochure on radon in schools, which provides valuable radon information to individuals, schools and local councils.[219] It goes as far as stating that "*some councils may not have recognised their duty to assess radon at work. Numerous employees and students are therefore likely to be exposed to unacceptably high levels*".[220] It provides detailed information on placement of radon detectors and suggests that schools may need from 15 and up to 70 radon detectors to sufficiently cover an entire school.[221]

6.5. Protection of Tenants

The Housing Health & Safety Rating System (HHSRS) is a risk based assessment tool, which is used by environmental health officers (local authorities) when evaluating potential health and safety risks and hazards, by looking at their likelihood and severity.[222]

The HHSRS protects occupants and visitors, and covers all residential properties, regardless of ownership, and can thus be used to assess risks and hazards in both private and social rented housing, as well as owner occupied housing, although the vast majority of HHSRS-work has been concerned with private rented housing .[223]

[218] Health and Safety Executive, Enforcement Policy Statement, 2015, at p. 1, online: http://www.hse.gov.uk/pubns/hse41.pdf.
[219] Radon in schools – Raising awareness of a natural radioactive gas in your buildings, Public Health England, 2014 (revised 2018), online: http://www.ukradon.org/cms/assets/gfx/content/resource_2759cs35c5a2cb36.pdf.
[220] Ibid., at p. 2.
[221] Ibid., at p. 3.
[222] Alex Adcock et al., The Housing Health and Safety Rating System (HHSRS), House of Commons Library, 2016, at p. 3, online: http://researchbriefings.files.parliament.uk/documents/SN01917/SN01917.pdf.
[223] Ibid.

HHSRS covers 29 different types of hazards. Number 8 of these is radiation, with the main concern being radon and its daughters, primarily airborne.[224]

If the authority finds a serious hazard (a so-called *Category 1-hazard*), the authority has a duty to ensure that the hazard is rectified. The authority may also carry out necessary radon mitigation work and reclaim the costs, if deemed necessary or if the owner/manager of the building requests this. [225] It appears that Radon levels above the action level of 200 Bq/m3 have been considered as *Category 1-hazards*, while radon levels just below the action level have been considered as *Category 2-hazards*[226] (the authority is not required to act, but may still take action orders if deemed necessary).[227]

The HHSRS regime also includes a power to enter dwellings and to leave measuring equipment such as radon detectors to measure radon levels, where authorities have reasonable grounds to leave such equipment in place.[228]

6.6. Incentives, Campaigns, Tax Credits

While free radon tests do not appear to be generally available, PHE has engaged in targeted campaigns, offering free radon tests to households in particularly radon prone areas. [229] [230] In one campaign,[231] PHE wrote to 18,000 households offering a free radon test, and of these, 4,600 initially accepted the offer, while the thousands that did not respond were sent a reminder letter.[232] In the end, more than 7,200 of the 18,000 households accepted the offer, and of these 7,200 over 700 had radon levels above the 200 Bq/m^3 action level.[233]

Following this free test campaign PHE, the local councils and the British Building Research Establishment (BRE), invited homeowners to a number of local drop-in events. During these all-

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[224] Hazards - Physiological requirements, Shelter Legal, online http://england.shelter.org.uk/legal/housing_conditions/housing_health_and_safety_rating_system/hazards.
[225] Housing Health and Safety Rating System – Guidance for Landlords and Property Related Professionals, Department for Communities and Local Government, 2006, at p. 14, online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/9425/150940.pdf.
[226] Hazard 8 – Radiation (Radon), Local Government Regulation, December 22, 2017, online: http://www.ihsti.com/lacors/ContentDetails.aspx?id=18493.
[227] Housing Health and Safety Rating System – Guidance for Landlords and Property Related Professionals, Department for Communities and Local Government, 2006, at p. 6, online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/9425/150940.pdf.
[228] Housing Health and Safety Rating System – Enforcement Guidance, Office of the Deputy Prime Minister, 2006, at p. 32, online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7853/safetyratingsystem.pdf.
[229] Homes at risk get free radon test, BBC News, October 29, 2009, online: http://news.bbc.co.uk/2/hi/uk_news/england/cornwall/8332931.stm.
[230] Take the test and see if your home is a radon risk, Public Health England news release, November 19, 2014, online: http://www.ukradon.org/cms/assets/gfx/content/resource_3446cs5b4a214624.pdf.
[231] Ibid.
[232] Homes at risk get free radon test, BBC News, October 29, 2009, online: http://news.bbc.co.uk/2/hi/uk_news/england/cornwall/8332931.stm.
[233] Radon gas found in around 700 Gloucestershire homes, Wilts and Gloucestershire Standard, September 18, 2015. http://www.wiltsglosstandard.co.uk/news/13769280.Radon_gas_found_in_around_700_Gloucestershire_homes/.

day events homeowners were given an informal opportunity to get information from experts on radon reduction, get information from radon contractors and see examples of mitigation measures and equipment, as well as information on simple mitigation measures that may be undertaken by homeowners with practical DIY experience.[234]

6.6.1. Tax credits

A tax relief (land remediation relief) is available "in all commercial property sectors where companies are subject to corporation tax. Unlike capital allowances, land remediation relief is available to property investors and developers alike."[235] [236] Relief can "cover […] the treatment of harmful organisms and naturally occurring contaminants such as […] radon […]"[237] and thus does not require actual industrial pollution.[238] The relief provides a deduction of 100%.[239]

While developers and investors may thus benefit from tax relief when mitigating radon, no authoritative sources have been found that can confirm whether or not any support or tax credits that cover radon have been made available to UK homeowners.

6.6.2. Dedicated Radon Website – www.UKradon.org

PHE has set up a dedicated website containing a variety of information about radon including mapping of radon affected areas, information targeted at different groups such as homeowners, employers, professionals (builders, realtors etc.) and local authorities and housing associations.

In addition to providing radon test kits free of charge during the above-mentioned targeted campaigns, PHE also provides radon test kits through www.ukradon.org. For households the kit contains two detectors at a price of £50.40 (C$87) incl. VAT and return shipment. [240] For workplaces where multiple detectors may be needed, the detectors are provided at a price of £21.00 (C$36) excl. VAT per detector incl. return postage.[241] The detectors remain the property of PHE, and the results are incorporated into PHE's radon database. [242]

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[234] Ibid.
[235] Land Remediation Relief: What is "land in a contaminated state"? Natural contaminants: Radon – examples, HM Revenue & Customs, June 8, 2017, online: https://www.gov.uk/hmrc-internal-manuals/corporate-intangibles-research-and-development-manual/cird61425.
[236] Land remediation relief - When can land remediation relief be claimed?, BDO United Kingdom, online: https://www.bdo.co.uk/en-gb/services/tax/capital-allowances/land-remediation-relief.
[237] Ibid.
[238] Land Remediation Relief: What is "land in a contaminated state"? Natural contaminants: Radon, HM Revenue & Customs, June 8, 2017, online: https://www.gov.uk/hmrc-internal-manuals/corporate-intangibles-research-and-development-manual/cird61420.
[239] Land Remediation Relief: Outline: From 1 April 2009 - Arsenic, radon and Japanese knotweed, HM Revenue & Customs, June 8, 2017, online, https://www.gov.uk/hmrc-internal-manuals/corporate-intangibles-research-and-development-manual/cird60025.
[240] Order a Home Measurement Pack, Public Health England, online: http://www.ukradon.org/services/orderdomestic.
[241] Order a Workplace Measurement Pack, Public Health England, online: http://www.ukradon.org/services/orderworkplace.
[242] Order a Home Measurement Pack, Public Health England, online: http://www.ukradon.org/services/orderdomestic_process .

6.7. Real Estate Transactions – Radon Bond

Basic radon information is part of real-estate transactions, where it appears as part of the environmental searches, for example with the following wording: "Records indicate that the property is in a 'Radon Affected Area' as identified by Public Health England."[243]

If a property is in a radon affected area, PHE recommends that real estate professionals ensure that the property is tested for radon. The current owner should be asked if a test has already been done and if not, the client should be advised to test when they move in.

PHE also suggests that a retained fund – a so-called *radon bond* – can be arranged to cover mitigation costs.[244]

A radon bond "*is simply a retained fund, the terms of which are negotiated between the purchaser and the vendor. It allows the conveyance of the property to proceed without undue delay. The purchaser is protected against the possible cost of radon reduction work and the seller does not lose sale proceeds if the [test] result is low.*"[245] A radon bond is thus not a requirement and depends on the parties to the real-estate transaction reaching an agreement on the size of the bond and the other terms of the agreement.

As a radon bond depends on testing being carried out after the property has sold, it is important to ensure that the time specified before expiry of the radon bond agreement gives the buyer sufficient time to complete a full radon test, get the result and arrange the work, if needed.[246] The duration of the bond may have to be a minimum of nine months to allow five to six months to move in and obtain radon test results, and then three months to organise and carry out mitigation work.[247] Furthermore, if post-mitigation monitoring or additional mitigation work is necessary, more time may be required.

If the tests results are low, meaning that radon mitigation is not required, the bond is released to the seller. If the results are high and mitigation work is required, the bond is used to pay this work, and any remaining funds are released to the seller once the works are complete. [248]

The UK Radon Association suggests that a £ 2,500 bond is a realistic sum that will cover most mitigation scenarios.[249] Other sources suggest that the amount of the radon bond may vary in size, with retention sums falling between £ 500 and £ 2,000.[250] [251] Furthermore, "a Radon Bond

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[243] Radon and Conveyancing, Public Health England, online: http://www.ukradon.org/information/conveyancing.
[244] Ibid.
[245] Example of Radon Risk Report for addresses in England and Wales, Public Health England and British Geological Survey, March 10, 2017, online: http://www.ukradon.org/cms/assets/gfx/content/resource_3986cs540393ae7f.pdf.
[246] Ibid.
[247] Frequently Asked Questions - How long should the Radon Retention or Bond run for?, BRE, online: https://www.bre.co.uk/page.jsp?id=3150#buying4.
[248] Information for House Buyers and Sellers, UK Radon Association, online: http://www.radonassociation.co.uk/guide-to-radon/information-for-house-buyers-and-sellers/.
[249] Ibid.
[250] Frequently Asked Questions - How much money should I ask to be placed in a Radon Retention or Bond?, BRE, online: https://www.bre.co.uk/page.jsp?id=3150#buying6.

may not be suitable when the buyers are planning to carry out major building work as soon as they move in or if the buyers are not planning to move in straight away."[252]

Overall, the radon bond has been in use for some time now, and is apparently popular amongst homebuyers.[253] While we have not found any detailed assessments of its adoption, its continued existence, and the support from organisations such as BRE,[254] [255] does suggest that it has worked and continues to work as intended.

6.8. Radon Action Plan?

The United Kingdom does not appear to have prepared a Radon Action Plan yet, as required by the BSS-Directive. While new a regulation has been passed, which requires that the Secretary of State must establish a national action plan that considers among other things the BSS-Directive, this regulation only entered into force on May 8, 2018, likely explaining why an action plan has not yet been prepared.[256]

7. Switzerland

Switzerland is not a member of the European Union, but has been proactive in radon testing and mitigation.

7.1. Radon Limits and Enforcement: Homes, (Pre)Schools and Workplaces

Switzerland has recently strengthened its requirements aimed at reducing indoor radon levels in the Swiss Radiation Protection Regulation (Ordonnance sur la Radioprotection - ORaP).[257] The changes which took effect January 1, 2018, include a number of clear requirements aimed at ensuring that action is taken to reduce radon levels, including an increased enforcement role for the individual cantons.

Among these changes is replacement of the previous reference level of 1000 Bq/m^3 with 300 Bq/m^3, found in article 155.2. While this new limit may not appear overly ambitious, the remainder of the provisions examined below appear to provide a relatively robust set of tools, including, in particular, the ability of cantons to demand radon testing and to issue mitigation orders. The impact of the revised rules thus depends on whether the responsible authorities – the

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[251] Annalise Searle, Radon Affected Areas And Important Measures Conveyancers Must Take, Today's Conveyancer, August 18, 2015, online: https://www.todaysconveyancer.co.uk/guest-writers/radon-affected-areas-and-important-measures-conveyancers-must-take/.
[252] Ibid.
[253] Environment and Heritage Service, Radon – a guide for homebuyers and sellers, 2002, at p. 6, online: https://www.dover.gov.uk/Environment/Environmental-Health/radon-homebuyers-sellers-guide-screen.pdf.
[254] Ibid.
[255] Frequently Asked Questions - Buying and selling buildings, BRE, online: https://www.bre.co.uk/page.jsp?id=3150.
[256] The Ionising Radiation (Basic Safety Standards) (Miscellaneous Provisions) Regulations 2018, Section 10, online: http://www.legislation.gov.uk/uksi/2018/482/made.
[257] Ordonnance sur la radioprotection (ORaP), 26 avril 2017, Chapter 3, in particular articles 155 and 156, online: https://www.bag.admin.ch/dam/bag/fr/dokumente/str/std/revision-verordnungen-strahlenschutz/revidierte-verordnungen-verabschiedet/stsv-erl-2018-fr.pdf.download.pdf/stsv-erl-2018-fr.pdf.

individual cantons in particular due to their enforcement responsibility – are willing to use the powers to strictly enforce the new lower limit.

In describing the revised ORaP, the Federal Office of Public Health stated that, with the changes to the ORaP, the cantons would be resuming all measuring tasks in schools and preschools, that it would provide information on the consideration of radon protection measures within the building-permit procedure for new buildings and conversions, and that the new practices would involve increased coordination efforts between the health and construction departments of the cantonal administrations.[258] In addition to the changes described below, this suggests a more central role for the cantons in handling radon in buildings.

Unfortunately, as the ORaP-regulation was amended recently, no data appears to be available yet on the effect of this new lower limit. It therefore remains to be seen to what extent the potential seen in the amended ORaP will be realised, including what effect the stronger cantonal role will have. A follow-up review of the impact of these changes in a few years' time would likely provide insight into what can be learned from the Swiss approach.

7.1.1. 300 Bq/m^3 reference level (1000 Bq/m3 limit for particular workplaces)

According to article 155.2, a 300 Bq/m^3 reference level now applies to buildings where people regularly spend several hours per day. The scope of this new limit is thus not limited to dwellings, but also includes schools preschools and workplaces.[259] Notably, radon is a serious challenge in Switzerland. Estimates suggest that a limit of 100 Bq/m3 would require mitigation of around half a million buildings, something which has been deemed unrealistic.[260] A 300 Bq/m^3 limit thus looks like a practical compromise for the time being.

Article 156.2 provides for a higher annual threshold value of 1000 Bq/m^3. This threshold applies to so-called radon-exposed workplaces exposed to radon, such as workplaces in underground installations, mines, caves and water supplies and other workplaces that are classified as such by the authorities.[261] While this level sounds very high, it is accompanied by a number of other provisions, which aim to limit worker-exposure. Further provisions call for radon measurements in radon exposed workplaces (art.165.1). If the 1000 Bq/m3 threshold is exceeded, the business in question must determine the annual effective dose from radon received by the exposed workers and check their effective doses least every five years (art. 167.1). If the effective dose of a worker is greater than 10 mSv per calendar year, the company must immediately take

[258] Rapport explicatif concernant la révision totale de l'Ordonnance sur la radioprotection (ORaP) (RS 814.501), Federal Office of Public Health, 2017, at p. 9, online: https://www.admin.ch/ch/f/rs/c814_501.html.
[259] Lignes directrices en matière de radon - Evaluation de l'urgence d'un assainissement, Office fédéral de la santé publique OFSP, February 16, 2018, online: https://www.bag.admin.ch/dam/bag/fr/dokumente/str/srr/wegleitungradon.pdf.download.pdf/Lignes%20directrices.pdf.
[260] Swiss lean towards new radon norms, Swissinfo, October 19, 2009, online: https://www.swissinfo.ch/eng/sci-tech/swiss-lean-towards-new-radon-norms/45716.
[261] Lignes directrices en matière de radon - Evaluation de l'urgence d'un assainissement, Federal Office of Public Health, at p. 2, online: https://www.bag.admin.ch/bag/en/home/themen/mensch-gesundheit/strahlung-radioaktivitaet-schall/radon/richt-grenzwerte.html.

organizational or technical measures to reduce the dose (art. 167.2). There are overall dose limits of 20 mSv per year (art. 167.3 in conjunction with art. 56.1)

7.1.2. Radon measurements to be carried out by authorized service providers

According to article 159.1, radon measurements must be carried out by an authorized service provider in accordance with prescribed protocols.

Article 159.2 states that the the Federal Office of Public Health (FOPH) will only recognize a service provider, if it has competent staff and appropriate measurement systems to perform the tasks required by the regulations and guarantees fully satisfactory performance of its tasks, in particular by ensuring the absence of conflicts of interest.

And finally, article 159.3 limits the period of validity of the approval of authorized service providers to a maximum of five years.

7.1.3. Mandatory entry of measurements in to central radon database

Together, articles 160.a. and 162 require that authorized service providers enter their measurement results into a central radon database within 6 months of completing the measurements. The database itself is managed by FOPH.

7.1.4. Cantons may/must require radon measurements

Article 164.1 gives cantons the power to require building owners to carry out radon measurements in buildings where people regularly spend several hours per day.

While the application of article 164.1 is discretionary, article 164.2 sets out a mandatory requirement that cantons ensure that radon measurements are carried out in school and preschools.

7.1.5. Cantons may carry out further radon measurements

In addition to ensuring measurements are carried out in accordance with articles 164.1 and 164.2, cantons are furthermore given the power in article 164.3 to initiate other radon measurements. It is not immediately clear what these measurements would look like, or what their exact purpose would be.

7.1.6. Mandatory mitigation (and mitigation orders) if 300 Bq/m^3 level is exceeded

Article 166.1 places a duty on building-owners to initiate mitigation measures, if the 300 Bq/m^3 reference level is exceeded, and states that the Federal Office of Health Protection and the cantons will provide guidance on the urgency of this mitigation. What exactly this entails is not clear.

Article 166.2 adds to the mitigation requirement by providing cantons with the power to issue mitigation-orders, where owners fail to act. This power appears to be discretionary.

Article 166.3, on the other hand, sets out a binding requirement that, if the radon reference level is exceeded in a school or preschool, the canton must order mitigation within three years.

Finally, article 166.4 makes it clear that, while the canton may be ordering the mitigation, the cost of such mitigation shall be borne by the owner of the building in question.

7.2. Mapping Efforts

Switzerland has carried out extensive radon measurements since 1994, with over 230,000 measurements completed as of 2016.[262]

The mapping focuses on regions with suspected high levels of radon, and in particular buildings with radon levels over 1000 Bq/m^3. The local cantonal authorities have played a key role by organizing the dispatch and collection of the dosimeters.[263] It would seem that the Swiss authorities decided early on to invest in radon mapping to ensure a more detailed picture of the extent of the radon issue.

Given the level of detail the mapping has allowed the preparation of a list of radon measurement results for each of the several thousand Swiss municipalities, which includes the following detailed information for each of those municipalities:

- Number of radon tested buildings.
- Number of inhabitants.
- Total number of buildings.
- Average radon levels.
- Highest radon levels measured in a residential building.
- Percentage of residential buildings with radon levels above 200 Bq/m^3, 400 Bq/m^3 and 1000 Bq/m^3;
- An overall assessment of whether the radon risk is high (>200 Bq/m^3), medium (100-200 Bq/m^3) or low (<100 Bq/m^3), on average in a given municipality.[264]

The detailed and rather localized information provided here adds valuable information when public authorities and citizens seek to interpret the measurement results for their particular area, and thus help provide a clearer picture of the actual radon risk. It also helps highlight to what extent further mapping may be needed in a particular area, and is thus of value if local authorities are contemplating carrying out local measurement campaigns.

7.3. Review of Mitigation Measures

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[262] Fabio Barazza et al., Radon Map of Switzerland - Experience in Switzerland, Regional Workshop on Radon in Workplaces, Federal Office of Public Health, 2016, at p. 12, online: https://gnssn.iaea.org/RTWS/general/Shared%20Documents/Radiation%20Protection/Regional%20Workshop%20on%20Radon%20in%20Workplaces%20as%20an%20Element%20of%20a%20National%20Radon%20Action%20Plan%20-%20Tallinn%2023-27%20May%202016/03_Barazza_RadonMap_250516.pptx.pdf.

[263] Fabio Barazza et al., The Assessment of the Radon Problem in Switzerland and the New National Radon Action Plan 2012-2020, Federal Office of Public Health, 2012, at p. 3, online: http://aarst-nrpp.com/proceedings/2012/01_The_Assesment_of_the_Radon_Problem_In_Switzerland.pdf.

[264] Radon risk in the Swiss municipalities, 2016, online: https://www.bag.admin.ch/dam/bag/en/dokumente/str/srr/stat-radon-2013.xls.download.xls/Radon%20risk%20in%20the%20Swiss%20municipalities.xls.

7.3.1. 2011-study

In Switzerland, four general types of mitigation measures appear to have been used, namely, improvement of the leak tightness, ventilation, radon drainage system or radon well and ventilation of a hollow space beneath the foundation.[265] The following results were found when evaluating their effectiveness in *existing* buildings:

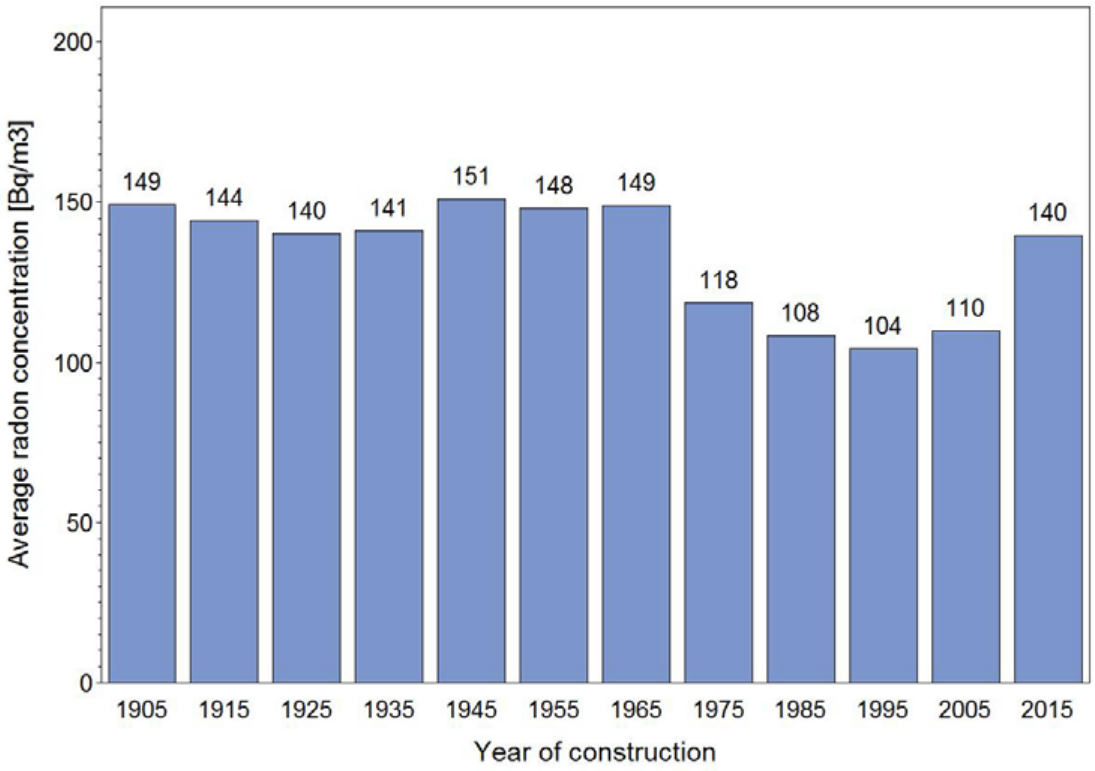
Mitigation method	**Ventilation**	**Leak tightness**	**Drainage/ Radon well**	**Hollow space**
Number of cases	67	50	21	9
Average reduction all cases	38%	26%	48%	49%
Average reduction Initial radon concentration <1000 Bq/m^3	24%	31%	44%	52%
Average reduction Initial radon concentration >1000 Bq/m3	48%	22%	56%	48%

We see that the survey shows that simple ventilation solutions used in Switzerland appear to lose their effectiveness for levels under 1000 Bq/m^3, while the drainage/radon well, ventilation of hollow spaces, is both more consistent and overall more effective than ventilation and leak tightness. While ventilation may be beneficial in existing buildings, it appears that its effect decreases when radon levels decrease – something which should be taken into account when comparing the cost-effectiveness of different mitigation efforts.

Furthermore, to identify communities with high radon risks, average indoor radon levels have been estimated on the basis of at least 20 radon measurements for each community.[266]

As experienced elsewhere in the world, it is also suggested that recent improvements in energy conservation is leading to a significant increase in radon levels, with the suggested solution being greater coordination of energy conservation efforts and radon prevention as well as stricter building regulations. This suggestion is a reflection of the following graph, which shows the average radon concentration as a function of year of construction (the dates indicate the middle of the corresponding decade), with a significant uptick in recent years: [267]

[265] Fabio Barazza et al., The Assesment Of The Radon Problem In Switzerland And The New National Radon Action Plan 2012-2020, Federal Office of Public Health, 2011, at p. 6, online: http://aarst-nrpp.com/proceedings/2012/01_The_Assesment_of_the_Radon_Problem_In_Switzerland.pdf.
[266] Ibid., at p. 3.
[267] Ibid., at p. 8, where the graph below is taken from.



From this graph we also see average radon levels ranging from 104 Bq/m^3 to 151 Bq/m^3, depending on the age of the home, which for the most part is well above WHO's proposed reference level of 100 Bq/m^3, highlighting the urgency of the radon problem in Switzerland, and a need to pay particular attention to radon levels in energy-efficient homes.

Another issue identified is architects and construction experts lacking knowledge of radon issues. As a solution to this challenge, the Federal Office of Public Health has identified training of building professionals as a priority action and, as a first step, radon delegates have been anchored at three universities of applied sciences (one in each linguistic region), with these delegates aiming to ensure that radon prevention is included in the core curriculums.[268] These three universities have furthermore been mandated to host radon competence centers to support these goals.[269]

7.3.2. 2017-study

A recent study looked at mitigation rates in particularly problematic buildings with radon level above 1,000 Bq/m^3. [270]

[268] Ibid., at p. 8.
[269] Advice by radon consultants - Radon competence centers, Federal Office of Public Health FOPH, online: https://www.bag.admin.ch/bag/en/home/themen/mensch-gesundheit/strahlung-radioaktivitaet-schall/radon/beratung-durch-radonfachpersonen.html.
[270] Fabio Barazza et al., A national survey on radon remediation in Switzerland, 2018 J. Radiol. Prot. **38** 25, at p. 26.

The study found that 46% of home-owners carried out radon mitigation after finding high radon levels in their homes. While one would expect the highest radon levels to be associated with the highest rate of mitigation, the results of the study suggested that knowledge of the risks associated with high radon levels was more important than the actual radon levels.

In the German-speaking part of Switzerland, the average radon level in the buildings covered by the study was 2507 Bq/m3 and the mitigation-rate a relatively low 40%. In the Italian-speaking part of Switzerland, the average radon level was 1877 Bq/m3 and the mitigation rate considerably higher at 60%. The study states that these numbers could be interpreted as showing that the greater awareness of the radon issue in the Italian-speaking part of Switzerland is crucial to the significantly higher rate of mitigation.[271]

The study also examined the percentage of post-mitigation testing, which was found to be a disappointing 52%, suggesting that some radon experts carrying out mitigation do not insist on such tests, while highlighting a possible shortcoming in the Swiss authorities' radon communications.[272]

Furthermore, the study found that installation of a less costly ventilator airing the basement was the most common mitigation measure (47%), followed by other measures such as various method of sealing the basement (30%), radon suction pit (26%) and sealing the ground floor above the basement (25%). More costly measures, such as radon drainage (13%) or ventilation for the entire building (6%), were far less frequent.[273]

This information, combined with the finding that high cost was the most common reason for not carrying out radon mitigation (31% of respondents), followed by a false assumption that radon does not pose a risk (23%),[274] suggests that a relatively unregulated approach to mitigation is likely to lead to either the least expensive solution being chosen or no mitigation at all. This furthermore shows a clear preference for cheaper mitigation methods, despite the proven effectiveness of more expensive methods, and thus suggests that financial support aimed at more costly mitigation efforts may have an impact on what mitigation efforts are actually undertaken.

The authors of the study also acknowledged that home-owners cannot be urged to carry out mitigation without proper support. This statement was prompted by the fact that, out of the 54% of respondents that had not mitigated 14% replied that they wished to mitigate, but had obtained no support – something which the authors label as unacceptable.[275] This finding may be of some significance, as it highlights a less obvious reason for some homeowners choosing not to mitigate. This in turn reveals a need to examine in greater depth the various reasons why some homeowners do not mitigate, as some may simply be in need of greater support in order to carry

[271] Ibid., at p. 29.
[272] Ibid., at p. 30.
[273] Ibid., at p. 31. The percentages amount to more 100% in total as some home-owners chose to implement more than one measure.
[274] Ibid., at p. 32.
[275] Ibid., at p. 32.

out mitigation. It also suggests that there is a potential for improving mitigation statistics by asking home-owners if they are considering mitigation, but are held back by a lack of support.

Finally, looking at how the work was carried out, the study found that 41% of homeowners took part in carrying out radon mitigation work, prompting a need for information material to aid in proper mitigation, while suggesting that extensive DIY-support might actually help motivate some home-owners.[276] While radon mitigation should ideally be carried out by a licenced professional, it might be considered whether some types of radon mitigation could be undertaken by homeowners, in whole or in part, based on extensive information and support. This could be combined with efforts to ensure testing before and after such work has been done, in order to evaluate such an approach and to ensure the measures are effective.

7.4. Internet Portal for Sharing Mitigation Examples

The Federal Office of Public Health hosts an internet platform located at www.worldradonsolutions.info, the purpose of which is to share information on mitigation methods and experiences. The website so far contains 37 case studies from 10 different European countries. The case studies provide more or less detailed descriptions and photos of the various mitigation efforts and furthermore include measurements of radon levels before and after mitigation. A similar approach could be considered in Canada.

7.5. Radon Awareness in Switzerland

A survey conducted in 2010 found that radon awareness in Switzerland is quite low, with 60% of the Swiss population having never heard of the radon problem. When focusing on areas of Switzerland with a higher risk of elevated radon levels the number of people without knowledge of radon dropped to 30%.[277]

While we have not come across more recent surveys focusing directly on radon awareness, the 30% number in high-risk areas is mirrored in the findings of the *2017-study* mentioned above, which stated that there was a greater awareness of the radon issue In the Italian-speaking part of Switzerland where radon-levels are the highest. All in all, these results are at odds with the high number of radon measurements that have been carried out in Switzerland so far, If these result are still somewhat valid, it appears that the Swiss authorities may need to improve their radon information campaign-approach, especially given the very high average radon levels in Switzerland.

7.6. Incentives

While the Swiss authorities seem to have handled and presumably funded a significant number of radon measurements, it appears that radon tests are usually paid for by those who wish carry

[276] Ibid., at p. 30.
[277] Gruson M, Murith C, Rumo S. Enquête: niveau de connaissance de la population au sujet du radon en Suisse. Radioprotection 45 n°1:11-30;2010.

out radon measurements, although examples can be found of cantons offering radon measurements free of charge.[278]

In terms of radon mitigation efforts, tax credits may be available, as highlighted in FOPH's Radon Handbook:

> The competent tax office will provide information about tax relief in connection with construction measures for radon protection or reduction. The process and magnitude vary between cantons. Basically, a remediation that preserves value may be subtracted from taxable income. Remediation that serves only to lower radon levels in buildings definitively preserves value in this sense, because it represents a repair of damage. In many cantons, this principle is linked to the length of ownership of the property. The shorter the length of ownership, the less may be taken off one's taxes, even for expenditure to preserve value. As yet no cases or rules are known of financial aids such as guarantees or low-interest loans by the public purse or health insurance companies. [279]

While attempts have been made to find specific examples of tax credits applying to radon mitigation, it has unfortunately not been possible to find such examples. It does, however, appear that a tax credit can be claimed for home renovations in general in Switzerland,[280] including in the canton of Zurich – the largest canton in Switzerland.[281]

7.7. Radon Action Plan

Switzerland has prepared 20-page Radon Action Plan, which runs from 2012 to 2020, and sets out seven key objectives:

1. Revision of the legal regulations.
2. Extending our knowledge of radon exposure in dwellings.
3. Promotion of a protection policy against radon in buildings.
4. Including the awareness of the radon problem into the process of energy efficiency mitigation.
5. Integrating the problem of radon into the training of construction specialists and the promotion of possible solutions.
6. Improving public awareness of health problems caused by radon.
7. Development of programmes on the scientific and technical aspects.[282]

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[278] Measuring the radon concentration, Federal Office of Public Health FOPH, online: https://www.bag.admin.ch/bag/en/home/themen/mensch-gesundheit/strahlung-radioaktivitaet-schall/radon/radonmessung.html.

[279] Swiss Radon Handbook, Federal Office of Public Health, 2000, at p. E/2, online: https://www.bag.admin.ch/dam/bag/en/dokumente/str/srr/broschueren-radon/radon-technische-dokumentation-art-311-346.pdf.download.pdf/radon-technische-dokumentation-art-311-346.pdf.

[280] Kosten für Unterhalt und Renovation, Homegate AG, https://www.homegate.ch/kaufen/schritte-zum-eigenheim/aktuell/steuern-2011/kosten-fuer-unterhalt-und-renovation.

[281] Merkblatt des kantonalen Steueramtes über die steuerliche Abzugsfähigkeit von Kosten für den Unterhalt und die Verwaltung von Liegenschaften , Kantonales Steueramt Zürich, 2009, online: https://www.steueramt.zh.ch/internet/finanzdirektion/ksta/de/steuerbuch/zuercher-steuerbuch-definition/zstb-30-3.html.

[282] National Action Plan concerning Radon 2012 – 2020, Federal Office of Public Health, at p. 4, online: https://www.bag.admin.ch/dam/bag/en/dokumente/str/srr/radonaktionsplan-2012-2020.pdf.download.pdf/radon-action-plan-2012-2020.pdf.

While the legal regulations have been revised as noted above, this only happened recently. It is therefore too early to tell what the impact will be. As for the other objectives mentioned here, a more detailed review of their progress is beyond the scope of this report. Given that the Action Plan will have run its course by 2020, it may be worth following up in two years' time and examining the results once the Action Plan has been evaluated by the Swiss authorities.

Appendix 2: Workplace Legislation and Radon - by Province and Territory

Contents

The following canvases Provincial and Territorial workplace legislation noting areas that are relevant, or make specific reference, to radon. Sub-headings in each Province or Territory address legislative or associated regulatory provisions in most or all of the following areas:

- **General duty clauses**
- **Compensation**
- **Indoor air quality/ventilation**
- **Radiation**
- **Radon specific provisions**
- **Studies**

Newfoundland

General duty clauses are found in the Occupational Health and Safety Regulations, 2012 under the Occupational Health and Safety Act(O.C. 2012-005) at s. 42. Employers shall monitor the use or presence of substances at the workplace that may be hazardous to the health and safety of workers (42 (1)); implement chemical and biological control program commensurate with the associated risks (42(2)) and eliminate hazardous substances from the workplace or where this is not practicable substitute a less hazardous substance (42(3)). There are provisions allowing the Minister to inquire into new substances and take measures to prohibit, restrict or modify the use of the substance until a time that an employer establishes to the minister that its use or presence is not injurious to the health of

workers (42 (6). There are broad provisions relating to atmospheric contamination and the duties of employers to keep this as low as reasonably practicable (42(7)).

Compensation. Newfoundland recognizes diseases of ionizing radiation.[1]

Indoor air quality. Section 45. (1) provides that an employer shall ensure that there is appropriate circulation of clean and wholesome air; there is adequate ventilation; and (c) impurities are made harmless and inoffensive in a workplace in accordance with standards established by ASHRAE and ACGIH. Provisions also call for, where practicable, local exhaust ventilation to be installed and maintained near to the point of origin of an impurity to prevent it entering the air of the workplace and the breathing zone of its workers (45 (3) and for impurities to be exhausted clear of the workplace (45 (4). Further, under "PART XVIII EXCAVATION, UNDERGROUND WORK AND ROCK CRUSHING" there are provisions related to ensuring that "respirable air in all underground workings is free from hazardous amounts of dusts, vapours and gases" (s. 413).

Radon specific provisions. Prior to 2012, regulations were specific to miners— contained in the Mines Safety of Workers Regulations. These specified radon exposure limits of 1.8 WLM in a consecutive 3 month period, and no more than 3.6 WLM in a consecutive 12 month period. These have been subsequently replaced by the more general Occupational Health and Safety Regulations, 2012, NLR 5/12. As well as the general clauses about exposure in section 42, there are specific provisions at section 42(7) incorporating the ACGIH threshold limit values. As such the new limits are 4 WLM per year.

Ionizing radiation generally. Newfoundland's *Workplace Health, Safety and Compensation Ac*t, RSNL 1990, c W-11 generally provides for compensation for workplace diseases (s. 90(1); the Workplace Health, Safety and Compensation Regulations, CNLR 1025/96 provides a list of what diseases are covered, and includes diseases caused by ionizing radiations realized through work involving exposure to the action of ionizing radiations (s. 25).

Nova Scotia

General duty clauses. The *Occupational Health and Safety Act*, SNS 1996, c 7 provides (at s. 13(1)) that Every employer shall take every precaution that is reasonable in the circumstances to (a) ensure the health and safety of persons at or near the workplace…(c) provide such information, instruction, training, supervision and facilities as are necessary to the health or safety of the employees; (d) ensure that the employees, and particularly the supervisors and foremen, are made familiar with any health or safety hazards that may be met by them at the workplace and… (f) conduct the employer's undertaking so that employees are not exposed to health or safety hazards as a result of the undertaking.

Explicit indoor air quality. The *Occupational Safety General Regulations*, NS Reg 44/99 have provisions for the supply of fresh air and removal of air from workplaces, and requirements to "keep the air resonably pure," at s.15(a) (ii), and "render harmless all gases, vapours, dust or other impurities that are likely to endanger the health or safety of any person therein," at s.15(a)(iii). Ventilation systems used

[1] Newfoundland's Workplace Health, Safety and Compensation Act, RSNL 1990, c W-11 s. 90 in conjunction with the Workplace Health, Safety and Compensation Regulations, CNLR 1025/96 at s. 25;

for controlling the dissemination of gases, vapours, dust or other impurities, are to be designed, installed, operated, maintained and repaired in an adequate manner by a competent person (15(c)).

Radon specific provisions. Nova Scotia incorporates by reference the ACGIH threshold limit values (TLVs) at Workplace Health and Safety Regulations, made under Section 82 of the *Occupational Health and Safety Act*, S.N.S. 1996, c. 7 O.I.C. 2013-65 (March 12, 2013, effective June 12, 2013), N.S. Reg. 52/2013. At section 2.3.

Compensation. The Workers' Compensation Act, SNS 1994-95, c 10 provides for compensation for exposure to radiation, at s. 15(1). Where the occupational disease from which the worker suffers was caused by exposure to radiation, the worker is eligible for compensation proportionate to the amount of the worker's total exposure to radiation that occurred within the Province.

Studies. In Nova Scotia, radon concentrations were collected over a three month period from 21 workplaces that had high potential for radon exposure, including water treatment facilities and coal power stations. The maximum concentration measured was 202 Bq/m^3.[2]

New Brunswick

Worksafe NB reports that the Province of New Brunswick does not regulate radon exposures in workplaces, except for underground mines. As with the practice at provincially operated workplaces (schools, health care facilities, etc.), WorkSafeNB recommends Health Canada's guidelines be followed in workplaces where non-radiation workers are located. [3]

General duty clause. The *Occupational Health and Safety Act*, SNB 1983, c O-0.2 provides that, at s. 9(1), every employer shall (a) take every reasonable precaution to ensure the health and safety of his employees. There are further requirements, at s. (2)(a.1), to ensure that the place of employment is inspected at least once a month to identify any risks to the health and safety of his employees… (c) provide the information that is necessary to ensure an employee's health and safety; (c.1) provide the instruction that is necessary to ensure an employee's health and safety; (c.2) provide the training that is necessary to ensure an employee's health and safety.

Compensation. The Workers' Compensation Act, RSNB 1973, c W-13 has a general compensation clause at s. 7(1).

Indoor air quality. *General Regulation*, NB Reg 91-191 (under the *Occupational Health and Safety Act*) defines "air contaminant" to include "any gas, fume, smoke, vapour, dust or other airborne concentration of a substance that may be hazardous to the health or safety of a person". (s. 2). Section 20 deals with ventilation, specifying that an employer shall ensure that a place of employment is adequately ventilated. Reference is made to the ASHRAE standard 62-1989, Ventilation for Acceptable Indoor Air Quality". Moreover, at s. 24 an employer shall ensure that an air contaminant is kept at a level of concentration that does not constitute a hazard to the health or safety of an employee exposed to it. The ACGIH threshold limit values are incorporated.

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[2] Mersereau HE, Scott A, Whelan K. "Workplace indoor radon survey in Nova Scotia, Canada." *Environmental Health Review* 2015;56(1):13-18.

[3] Worksafe NB 2018. Radon in the Workplace. available at http://www.worksafenb.ca/safety-topics/radon-in-the-workplace/ accessed May 7 2018.

Radon specific provisions. There are particular provisions for underground miners. The *Underground Mine Regulation*, NB Reg 96-105 provides that employers shall have air monitoring plans (s. 53(5)) and specific monitoring protocols (s. 62)—where concentrations are in the range of 0.04 WL to 0.20 WL, inclusive, monitoring must be at least quarterly, and where concentrations are over 0.20 WL, at least monthly. If radon or thoron daughter levels at any time exceed 0.30 WL, an employer shall take immediate steps to reduce levels and take precautions to protect employees (62(3)). Individual exposures cannot exceed 4.8 WLM per year and the time weighted average concentration does not exceed 0.40 WL (62(4)).

Prince Edward Island

General duty clauses. The *Occupational Health and Safety Act*, RSPEI 1988, c O-1.01 provides, at s. 12(1), that an employer shall ensure that every reasonable precaution is taken to protect the occupational health and safety of persons at or near the workplace. As well, workers should have such information, instruction, training, supervision and facilities that are necessary to ensure the occupational health and safety of the workers.

Compensation. The *Workers Compensation Act*, RSPEI 1988, c W-7.1 contains a general compensation clause, referencing "personal injury by accident arising out of and in the course of employment." Accident is defined at s. 1(a) as a chance event occasioned by a physical or natural cause, and includes ...any event arising out of, and in the course of, employment, or.. an occupational disease, and as a result of which a worker is injured.

Ventilation. The *Occupational Health and Safety Act, General Regulations,* PEI Reg EC180/87 states that an employer shall ensure that the workplace is adequately ventilated by either natural or mechanical means such that the atmosphere does not endanger the health and safety of employees under normal working conditions (s. 11.1). Where practical, contaminants shall be controlled at the source by means of hoods, ducts or such other means as may be necessary (11.2). The Threshold Limit values of the ACGIH are referenced (s. 11.3).

No other radon specific or applicable radiation regulation was found.

Quebec

General duty clause. One is found in the Act respecting the occupational health and safety, CQLR c S-2.1 at s. 51.

Compensation. *The Act respecting industrial accidents and occupational diseases*, CQLR c A-3.001, has the broad objective of providing compensation for employment injuries and the consequences they entail for beneficiaries (s. 1). This Act applies to every worker to whom an industrial accident happens in Québec or who contracts an occupational disease in Québec and whose employer, when the accident happens or the disease is contracted, has an establishment in Québec (s.7). There are broad provisions for radiation in Division IV, referring to disease caused by ionizing radiation and any work involving exposure to ionizing radiation (5). The *Workers' Compensation Act*, CQLR c A-3 provides at s. 111 (8) for presumptions of causation (in conjunction with Schedule D.) Schedule D at (8)

provides for diseases caused by exposure to X-rays, radium or other radio-active substances , but does not provide a description of process, suggesting there is no presumption.

Ventilation. The *Regulation respecting occupational health and safety*, CQLR c S-2.1, r 13 at s. 101 states that establishments shall be adequately ventilated either by natural or mechanical means, and excessive air draughts shall be avoided. Ventilation systems and devices in service shall be designed, manufactured and installed in compliance with state-of-the-art techniques current at the time of their installation.

Radiation. The *Regulation respecting occupational health and safety,* CQLR c S-2.1, r 13 has various clauses relating to radiation. However, the only general language, e.g. that might cover atmospheric radon, states that workers exposed to ionizing radiation shall be monitored by dosimetry (s. 144). In the event of an overdose, workers thus exposed shall undergo medical examinations at more or less regular intervals, depending on the duration of exposure.

No radon specific workplace regulation was found.

Ontario

General duty clause. The *Occupational Health and Safety Act,* RSO 1990, c O.1 provides, at s. 25 (2)a), that an employer shall ensure that, an employer shall, provide information, instruction and supervision to a worker to protect the health or safety of the worker, and, at s. 25 (2(h)(h), take every precaution reasonable in the circumstances for the protection of a worker.

In 2016 Ontario's Ministry of Labour updated its radon policies. It now states that the NORM Guidelines are "are considered the industry standard for NORM protection in workplaces." As such, the Ministry invokes the general duty clause of Ontario's *Occupational Health and Safety Act* (OHSA) (s.25(2)(h) and states that "this includes protecting workers from the hazards associated with radon exposure. When enforcing the general duty clause, the Ontario Ministry of Labour's Radiation Protection Service may take the NORM Guideline and its recommendations into consideration."[4]

Compensation. The *Workplace Safety and Insurance Act*, 1997, SO 1997, c 16, Sch A has a general clause (at s. 13) that a worker who sustains a personal injury by accident arising out of and in the course of his or her employment is entitled to benefits under the insurance plan. The worker is entitled to benefits under the insurance plan as if the disease were a personal injury by accident and as if the impairment were the happening of the accident (s. 15).

The Act provides for presumptions of causation at s.15(3) by reference to Schedule 3. Schedule 3 is provided at O. Reg. 175/98, General, which includes occupational diseases and includes "any disease due to exposure to x-rays, radium or other radioactive substances (s. 22). However, there is no accompanying process, suggestion a lack of presumption.

[4] Ontario Ministry of Labour, 2016. Radon in the workplace. Available at https://www.labour.gov.on.ca/english/hs/pubs/gl_radon.php accessed May 7, 2018.

I**ndoor air quality**. No general ventilation clause was found. Ventilation requirements occur in specific regulation and Building Codes but none were found with general language that might cover radon.

Radiation. Employers are required under section 4 of *Regulation 833, Control of Exposure to Biological or Chemical Agents*, to limit the exposure of workers to specified hazardous biological or chemical agents in accordance with the values set out in the "Ontario Table" (which is Table 1 in the Regulation) or, if the agent is not listed in the Ontario Table, the 2015 ACGIH Table that is incorporated by reference in the Regulation. No specifics are given for radon, so the ACGIH tables apply.

Radon specific provision. Apart from the recent policy changes noted above with respect to the NORM Guidelines, there are also specific mine regulations. The *Regulations for Mines and Mining Plants*, O. Reg. 583/91 provides for testing of air in underground mines (s. 298), quarterly testing if concentration is greater 0.06 WL up to 0.1 WL, with monthly testing if the concentration exceeds 0.1 WL Employers shall ensure radon is at the lowest practical level (s. 290 (1)). Occupational limits of 1 WLM per year are established (s. 290(2)). Mines should be cleared and mitigated at 0.33 WL (s. 291). An employer should develop and implement (in consultation with the joint health and safety committee or health and safety representative), descriptions of work practices for workplaces that exceed 0.1 WL (s. 292(1)) including procedures for investigating the cause of and reducing radon level concentrations to the lowest practical level. (s. 292(2)).

Manitoba

General Duty clauses. *Workplace Health and Safety Act*, CCSM c. W210 at s. 4(1) provides that every employer shall ensure, so far as is reasonably practicable, the safety, health and welfare at work of all his workers.

Compensation. There is a general compensation clause in *The Workers Compensation Act*, CCSM c W200 at s. 4(1) which provides for compensation for personal injury by accident. Accident is defined to include events, and occupational diseases that happen at work (s. 1(1)).

Indoor air quality. The *Workplace Health and Safety Regulation*, Part 4, General Workplace Requirements, provides for rules on air quality and ventilation. At s. 4.1 it states that an employer must, as much as is reasonably practicable, ensure that (a) a workplace has appropriate air quality and is adequately ventilated, and (b) contaminants and impurities are prevented from accumulating in the air at a workplace.

Radon specific provision. The *Workplace Health and Safety Regulation* requires employers to develop and implement safe work procedures respecting the use of radiation in the workplace and incorporates the ACGIH publication Threshold Limit Values for Chemical Substances and Physical Agents and Biological Indices (s. 18.2).When workers in a workplace are, or may be, exposed to levels of radiation in excess of the limits, an employer must implement procedures that control exposure to radiation in the workplace (18.3). There are also duties to inform workers of the potential hazards of radiation exposure (s. 18.4).

Saskatchewan

General duty clauses. The *Occupational Health and Safety Regulation* 1996 O-1.1 REG 1 provides for general duties at section 12. The duties of an employer at a place of employment include the provision and maintenance of plant, systems of work and working environments that ensure, as far as is reasonably practicable, the health, safety and welfare at work of the employer's workers. There are also duties to provide information.

Compensation. *The Workers' Compensation Act*, 2013, SS 2013, c W-17.11 defines "injury" (at s. 2(1)) to include the results of a chance event occasioned by a physical or natural cause or a disabling or potentially disabling condition caused by an occupational disease and "occupational disease" to mean a disease or disorder that arises out of and in the course of employment. Section 26(1) provides that if a worker suffers an injury, the worker is entitled to compensation.

Indoor air quality. The *Occupational Health and Safety Regulations*, 1996, RRS c O-1.1 Reg 1 at s. 65 provides that an employer, contractor or owner shall ensure the adequate ventilation of a place of employment; and to the extent that is reasonably practicable, render harmless and inoffensive, and prevent the accumulation of, any contaminants or impurities in the air by providing an adequate supply of clean and wholesome air and maintaining its circulation throughout the place of employment. As such, a mechanical ventilation should be used that is sufficient and suitable to protect the workers against inhalation of a contaminant and to prevent accumulation of the contaminant (s. 66(1)).

Radiation and radon specific provisions. The Saskatchewan Employment Act, SS 2013, c S-15.1 and the accompanying Radiation Health and Safety Regulations, RRS c R-1.1 detail allowable doses of ionizing radiation, including from radon, but these provisions appear to apply only to 'equipment', leaving no room for employer responsibility or naturally occuring radon or building design issues that exacerbate radon exposure. The Radiation Health and Safety Regulations, 2005 provides for fees for radon measurement—at s. 46. The fee payable to the department for carrying out a radon gas measurement on request is $35 for each measurement. However, this was not a regulated cost for radon testing, this was the fee that the Radiation Safety Unit would charge in order to provide a radon test to businesses or members of the public. However, this service is no longer provided by the Radiation Safety Unit.[5]

Alberta

Health Canada staff in Alberta report that Health and Safety Alberta does not prioritze radon.[6] This might be due to the traditional belief that "the concentration of NORM in most natural substances is so low that this risk is generally regarded as negligible".[7] That said, there is an Occupational Health Bulletin devoted to radon published in 2015, which cites the Health Canada Guidelines of 200 Bq/m^3 rather than the *Canada Labour Code* standards then prevalent: It does recommend that workers contact Worksafe Alberta and provides a phone number.[8]

[5] as related by Brent Preston, Manager, Health Standards, reporting to Sandy Hutchinson, Health Canada).
[6] Christina Fok, email to author, April 6, 2018
[7] Alberta Occupational Health and Safety, 2009. OHS Code Explanation Guide: Part 20 Radiation Exposure, Section 291 Prevention and protection. Available at http://work.alberta.ca/SearchAARC/671.html accessed May 14, 2018.
[8] Worsafe Alberta, 2015. Radon in the Workplace: Occupational Health and Safety Bulletin. Available at http://work.alberta.ca/documents/ohs-bulletin-rad007.pdf accessed May 14, 2018.

General duty clauses. The *Occupational Health and Safety Act*, RSA 2000, c O-2 states at section 2 that every employer shall ensure, as far as it is reasonably practicable for the employer to do so, the health and safety of workers engaged in the work of that employer, and those workers not engaged in the work of that employer but present at the work site at which that work is being carried out.

Compensation. Section 24 of the *Workers' Compensation Act,* RSA 2000, c W-15 provides for compensation generally to workers who suffers personal injury by an accident and to the dependants of a worker who dies as a result of an accident. At 24(6) there is a presumption of causation for occupational diseases caused that arise within 12 months of working. The *Workers' Compensation Regulation*, Alta Reg 325/2002 provides (at s. 20(1) for "occupational disease" through reference to a Schedule: it is a disease or condition listed in Column 1 of Schedule B that is caused by employment in the industry or process listed opposite it in Column 2 of Schedule B.

COLUMN 1: DESCRIPTION OF DISEASE	Column 2: Industry or Process or Condition
1. Posioning by (m) Other toxic substances.	(m) where there is significant occupational exposure to toxic gases, vapours, mists, fumes or dusts.
9 Radiation injury or disease	9 An industry or process (a) due to ionizing radiation; (a) where there is significant occupational exposure to ionizing radiation;

Indoor air quality. Alberta has an *Occupational Health and Safety Code* (2009), adopted under the *Occupational Health and Safety Act*, RSA 2000, C O-2 and the *Occupational Health and Safety Code 2009 Order*, Alta Reg 87/2009. The Code first defines "confined spaces" as meaning a restricted space which may become hazardous to a worker entering it because of (a) an atmosphere that is or may be injurious by reason of oxygen deficiency or enrichment, flammability, explosivity, or toxicity, (b) a condition or changing set of circumstances within the space that presents a potential for injury or illness, or (c) the potential or inherent characteristics of an activity which can produce adverse or harmful consequences within the space. This language appears to be general enough to potentially include an indoor space with a radon problem, although the Code clearly contemplates problematic and controlled environments. The Code then sets out requirements to test such spaces. They require a hazards assessment (s. 45) an entry permit system (s. 47(1), protections against release of hazardous substances or energy that could harm them (s. 49), testing of the atmosphere within (s. 52), and a ventilation system (s. 53).

Radon-specific provisions. No specific provisions were found that mention radon.

Radiation. The *Occupational Health and Safety Code, 2009*, has a specific part (Part 20) devoted to Radiation Exposure. Section 291 states that if workers may be exposed to ionizing radiation at a work site, an employer must (a) develop and implement safe work practices and procedures to be used when the workers deal with or approach the radiation source, (b) if practicable, involve the workers in the development and implementation of the safe work practices and procedures, and (c) inform the workers of the potential hazards of ionizing radiation and the radiation source.

As noted above, the *Radiation Protection Regulations Alberta Regulation* 182/2003 exclude natural background radiation.[9] Otherwise it matches federal standards for radiation workers, e.g. 50 mSV in one year, 100 mSv in 5 years, 4 mSv for a pregnancy, and for a person who is not a radiation worker, 1 mSv in a year.

British Columbia

A **General duty clause** is found in the *Occupational Health and Safety Regulation*, BC Reg 296/97, Part 4 - General Conditions - 296/97. At 4.1: A workplace must be planned, constructed, used and maintained to protect from danger any person working at the workplace.

Compensation. The Workers Compensation Act RSBC 1996, c 492 has a general provision on coverage: 5 (1)Where, in an industry within the scope of this Part, personal injury or death arising out of and in the course of the employment is caused to a worker, compensation as provided by this Part must be paid by the Board out of the accident fund. Where a worker suffers from an occupational disease and is thereby disabled from earning full wages at the work at which the worker was employed or the death of a worker is caused by an occupational disease; and the disease is due to the nature of any employment in which the worker was employed, whether under one or more employments, compensation is payable as if the disease were a personal injury arising out of and in the course of that employment (section 6). Subsection 6(11) has a particular provision for lung diseases: Where a deceased worker was, at the date of his or her death, under the age of 70 years and suffering from an occupational disease of a type that impairs the capacity of function of the lungs, and where the death was caused by some ailment or impairment of the lungs or heart of non-traumatic origin, it must be conclusively presumed that the death resulted from the occupational disease. Further Schedule B lists occupational diseases includes lung cancer "where there is prolonged exposure to the dust of uranium, or radon gas and its decay products."

Indoor air quality Sections 4.70 to 4.80 of the Occupational Health and Safety Regulation, BC Reg 296/97 apply to indoor or enclosed areas when occupied by workers. At 4.72 (1) it states that an employer must ensure that a ventilation system for the supply and distribution of air and removal of indoor air contaminants is designed, constructed and operated in accordance with (a) established engineering principles, and (b) ASHRAE Standard 62-1989,Ventilation for Acceptable Indoor Air Quality. As such, (at 4.72(2)) an adequate supply of outdoor air must be provided to the workplace in accordance with Table 2 of ASHRAE Standard 62-1989. For a building ventilation system installed prior to 1989, an adequate supply of outdoor air must be provided in accordance with the ASHRAE standard in place at the time the ventilation system was designed (4.72(3)).

Radon-specific provisions *Occupational Health and Safety Regulation*, BC Reg 296/97, Part 7 - Noise, Vibration, Radiation and Temperature provides provisions on radiation. However, at 7.18 (2) there is an explicit exclusion for natural background radiation, unless specified by the Workers Compensation Board. At 7.19: (1) a worker's exposure to ionizing radiation must not exceed any of the following: (a) an annual effective dose of 20 mSv… (2) If a worker declares her pregnancy to the employer, her effective dose of ionizing radiation, for the remainder of the pregnancy, from external and internal sources, must be limited by the employer to the lesser of (a) 4 mSv, or (b) the dose limit specified for pregnant

[9] *Radiation Protection Regulation*, Alta Reg 182/2003 s. 3(3)(b)

workers under the *Nuclear Safety and Control Act* (Canada). The employer must ensure that the exposure of workers to ionizing radiation is kept as low as reasonably achievable below the exposure limits. Section 7.20 provides that if a workers exceeds or may exceed an action level there needs to be a control plan developed and implemented, and workers need to be instructed on how it works. Workers must generally be informed of reproductive hazards linked to ionizing radiation (s. 7.21) and provide counselling to pregnant workers with respect to radiation concerns. If a worker exceeds or may exceed the action level for ionizing radiation, the employer must ensure that the worker is provided with and properly uses a personal dosimeter acceptable to the Board (s. 7.22).

Yukon

General duty clauses. Occupational Health and Safety Act, RSY 2002, c 159 provides, at s. 3(1), that every employer shall ensure, so far as is reasonably practicable, that

> (a) the workplace, machinery, equipment, and processes under the employer's control are safe and without risks to health;
> (b) work techniques and procedures are adopted and used that will prevent or reduce the risk of occupational injury; and
> (c) workers are given necessary instruction and training and are adequately supervised, taking into account the nature of the work and the abilities of the workers.

Compensation. The Workers' Compensation Act, SY 2008, c 12 provides for general rights of compensation (s. 4(1).

Indoor air quality. Occupational Health Regulations, YOIC 1986D/164 at s. 7(1) provide for ventilation systems for controlling health hazards. The ACGIH "Industrial Ventilation: A Manual of Recommended Practice" is referenced. S. 8 (1) states: airborne contaminants shall be controlled at their source by use of an effective local exhaust system; where this is not practical, general ventilation systems, or a combination of the two shall be used.

Radon specific provisions Occupational Health Regulations, YOIC 1986D/164 has particular provisions on radon, at ss. 43 to 46. Sec. 44 stipulates that the employer shall ensure that airborne concentrations of radon, where workers are exposed, are reduced to levels as low as reasonably practicable. Corrective action must be taken immediately at 1 WLM radon concentrations (s. 45). There are requirements to submit radiation plans to the Chief Mines Safety Officer (s. 46(1), and prescribed methods of measurement (s. 46(2). Records of measurements are to be submitted (s.46(3) and a copy posted at the workplace at a location convenient to all workers (s. 46(4)).

Northwest Territories

General duty clauses. *The Safety Act*, RSNWT 1988, c S-1 states (at s. 4(1)) that every employer shall maintain his or her establishment in such a manner that the health and safety of persons in the establishment are not likely to be endangered; take all reasonable precautions and adopt and carry out all reasonable techniques and procedures to ensure the health and safety of every person in his or her establishment.

Compensation. The *Workers' Compensation Act*, SNWT 2007, c 21 at s. 10 has a general clause on compensation.

Indoor air quality. The *Occupational Health and Safety Regulations*, NWT Reg 039-2015 at section 69 provide that employers shall ensure adequate ventilation at work to the extent that is reasonably possible, render harmless, and prevent the accumulation of, any contaminants or impurities in the air by providing an adequate supply of clean and wholesome air and maintaining its circulation throughout the work site. Employers should provide a mechanical ventilation system that is sufficient and suitable to protect workers against inhalation of contaminants (s. 70).

Radiation and radon-specific provisions. The *Mine Health and Safety Regulations*, NWT Reg (Nu) 125-95 has specific requirements for radon. S. 9.80 provides for radon emitting devices— the mine manager shall ensure workers are protected when radiation-emitting equipment is used. Reference is made to the Threshold Limit Values of the ACGIH. As well it incorporates the federal *Atomic Energy Control Regulations* (Canada) radiation exposure guidelines. Schedule 7 of the Regulations in particular speaks to radon, and also incorporates the *Atomic Energy Control Regulations* specific to radon. These provide for limits of 4 WLM per year for radiation workers, and 0.4 for anyone else. There are further provisions allowing the chief inspector to order the manager to perform hazards analysis to determine if a radon hazard exists (9.83 (1)), and for mine monitoring (9.83)

More broadly, the *Occupational Health and Safety Regulations*, NWT Reg 039-2015 have specific provisions for workers who use radiation emitting equipment. Effective doses are to be as low as is reasonably achievable with economic and social factors taken into consideration and with limits of 50 mSv in a year, 100 mSv in a 5 year period, 4 mSv for the balance of a pregnancy and 1 mSv for non-occupational workers (by operation of s. 340 (2), and Schedule U, which states limits). There are provisions for monitoring (s. 342), and dosimetry if the effective dose levels are over 1 mSv per year (s. 343). While most of the provisions are worded to consider radiation-emitting equipment one clause, s. 344 is written in a way that appears to extend to all workers. S. 344 (1) states that an employer for whom an occupational worker works or trains shall maintain a separate, cumulative record on a continuous and permanent basis (a) measurements of actual doses of ionizing radiation received, both externally and internally, by the worker for the current one-year and five-year dosimetry periods; and (b) the committed doses of ionizing radiation received from radioactive substances deposited within the body of the worker as determined by monitoring or sampling procedures conducted at the work site or from bio-assay procedures. S. 344 provides for employers to inform workers of this information, at at least 3 month intervals.

Nunavut

Nunavut appears to have incorporated the same statutes as the Northwest Territories concerning Occupational Health and Safety, Workers Compensation and Mine Health and Safety and as such a separate analysis was not performed.

Appendix 3: Occupier's Liability Law - by Province and Territory

The following table canvasses occupier's liability law by province/territory noting legal obligations and any relevant case law.

Newfoundland	Continues to rely on common law of occupier's liability, which "is a mess" : *Stacey v. Anglican Churches of Canada*, 1999 CanLII 18933 (NL CA) at para. 13)1. There is a positive obligation upon occupiers to ensure that those who come onto their properties are reasonably safe. The onus is upon the plaintiff to prove on a balance of probabilities that the defendant failed to meet the standard of reasonable care - the fact of the injury in and of itself does not create a presumption of negligence - the plaintiff must point to some act or failure to act on the part of the defendant which resulted in her injury. When faced with a *prima facie* case of negligence, the occupier can generally discharge the evidential burden by establishing he has a regular regime of inspection, maintenance, and monitoring sufficient to achieve a reasonable balance between what is practical in the circumstances and what is commensurate with reasonably perceived potential risk to those lawfully on the property. The occupier is not a guarantor or insurer of the safety of the persons coming on his premises (*Smith v. 60144 Newfoundland and Labrador Inc.*, 2017 CanLII 58724 (NL SC)
Nova Scotia	*Occupiers' Liability Act*. 1996, SNS c. 27, s. 1. replaces common law rules (s. 3), applies to landlords (s. 9) and Crown (s. 11, with some exceptions). But see *MacIntyre v. Cape Breton District Health Authority*, 2009 NSSC 202 (court finding breach of duty of care but not causation); affirmed *MacIntyre v. Cape Breton District Health Authority*, 2011 NSCA 3 (CanLII)— faulty renovation procedures leading to release of heavy metals.
New Brunswick	Common law of occupier's liability abolished (Law reform act, C. l-1.2, 1993, sec. 32; *Baldwin v. Canadian Tire* 2017 NBQB 03), but cases now decided under general rules of negligence (*McAllister et al v. Wal-Mart Canada Inc.*, 1999 CanLII 9427 (NB QB), 1999 Carswell NB 89, upheld in the New Brunswick Court of Appeal, 2000 CanLII 12588 (NB CA), *Hickey v. New Brunswick Housing Corporation*, 2014 NBCA 36 (CanLII) interpreted in light of other provinces occupier's liability legislation (*Baldwin v. Canadian Tire*, 2017 NBQB 3).
PEI	*Occupier's Liability Act* R.S.P.E.I. 1988, Cap. 0-2 Common law superseded (s. 2); landlord's duties (s. 7); binds Crown (s. 9)
Quebec	Quebec Civil Code 1467. The owner of an immovable, without prejudice to his liability as custodian, is bound to make reparation for injury caused by its ruin, even partial, whether the ruin has resulted from lack of repair or from a defect in construction.

Ontario	*Occupiers' Liability Act*, R.S.O. 1990, c. O.2 The Act provides that the Act supersedes common law actions that may fall under the same umbrella (s. 2). There are specific provisions giving landlords a duty of care towards tenants, as well as any visitors (s. 8(1)). The Crown is bound by the Act, e.g. one can sue government (s. 10 (1)), with an exception for public highways or roads (s. 10(2)). There may be overlapping claims with residential tenancies, in which case the Landlord and Tenant Board has exclusive jurisdiction in matters under $25,000 (*Letestu v Ritlyn Investments*, 2016 ONSC 6540) ((no cases on radon, lead paint, asbestos, formaldehyde, radiation, pollutant, pollution; one case certifying a class action in relation to toxic mold on Indian reserves—*Grant v. Canada* (Attorney General), 2009 CanLII 68179 (ON SC)
Manitoba	*Occupier's Liability Act*, C. C. S. M. c. 08. Common law rules abolished (s. 2); landlords duties (s. 6) ; applies to Crown, with some exceptions (s. 8)
Saskatchewan	Relies on common law (e.g. *Fehr v. Karz (O.T.) Kafe Ltd*., 1993 CanLII 8960 (SK QB); *Kosteroski v. Westfair Properties Ltd. et al.,* 1997 CanLII 17181 (SK QB). There are surprisingly few cases. In *R. v. Brooks*, 2009 SKQB 509 duty of care found (at para 102) but certification falters on basis of lack of common class, affirmed *R. v. Brooks*, 2010 SKCA 55 — the case appears to support a cause of action for chemical defoliants creating toxic areas of a military base.
Alberta	*Occupiers ' Liability Act*, RSA 2000, c.0-4 there seem to be no provisions for landlords to be liable nor cases in which they are found liable.
BC	*Occupiers Liability Act* R.C.B.C 1996, c. 337.This sets up a statutory duty of care which the courts have ruled is a distinct duty from that of negligence at common law. *Rendall v. Ewart* (1989), 1989 CanLII 232 (BC CA), 38 B.C.L.R. (2d) 1 (C.A.)
Yukon	No legislation, but courts draw on occupier's liability legislation and judicial interpretation elsewhere in Canada— Ontario and BC— as codification of common law (*Mineault v. Takhini Hot Springs Ltd.,* 2002 YKSC 48).
NWT	No legislation no case law; presumably same as Yukon.
Nunavut	No legislation no case law; presumably same as Yukon.

Appendix 4: Radon and Residential Tenancies Law - by Province and Territory

CONTENTS

The following canvases Provincial and Territorial residential tenancies legislation noting areas that are relevant, or make specific reference, to radon. Sub-headings in each Province or Territory address legislative or associated regulatory provisions in most or all of the following areas:

- **Application and exclusion**
- **Remedies**
- **Investigation/inspection powers**
- **Radon-relevant provisions**
- **Associated regulations**
- **Precedent, appeal, and judicial review**
- **Associated regulation/associated public health regulation**
- **Associated maintenance standards**
- **Radon advocacy**

Newfoundland

Application and Exclusion: Section 3 (1) of the *Residential Tenancies Act* SNL 2000 c. R-14.1 provides a broad coverage to situations where a landlord tenant relationship exists. Section 3(4) provides exclusions— for transient accommodations such as hotels, motels, and hostels, vacation homes, prisons or rehabilitation centres; temporary shelters, hospitals, nursing homes, student dorms or units rented to students by Memorial University, co-op housing roommates, and (unlike other jurisdictions, at 4(g) living accommodation provided by a religious, charitable or non-profit organization for the purpose for which it is established. Other exclusions are allowed by regulation but there are none. The Crown is bound by the Act (s 4(1) but with exclusions for the setting of rent and other issues particular to social housing (s. 4(2).

Remedies. If a landlord commits a material breach of the rental agreement, the tenant can give wrltten notice of breach; and if the landlords does not remedy the situation, the tenant can leave (s. 19. (1)) Similar remedies can occur if the premises are not fit for habitation (s. 20(1) if the premises are not in in a fit state of repair, or the tenant is denied peaceful enjoyment (s. 22(1). The Act sets out a dispute resolution system— a landlord or tenant can apply to the director to resolve legal questions, concerning breaches of the rental agreement or contraventions of the Act. (s. 35) .Section 41, sets out a long list of powers of a director upon hearing an application, including directly a landlord to pay a tenant compensation or perform an obligation. Enforcement can occur through the courts. There are separate provisions for fines, up to $400 a day (45) and imprisonment up to four months (s. 45).

Investigation Powers. The RTA provides for the Director (and staff) to have a range of investigative powers, including to obtain warrants to enter residential premises where there are issues with compliance with the Act (s. 34). However, we were told that any health concerns related to rented or non-rented properties would be investigated by municipal building inspectors or a provincial health inspector rather than Service Newfoundland. Such concerns would only come to the attention of the Residential Tenancies Section if there was an application by a tenant for an order of repairs, or to terminate a tenancy.[1]

Relevant provisions re radon: S. 8 provides statutory conditions— e.g. they are binding on the parties regardless of other terms in the landlord-tenant contract. The landlord shall maintain the premises in a good state of repair and fit for habitation during the tenancy and shall comply with a law respecting health, safety or housing (s 8(1)(a)). S. 8(7) covers peaceful enjoyment— The landlord shall not unreasonably interfere with the tenants peaceful enjoyment of the premises, a common area or the property of which they form a part. We did not find significant or relevant cases.

Associated Regulations. The *Occupancy and Maintenance Regulations, CNLR 1021/96*, under the *Urban and Rural Planning Act* (O.C. 96-201) provide regulations that apply to a list of municipalities, spelling out conditions for human habitation. (This project has not included a full accounting of municipal habitability laws in Newfoundland). The provisions are tightly worded, specifying e.g. requirements for insulation and no provisions appears to touch on radon explicitly or incidentally.

Precedent, Appeal and Judicial Review. Decisions of Residential Tenancies at Service Newfoundland are not published.[2] Appeals can be made from orders of the Director on questions of jurisdiction or law (s. 44(1).

Nova Scotia

Application and Exclusion: While meant to cover landlord tenant relations, Not all rental housing is included in the *Residential Tenancies Act*, RSNS 1989, c. 401.The definition of 'residential premises' at s. 2 (h) excludes University and college residences, hospitals, municipal homes, prisons, reformatories, some nursing homes, and hotels are not governed by the RTA.

Remedies: Tenants and landlords can apply to the Residential Tenancies Board to determine a question arising under the Act, to allege a breach of a lease or a contravention of the Act. The Director

[1] Correspondence of Jean Bishop, Director, Director of Residential Tenancies. Department of ServiceNL April 18, 2018.
[2] Correspondence of Jean Bishop, Director, Director of Residential Tenancies. Department of ServiceNL April 18, 2018.

can investigate, mediate (s. 16) make an order for a landlord or tenant to comply, make repairs, pay compensation, end the tenancy or order compliance with a mediated settlement (s. 17A). While decisions of the Board are not published appeals of orders can be made to Small Claims Court.

Investigations: No independent powers but can be triggered by a complaint concerning landlord tenant conflicts and as part of a settlement (s. 16)

Relevant provisions re radon: s. 9 provides statutory conditions, including that the landlord shall keep the premises in a good state of repair and fit for habitation during the tenancy and shall comply with any statutory enactment or law respecting standards of health, safety or housing. We found some decisions of the Small Claims Court that applied these statutory conditions, ruling they were violated by the presence of bedbugs,[3] mold,[4] mice infestations[5] but no cases were found that dealt with radon, lead paint, asbestos, formaldehyde, radiation, pollutant or pollution.

Precedent, Appeal and Judicial Review We were informed by an anonymous civil servant that Residential Tenancies hearings are not intended to be matters of public record in Nova Scotia and "outcomes of these meetings are not available for research or reference". However, there is a right of appeal to Small Claims Court (at s. 17C) allowing for judicial interpretation and stare decisis. Courts have ruled that decision of a Residential Tenancy Officer is not entitled to any deference on an appeal. In fact, an appeal to the Small Claims Court from an Order of the Director of Residential Tenancies requires a hearing *de novo.*[6]

Prince Edward Island

Application and Exclusion: The *Rental of Residential Property Act*, c. R-13.1 applies to rental agreements (s. 1), although certain provisions relating to subletting and rent increases do not apply to residential premises developed and financed by the state, non-profit housing or cooperative housing (s. 5(2); s. 20)

Investigation and Remedies: If a Landlord (lessors) and tenants (lessees) does not comply with a statutory condition or a term of the rental agreement, a person can apply to the Director to seek a remedy. The Director shall investigate and has a range of powers, including ordering amounts to be paid, adjusting rent, or ordering compliance with the Act (s.8). Orders can be contested and then go to a hearing de novo at the Island Regulatory & Appeals Commission. (s. 25, 26).

Relevant provisions re radon: Section 6 sets out statutory conditions, which include keeping the premises in a good state of repair and fit for habitation, complying with health, safety or housing standards (s. 6(1)), and quiet enjoyment (s. 6(9)). Tenants were successful in rent reductions for mice infestations[7] for a moisture problem[8] and water problems and mold [9] but no actions were found for

[3] *Opus 3 Investments Ltd. v. Schnare*, 2009 NSSM 12
[4] *Buteau v. Summa Holdings Inc.*, 2011 NSSM 27
[5] *Cap Reit LLP*, 2013 NSSM 30
[6] *Opus 3 Investments Ltd. v. Schnare, 2009* NSSM 12 at para. 33
[7] Order LD02-205 - v. Cindy & Gail DesRoches
[8] A-004-04 Re: Shady Acres Cottages v. Director of Residential Rental Property)
[9] Order LR02-03 - Rental Appeal -A-005-02 Leo Gallant (Pat Boates-Jones)

radon, bedbugs, lead paint, asbestos, formaldehyde, radiation, pollutant or pollution. No higher court decisions were found on these topics.

Precedent, Appeal and Judicial Review. Decisions of the Island Regulatory & Appeals Commission are available online and can be searched,[10] and can be appealed to the Supreme Court on questions of law. The level of deference owed to the Commission by higher courts is one of reasonableness.[11]

Associated Public Health regulation The *Rental Accommodation Regulations*, PEI Reg EC142/70 enacted under the province's *Public Health Act*, RSPEI 1988, c P-30.1. It contains detailed provisions concerning issues such as drinking water, room temperature and weatherproofing, but nothing specifically applicable to radon. Very general language requires that property owners carry out repairs necessary to make rental units sound and safe. Sec. 15 provides that a contravention or failure to meet the requirements of these regulations may constitute a health hazard. This then sets in motion a series of powers of inspectors to investigate and make orders as provided for in the *Public Health Act*.

New Brunswick

The *Residential Tenancies Act,* SNB 1975, c R-10.2 is far less complex a statute than the comparable ones in Ontario, British Columbia or elsewhere and there is very little precedent or case law to analyze.

Application and Exclusion. The Act applies to all tenancies of residential premises and tenancy agreements respecting such premises, unless otherwise stated in the Act (s. 2) Section 29.1(1) extends this to the Crown in right of the Province, but excludes premised developed and finances under the *National Housing Act*, R.S.C. 1970, c. N-10 and administered by or for the Government of Canada, the Province of New Brunswick or a local government, or any agency thereof (e.g. most social housing). There is also a carve out for cooperatives where the tenant is a member (s. 29.1(3)). The definition of 'premises' in the Interpretation section (s.1 (1)) also operates to exclude a range of living types, such as vacation homes, roomate situations, hotels, nursing homes, hospital, prisons etc.

Investigations and Remedies: Where a landlord fails to comply with his obligations under this Act or the terms of the tenancy agreement, a tenant may serve on the landlord a notice stating the complaint (6(1)). The landlord has time to comply and if it lapses the tenant may inform a residential tenancies officer (6(2.1)). The officer can then investigate (s. 6(3)) including inspecting and issue compliance orders. If the landlord refuses, the officers can perform the obligations (6 (4)) or in some cases order an end to the tenancy (s. 6(6.4)) compensation (s. 6(6.7)). There are guidelines for landlords and tenants laid out at the New Brunswick Residential Tenancies Tribunal, which state officers aim to mediate disputes.[12]

Relevant provisions re radon: There are provisions concerning the premises being of good state of cleanliness, repair and fir for habitation (s. 3 (1) a, b), compliance with all health, safety, housing and building standards (s. 3 1(c)). No relevant case law was found.

[10] Island Regulatory & Appeals Commission, Rental Appeals. http://www.irac.pe.ca/appeals/rental/
[11] Charlottetown (City) v. Island Reg. & Appeals Com., 2013 PECA 10
[12] http://www.snb.ca/RTT-TLL/E/ten-loc/tl_problem_E.asp

Precedent, Appeal and Judicial Review. Landlords or tenants unhappy with officers decisions can appeal to the Court of Queen's Bench, the ground that it was made without jurisdiction, or on the basis of an error of law (s. 27(4)). The judge can hear new evidence, e.g. hold a new hearing (s. 27(5)) but can only affirm or reject the underlying decision, sending it back to officers to re-determine with directions (27(9)). Decisions of officers at the tribunal are reviewed by higher courts on a reasonableness standard.[13]

Associated Regulation. None were found. However, the *Public Health Act,* RSPEI 1988, c P-30.1enables regulation respecting rental accommodations, including "minimum space per occupant and the minimum dimensions of rooms, rental accommodations located in basements or cellars, ventilation, light, heat, electricity and potable water, equipment and maintenance, and responsibilities of tenants (s. 72 (tt.1)).

Quebec

Quebec's rules on residential leases are found in the *Quebec Civil Code* (CcQ), Book Five, Title Two, Chapter 3, "Leasing" ss. 1851-1999. Provisions are not unlike common law jurisdictions: The landlord tenant (or 'lessor'-'lessee') relationship is contractual, but the Code provides for necessary terms (s. 1893). There are rules on the landlord (or "lessor") ensuring a good state of repair, 'peaceable enjoyment" (s. 1854) and a "good habitable condition" (s. 1910). The lessor may not offer for rent or deliver a dwelling that is unfit for habitation. A dwelling is unfit for habitation if it is in such a condition as to be a serious danger to the health or safety of its occupants or the public, or if it has been declared so by the court or by a competent authority (s. 1913).Landlords must remedy defects and lack of knowledge is not an excuse.[14]

Application and Exclusion: The Code provisions cover leases of rooms and mobile homes. There are exceptions for dwellings leased as a vacation resort, dwelling in which over one-third of the total floor area is used for purposes other than residential purposes, rooms situated in a hotel establishment, single rooms in the lessors principle residence (e.g. roommates), health or social services institution (1892)

Remedies: There are provisions whereby a lessee can apply to the court to for permission make repairs and then subtract amounts paid from rent (s. 1867). For emergency repairs, the lessee need not go to court first (s. 1868).There are requirements for lessees to report serious defects to the lessor (s. 1866).A lessee can refuse to take possession of a dwelling that is unfit for habitation (1914). They can abandon a dwelling unfit for habitation but must give notice (s. 1915), allowing for rent to be waived (1916). The lessee may apply to the court for an order requiring the lessor to perform obligations (1918). The lessee may carry out a repair or incur an expense that is urgent and necessary if the lessor neglects to do so. Nonperformance also entitles the lessee to apply for a reduction of rent; where the court grants it, the lessor, upon remedying his default, is nonetheless entitled to the re-establishment of the rent for the future. Failure to perform an obligation by one of the two parties allows the other party to apply for, in addition to damages, specific performance of the obligation in cases that permit it. The party can apply for the termination of the lease where non-compliance results in serious injury to the

[13] **Nethervue Park v. MacKinnon et al., 2013 NBQB 15**
[14] *CGU Insurance Company of Canada c. Guindon, 2006 QCCS 279* Barak c. Osterrath, 2012 CanLII 150609

tenant or, in the case of the lease of an immovable property, to other tenants (1863).When the Régie du logement issues an order to carry out work, a defendant who refuses to comply can be found in contempt of the tribunal. The proceeding for contempt of court is filed with the Superior Court by the beneficiary of the decision who must institute the proceeding. Note that if the offender is found guilty of contempt of court, the minimum fine is $5000.[15]

There are a number of cases in Quebec before the Régie du logement that deal with radon.[16]. These are documented in this report at 4.6.2. While none is a decisive "win," they do point to significant judicial recognition of radon as a problem, but also for the need for tenants to do adequate testing to prove their claims.

Precedent, Appeal and Judicial Review. Decisions of the Régie du logement may be appealed on the leave of a judge of the Court of Québec, (section 91 of the Act respecting the Régie du logement).

Associated Regulations. Municipalities can lodge a complaint in Municipal court to impose fines on offenders and refer the matter to the Superior Court to obtain an order. The Superior Court may compel the lessor to resolve the problem, enable the municipality to do so at the lessor's expense, order the evacuation and even the demolition of the building. Certain cities of Québec have regulations on the sanitary condition of dwellings, in particular Montréal, Québec and Gatineau.[17]

Ontario

Application and Exclusion: Ontario's *Residential Tenancies Act, 2006*, SO 2006, c 1 applies to residential tenancies generally, but there is a broad class of accommodation excluded from the RTA, including housing cooperatives, vacation accommodation, on-farm worker's housing, corrections, various hospitals, long-term care facilities, and group homes, emergency shelters, student and staff housing at educational institutions, accommodations without separate bathrooms and kitchens (unless intended for students), therapeutic services and some others.[18] When the Crown is the direct owner, such as for leased land in a park, the RTA does not apply due to a lack of explicit provision in the statute to the effect that the Crown is bound [19] However, Government owned residences appear well contemplated in the Act, and agencies such as the Toronto Community Housing Corporation appear before the Landlord and Tenant Board.[20] There is a complicated set of exemptions for diverse types of social housing, but these do not normally apply to provisions around habitability that may cover radon. What can be called the "social housing exemptions" apply to most social housing. Habitability concerns still apply, however, exemptions are created for various issues around rent increases, rent control, termination of leases and other matters. [21]

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[15] Régie de logement, Quebec, 2018. Unsanitary Conditions. at https://www.rdl.gouv.qc.ca/en/the-dwelling/unsanitary-conditions
[16] *Duff Conacher* c. *National Capital Commission* , file 22-051117-006G; 22-060118-001T-060227 decision of 28 September 2006,*Barak c. Osterrath*, 2012 CanLII 150609 *Bonin c. National Capital Commission*, 2013 CanLII 122747 (QC RDL); *Pickard c. Arnold*, 2015 CanLII 129833; *Bramley c. Vanwynsberghe*, 2017 QCRDL 11313
[17] Régie de logement, Quebec, 2018. Unsanitary Conditions. at https://www.rdl.gouv.qc.ca/en/the-dwelling/unsanitary-conditions
[18] RTA, s. 5
[19] *Copeland & Soucie v. H.M.Q.*, 2014 ONSC 620
[20] TST-75267-16 (Re), 2017 CanLII 28560 (ON LTB), <http://canlii.ca/t/h3r1g>, retrieved on 2018-03-16
[21] RTA at s. 7(1) provides a long list of exceptions that apply to most social housing, including provisions related to a landlord charging a new tenant amounts greater than a previous tenant or giving a notice of rent increase without having completed orders (s. 30 , (1) (6, 7,8); Compensation to tenants of one month after a notice of termination (48.1); protections from conversion to

Remedies: A tenant or former tenant of a rental unit may apply to the Landlord and Tenant Board for an order determining that the landlord has breached obligations. (s. 29 (1)). The Board can order an abatement of rent, order repairs, and allow a tenant to recoup costs of repairs the tenant has already or will pay for(s. 30(1).

Investigations. The Act provides for prescribed maintenance standards and a complaints process where there are no municipal property standards by-laws at play (because the residence is in unorganized territory, if there are no relevant bylaws or if they are excluded from applying to the resident (s. 224). If so, there is a process of written complaints, and investigations. Inspectors have the power to issue work orders (s. 225(1) to which landlords have a right of review (s. 226)

Relevant provisions re radon: Ontario's Residential Tenancies Act provides that a landlord is responsible for providing and maintaining a residential complex, including the rental units in it, in a good state of repair and fit for habitation and for complying with health, safety, housing and maintenance standards.[22] These provisions cannot be contracted out of.[23] In Ontario, there are many cases on mould,[24] cockroach infestations, [25] bedbugs,[26] vermin,[27] and asbestos,[28] and as documented above, one on radon.[29] There might be a worry that in Ontario a specific principle around latent defects could pose an obstacle. Ontario decisions (at the Board and in Superior Courts) hold that landlord will not be held financially liable in connection with a "latent defect" i.e. a defect that cannot be reasonably be ascertained before the problem occurs.[30] For instance, a Landlord might not be held responsible for problems in a roof [31] or a toilet flush lever[32] or drains[33] until notified by the tenant. However, radon is easily detected and a tenant should be able to argue that it is reasonable to ask landlords to test.

Precedent, Appeal and Judicial Review. The Landlord and Tenant Board hears all question of fact and law under the RTA. (s.174). The Board has exclusive jurisdiction to hear disputes that fall under

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condominums (s. 51); compensation for termination for purposes of demolition or conversion to non residential use (s. 52) or repairs and renovations (s. 54) for serverance of units in a complex (s. 55, s. 56); Various provisions allow tenants to assign a unit to another person (s. 95),to sublet (s. 97) and if the landlord does not reasonable consent there is recourse to the LandLord tenant baord (s. 98);Orders to evict tenants that overstay (101), powers for tenants to get orders from overstaying subtennants (102); Powers of a landlord to negotiation a new tenancy agreement with assignees of the tenancy (s. 104);Rent control and notice provisions (s. 111 to 115, 117, 120, 121, 122, 126 to 133, 167); certain provisions concerning notice of rent increase (117);specific notice provisions for beginning tenancy in care homes (s. 140); Assignment, subletting in care homes (s. 143); structure o rental agreements for care homes (s. 149); notice of, and charges for, meals in care homes (s. 150, s. 151), and rules for assignments of tenancy and rent for in mobile homes (s. 159, s. 165)

[22] *Residential Tenancies Act*, 2006, SO 2006, c 17 section 20

[23] *The Taylor v. Allen*, 2010 ONCA 596

[24] *CET-53938-15 (Re)*, 2016 CanLII 88442 (ON LTB); *TET-79491-17 (Re)*, 2017 CanLII 94119 (ON LTB)

[25] *TET-64092-15 (Re)*, 2016 CanLII 88461 (ON LTB); *CET-59089-16 (Re)*, 2016 CanLII 88093 (ON LTB)

[26] *TET-73149-16 (Re)*, 2017 CanLII 48926 (ON LTB) *TST-02331 (Re)*, 2010 CanLII 12124 (ON LTB) *ST-56660-14 (Re)*, 2014 CanLII 71672 (ON LTB)

[27] *ST-56660-14 (Re)*, 2014 CanLII 71672 (ON LTB)

[28] *EAL-57406-16 (Re)*, 2016 CanLII 72097 (ON LTB)

[29] *CET-67599-17 (Re)*, 2017 CanLII 60362 (ON LTB)

[30] *McQuestion v. Schneider* (1975), 1975 CanLII 764 (ON CA), 8 O.R. (2d) 249 (C.A.).TSL-60859-15 (Re), 2015 CanLII 36941 (ON LTB)

[31] *TST-34965-12 (Re)*, 2013 CanLII 52167 (ON LTB)

[32] *TST-75642-16 (Re)*, 2016 CanLII 71189 (ON LTB)

[33] *TNT-46952-13 (Re)*, 2013 CanLII 52075 (ON LTB)

the RTA so long as they are within the monetary limit (now set at 25,000).[34] There is, however, a time limit—applications must be made within a year after the day the alleged conduct occurred (s. 29(2)). Appeals can proceed to the Board, but it can also handle appeals on errors (s. 209 (2)). Interpretation Guidelines state that the LTB will only exercise its discretion to grant a review when it is satisfied the order contains a serious error, a serious error occurred in the proceeding or the requestor was not reasonably able to participate in the proceeding. A review is not an appeal or an opportunity to change the way a case was presented.[35] There is also a right of appeal, on questions of law, to the Divisional Court (s. 210 (1)) which can affirm, rescind, amend or replace the decision or order; or remit the matter back to the the Board (s. 210 (4).) One can find hundreds of cases reviewing decisions of the Landlord-Tenant Board. As discussed at section 4.6.4 above, the standard of review is one of reasonableness.

Associated Maintenance Standards. Ontario Regulation 517/06 Maintenance Standards only appeal where other relevant municipal bylaws are not in effect. Moreover, the provisions are quite specific, relating to need for hot and cold water, the state of repair of floors, stairs and decks. We did not find clauses which might support radon action. As will be discussed elsewhere in this report, some cities such as Guelph and Thunder Bay have adopted radon regulations.

Radon advocacy. There has been extensive advocacy aimed at changing the situation concerning radon in Ontario. A private members bill in 2014, the Radon Awareness and Prevention Act, would have required the Minister of Municipal Affairs and Housing to test for radon in the "normal occupancy area" of "provincially owned dwellings" (by Dec 31 2021), and to require reasonable action be taken to reduce the radon level if found to be above 200 Bq/m.[3] [36] In 2016 there were consultations concerning changes to the Residential Tenancies Act. Various organizations pushed for provisions relating to radon, including the Canadian Association of Radon Scientists and Technologists (CARST) , the Ontario Lung Association, and the Canadian Environmental Law Association, buttressed by publicity from Mike Holmes, a television home renovation celebrity.[37] The campaign focused on having radon testing be mandatory in all residential tenancies; for mitigation to be mandatory where radon levels are above 200 Bq/m3; test results to be made available to all tenants upon request; and, property disclosure statements disclose whether there is a known presence of radon in homes at the time of sale or transfer of real property. The changes were not implemented, although this period did see policy level change in occupational health and safety and public health (as discussed elsewhere in this report).[38]

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[34] RTA, s. 168 (2); s. 207(2); *Mackie v. Toronto (City)*, 2010 ONSC 3801; *Letestu v Ritlyn Investments*, 2016 ONSC 6540 (at para 65)

[35] Review of an Order, Interpretation Guideline 8, available at http://www.sjto.gov.on.ca/documents/ltb/Interpretation%20Guidelines/08%20-%20Review%20of%20an%20Order.html accessed March 2 2018.

[36] Ontario Legislature, Bill 11, An Act to reduce radon levels in dwellings and workplaces, raise awareness about radon, provide for the Ontario Radon Registry and Session 1, Parliament 41 (First Reading Carried July 10, 2014) . Further discussed in Dunn and Cooper (2014), ibid, at p. 38

[37] (Canadian News Wire, 2016. Mike Holmes Asks Ontario Residents to Push for Mandatory Radon Testing. June 29, 2016 available at https://www.newswire.ca/news-releases/mike-holmes-asks-ontario-residents-to-push-for-mandatory-radon-testing-584890761.html accessed April 15, 2018

[38] Testimony of Bob Wood,: Standing Committee on General Government - 2017-May-09; http://www.ontla.on.ca/web/committee-proceedings/committee_transcripts_details.do?locale=en&Date=2017-05-09&ParlCommID=8998&DocumentID=32241; Warkentin, P. 2017. CARST/ACSTR & Lung Association-Ontario Urges Wynne Government To Protect Residential Tenants/Homeowners Lungs. available at http://www.carst.ca/carstblog/4766058 accessed April 15, 2018.

Manitoba

Application and Exclusion: The Residential Tenancies Ac, CCSM, C. 11 t applies to rental units and residential complexes and to tenancy agreements (s. 2), with a range of exclusions for hotels, vacation homes, Cooperatives, prisons and therapeutic centres, temporary shelters, hospitals, student dorms etc. (at s. 3) The RTA binds the Crown (s. 5)

Remedies: The Residential Tenancies Branch (RTB) can make orders to fix units or otherwise comply with health, building and maintenance standards **(s.** 59(3)) or to compensate tenants (s. 59.2), for landlord to pay tenants reasonable moving expenses and some rent (s. 62(3). In some circumstances tenants can give notice and leave (s. 89(1). A person who wishes to have a question or matter determined can make an application to the director (e.g. the RTB). (s. 152) The director shall investigate to try to mediate a settlement (s. 153). The director then has power to issue orders (s. 154). Orders can include statements as to rights and obligations, ordering payments, requiring landlord or tenant to comply with or perform an obligation, pay compensation, authorize the end of a tenancy. The director cannot handle person injury or death issues (s. 152(3)). The director has a unique power of being able to ban a landlord from renting a unit if the unit is in sufficient bad shape or would endanger the health and safety of a tenant (s. 154(1)(10). In most cases, the landlord or tenant can appeal the decision to the Residential Residencies Commission for a hearing. (s. 161). No database of such decisions was found.

Relevant provisions re radon: There are provisions for the landlord to provide and maintain the unit in a good state of repair and fit for habitation and in compliance with health, building and maintenance and occupancy standards provided by law (s. 59 (1)). The tenants knowledge at the time of moving in is irrelevant (s. 59 (2). The Landlord has a duty not to interfere with quiet enjoyment (s. 62(1).

Manitoba's RTA provides a unique mechanism whereby tenants and landlords might share the cost of repairs (that could apply to radon mitigation where tribunals are otherwise unwilling to impose formal obligations on landlords). At s. 137 the Act provides that a tenant can request an improvement to a unit, and the landlord may apply to the director for an order fixing the value of the improvement, alteration, service, facility, privilege, accommodation or thing. The director may make an order fixing the value to the tenant of the improvement and specifying how this could be paid for. This potentially allows a tenant to request radon mitigation but only pay for it pro-rated to their time they rent their unit.

Investigations. Director may initiate may, on his or her own initiative, investigate and determine a matter arising under a tenancy agreement (152(2)). Once an application is made to the Director concerning a question or matter, the director shall investigate as part of seeking a solution (such as mediation (s. 153(1)).

Precedent, Appeal and Judicial Review. The RTA provides that in some cases decisions of the director can be appealed directly to the court system (s. 153(7)). Alternatively once the commission makes a ruling, a party to the proceeding can ask for leave to appeal to the Court of Appeal on questions of jurisdiction or law. (s. 175). This is considered a very limited opportunity to appeal a decision.[39] Leave will only be granted if the outcome will be applicable to other similar disputes and there there is an arguable chance of success.[40]Deference is accorded using the reasonableness standard.[41] The Court of

[39] *Manitoba Housing Authority v. Horvat*, 2010 MBCA 43 para. 3).
[40] *Sarna v Nesha*, 2016 MBCA 55 (CanLII) (at para 2).

Appeal can make a new order, affirm the decision or send it back to the Commission (s. 178). Overall there is very little applicable case law in Manitoba concerning residential tenancies that can offer guidance concerning action on radon.

Linked Public Health regulation. The minimum standards for rental dwellings are outlined in the *Dwellings and Buildings Regulation 322/88 R* under *The Public Health Act.*(C.C.S.M. c. P210). These are very specific around issues such as water or windows, but one clause appears to have general application and be relevant: 10(2) Natural or artificial ventilation shall be provided in all cellars to the satisfaction of a medical officer or inspector. As well, the Health Protection Unit's Safe Housing Program responds to concerns from tenants and the general public. Public Health Inspectors inspect rental houses, apartments, hotels, and other types of accommodations to determine whether these places are satisfactory and free from health hazards. Inspectors enforce and apply the regulations to ensure that housing units provide safe and healthy living environments including safe indoor air.[42]

Saskatchewan

Application and Exclusion: The *Residential Tenancies Act*, 2006, SS 2006, c R-22.0001 applies to tenancy agreements, rental units and other residential properties (s. 3), with some exceptions (at s. 5) that are much the same as other jurisdictions. The Act is silent concerning whether government owned buildings are covered, although cases routinely show the Saskatoon Housing Authority and Regina Housing Authority as defendants.[43]

Remedies: There are provisions for landlords to pay compensation (s. 8) and at s. 70 (6) the RTA provides that hearing officers can make any order the hearing officer considers just and equitable in the circumstances, including stopping any contraventions of a residential tenancy agreement or the Act, or payment of compensation to tenants.

Relevant provisions re radon: Provisions for quiet enjoyment, although these are phrased in terms of reasonable privacy and "unreasonable disturbance" (s. 44). Good repair and fit for habitation requirements (s. 49 (1)). Further tenancy agreements must include standard conditions as provided in the Residential Tenancies Regulations[44]; these restate provisions for quiet enjoyment and good state of repair.[45] Cases show the general provisions of quiet enjoyment and state of repair used successfully by tenants to get rate abatement and repair in cases of ant and mice infestation,[46] cockroach infestation,[47] bedbugs,[48] mould,[49] and, as discussed above, second-hand smoke.

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[41] *The Children's Clubhouse v. Helgason et al.*, 2012 MBCA 32 (CanLII)
[42] Manitoba Health, Seniors and Active Living 2018. Safe Housing, at https://www.gov.mb.ca/health/publichealth/environmentalhealth/protection/housing.html aaccessed may 10 2018
[43] *Victoreen Kampen v Saskatoon Housing Authority*, 2011 SKQB 389; *Sapriken v Regina Housing Authority*, 2013 SKQB 401
[44] RTA (s. 18)
[45] listed in the Residential Tenancies Regulations, 2007 RRS c R-22.0001 Reg 1 (at Part II, Schedule 1), s. 7 and s. 8
[46] N.D. v. Boulevard Real Estate Equities Ltd. 2015 SKORT 117 (CanLII)
[47] D.N. V. NPR Limited Partnership, 2016 SKORT 408; Boardwalk REIT Properties Ltd v. R.S. 2016 SKORT 147 R.N. v HD Developments Ltd., 2017 SKORT 189
[48] L.R. v L.A., 2017 SKORT 263 Hingston v. Gamelin 2010 Q.B.G. No. 1275 Milne v Metropolitan Regional Housing Authority 2010 NSSM 5
[49] U.O. v B.U., 2016 SKORT 37; R.P. v Cress Housing Corporation, 2016 SKORT 447; O.A. v T.E., 2017 SKORT 129

Precedent, Appeal and Judicial Review. Decisions of Hearing Officers are publicly available.[50] Tenants or landlords may appeal the decision or order on a question of law or of jurisdiction to the Court of Queen's Bench (RTA, s. 72(1)). The Superior courts show deference, with a "reasonableness" standard of review. [51]

Investigations. Once receiving an application or determining that a hearing should be held the director may direct an investigation (s. 70(1). The Act also gives special powers to the Director to investigate landlords, including entering residential properties or place where a landlord carries on business, or where any books or records are or should be kept. The Director can inspect books, make oral or return inquiries, request assistance with an investigation, and other powers (s. 87).

Linked public health regulation. There is no explicit reference to tenant protection in Saskatchewan's *Public Health Act*, RSS 1978, c P-37 nor any regulation relating to minimum standards for rental housing in Saskatchewan. The *Residential Tenancies Regulations*, 2007, RRS c R-22.0001 Reg 1 do not touch on health and safety standards. Public health regions accept the application of the Act to rental housing, and inspectors investigate substandard rental unit conditions on a complaint basis. As with all buildings, under authority of the Act, Public Health Inspectors may order a property owner or landlord to remedy any condition that creates or has the potential to create a health hazard or condemn the building until the health hazard is addressed.[52]

Alberta

Application and Exclusion: The act applies to tenancies of residential premises (s. 2(1) with exceptions much like in other provinces (listed at 2(2)).The Crown in right of Alberta is bound by this Act (s. 4).

Provisions concerning radon. Alberta has a slightly unique system in that habitability considerations are supplied as objective standards in separate Regulation. As such, section 16 of the RTA provides for quiet enjoyment, but does not mention a fit state of repair or habitability—instead it speaks of landlords meeting minimum standards as prescribed under the *Public Health Act*. (We will discuss that below, further). Decisions of the Dispute Resolution Service are not published, which frustrates attempts to understand the system, but there are some decisions made in the courts. Here cases can be found where tenants are successful in securing abatement of rent for severe mould conditions[53], for water leakage[54], and bedbug infestation[55] and termination of rental agreement due to water leakage.[56]

Inspection. The RTA also gives the Director of Residential Tenancies (or authorized persons) powers to apply to court for warrants (s. 65) to inspect (s. 64) concerning contraventions of the Act.

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[50] available on the Canadian Legal Information Institute (CanLII) website
[51] Regina Housing Authority v Y.A., 2018 SKQB 70 (CanLII)
[52] see for example Saskatoon Health Region, 2018. Housing and Public Accommodation at https://www.saskatoonhealthregion.ca/locations_services/Services/Health-Inspection/Pages/HousingandPublicAccommodation.aspx accessed May 18 , 2018.
[53] Clay v. Bovaird, 2003 ABQB 327
[54] Perpelitz v. Manor Management Ltd., 2014 ABPC 63
[55] Boardwalk Rental Communities v. Ravine, 2009 ABQB 534
[56] *Brown v. Libertas Property Management Inc.*, 2011 ABPC 148

Precedent, Appeal and Judicial Review. Procedures are provided for in the *Residential Tenancies Dispute Resolution Service Regulation*, Alta. Reg. 98/2006). [57] Disputes can be heard by dispute officers on claims up to $50,000.[58] They also have the power to send cases up to superior courts, where officers believe the matter involves questions of constitutional law or human rights, that the court is more appropriate or its outside the jurisdiction of the Dispute Resolution Service.[59] Decisions of the Residential Tenancy Dispute Resolution Service are reviewable by higher courts following the reasonableness standard.[60] Parties have the option of proceeding directly to the Provincial Court (s. 48(1), from which there is a right to appeal to the Court of Queen's Bench (s. 53(1)). As noted, for cases that stay in the Dispute Resolution Office, there is no public record. Alternatively, the court decisions follow normal case law practice. Appeals can also be heard at the Court of Queen's Bench from the Dispute Resolution Office.[61] The existence of a limited right of appeal under the *RTDRS Regulation* does not oust the inherent and constitutional jurisdiction of superior courts to review decisions. The *RTA* and *Regulation* limit appeals of a TDO's decision to Superior Courts on questions of law or jurisdiction. New evidence is inadmissible, and only limited inferences may be drawn from the facts expressly found by the TDO. Those inferences cannot be inconsistent with the facts expressly found by the TDO and they must be necessary to determining the question of law or of jurisdiction.[62] The Alberta courts apply a "reasonableness" standard to decisions of the Dispute Resolution Office, given the unique expertise of the tribunal as a specialized extra-judicial body for resolving disputes, and clauses in the enabling legislation that give it exclusive authority over landlord-tenant disputes. [63]

Linked public health regulation. *The Housing Regulation* [64] contains a number of provisions that, while not explicitly including radon ingress, might be relevant. A landlord is to ensure that housing premises are structurally sound, in a safe condition, in good repair, and maintained in a waterproof, windproof and weatherproof condition (s. 3(1)). Further, an owner shall maintain the housing premises in compliance with *the Minimum Housing and Health Standards* (s. 4). Here also there are no specific provisions on radon but general provisions that might apply if generously construed: Part III states that "The owner shall ensure that the housing premises is structurally sound, in a safe condition, in good repair, and maintained in a waterproof, windproof and weatherproof condition". Further, the *Housing Regulations* and the *Minimum Housing and Health Standards* are enforced by inspections of housing premises by Public Health Inspectors/Executive Officers of Regional Health Authorities on a systematic or complaint basis. The result is that in some cases, tenancy issues around habitability are handled as prosecutions for violation of the *Health Act* and *Regulations* in provincial court. [65] Moreover, the Court of Queen 's Bench of Alberta has an inherent power to grant injunctive relief to prevent ongoing breaches of the *Health Act* and its regulations, providing renters and Public health officials with a unique avenue of redress.[66] Actions may be taken by public health officials to address problems with standards, and subsequent procedures may be initiated by tenants under the RTA to seek abatement of

[57] *Residential Tenancies Dispute Resolution Service Regulation*, Alta. Reg. 98/2006 available at http://www.qp.alberta.ca/documents/Regs/2006_098.pdf accessed April 12, 2018
[58] https://www.servicealberta.ca/landlord-tenant-eligibility.cfm
[59] *Residential Tenancies Dispute Resolution Service Regulation*, Alta. Reg. 98/2006. s. 17
[60] *CIBC Mortgages Inc v Bello*, 2018 ABQB 176
[61] Boardwalk Retal Communities v. Ravine, 2009 ABQB 534.
[62] (*Regulation* s 25)
[63] Greater Edmonton Foundation v Hetland, 2017 ABQB 430
[64] *Housing Regulation (Alberta Regulation 173/1999 under the Public Health Act) available at* http://www.qp.alberta.ca/documents/Regs/1999_173.pdf
[65] c.f. R. v. Wannas, 2004 ABPC 85 (CanLII); Alberta (Health Services) v Bhanji, 2017 ABCA 126; R v George, 2018 ABPC 20 (
[66] Capital Health v. Gaida, 2004 ABQB 768—ordering reinstatment of electricity to a rental home

rent, early termination and other issues relating to the landlord tenant relationship. [67] It should be noted, however, that were public health inspectors in Alberta have taken action on radon it has not been on the basis of these Regulations but of general nuisance clauses in the Health Act— the feeling was that the clauses in these Regulations were not specific enough to offer sufficient guidance.[68]

British Columbia

Application and Exclusion: BC's *Residential Tenancy Act* S.B.C. 2002, c. 7 applies to all tenancy agreements, rental units and other residential property. (s. 2(1)). A broad class of accommodation is excluded from the *Residential Tenancies Act*: student housing owned by colleges and universities are not covered,[69] and short term vacation or travel accommodation,[70] correctional institutions,[71] and trailer parks.[72] As well, a number of types of housing that are excluded encompass "social housing" emergency shelters and transitional housing,[73] and a range of community care, continuing care, therapeutic treatment, and hospital settings.[74] Generally, housing owned directly by government is covered. (Providers include: the British Columbia Housing Management Commission (BC Housing), the Canada Mortgage and Housing Corporation (CMHC), the City of Vancouver, the City of Vancouver Public Housing Corporation, Metro Vancouver Housing Corporation, the Capital Region Housing Corporation). The provisions that pertain to radon (see below) apply. However, specific provisions of the RTA related to rent increases and evictions do not apply in some cases. These are narrow exceptions, and are designed to allow public housing providers to only house persons who qualify, and to set rents in relation to income (and which might change by a persons income rather than the normal rent control provisions). Here, the Residential Tenancy Regulation lists out a variety of government agencies, from all three levels of government that might provide housing with rents geared to income.[75] Similar rules apply to housing societies or non-profit municipal housing corporations that have or has had operating agreements with the government of British Columbia, the British Columbia Housing Management Commission, the Canada Mortgage and Housing Corporation, a municipality, or a regional district.[76]

Remedies: The RTA upholds the basic contractual nature of landlord-tenant relations but prescribes a limited amount of necessary terms for tenancy agreements and procedures between landlord and tenant. As such, a landlord must prepare a tenancy agreement in writing (s. 13) and that agreement must include, and cannot change or remove, a series of standard terms (s. 14). The Act provides that if a landlord or tenant does not comply with this Act, the regulations or their tenancy agreement, the non-complying landlord or tenant must compensate the other for damage or loss that results (s.7). Section 67 of the Act grants a dispute Resolution Officer the authority to determine the amount and to order payment under these circumstances. Section 62 (3) allows a Dispute Resolution Officer to make orders to give effect to the rights, obligations and prohibitions under the Act, including an order that a landlord or tenant comply with this Act, the regulations or a tenancy agreement. There are particular

[67] Brown v. Libertas Property Management Inc., 2011 ABPC 148
[68] Interview with Ryan Lau, April 18 2018
[69] RTA s.4(b)
[70] RTA s. 4(e)
[71] RTA s. 4(h)
[72] RTA s. 4(j)
[73] RTA s, 4(f)
[74] RTA s. 4(g)
[75] Residential Tenancy Regulation, B.C. Reg. 477/2003 O.C. 1239/2003 section 2
[76] Residential Tenancy Regulation, s. 2(g),and (h)

provisions allowing tenants do undertake emergency repairs (at s. 33) but only that are urgent, necessary for health and safety or preserving the property, and related to a limited list of issues (e.g. leaks in pipes, defective locks)— and it seems unlikely radon would fit.

Inspections. There are provisions whereby the Director of Residential tenancies can conduct investigations, even where there is no application for dispute resolution (s. 87.1). The director has the power to order monetary penalties after holding a hearing or to enter into an agreement.(s. 87.3) Penalties are up to 5,000 dollars, but a separate penalty can accrue for each day (s. 87.4).

Relevant provisions re radon: The Act provides that a landlord must provide and maintain residential property in a state of decoration and repair that complies with the health, safety and housing standards required by law (s. 32(1)(a)) or makes it suitable for occupation by a tenant.(s 32(1)(b)). There is a general clause (at s. 28) stating that a tenant is entitled to quiet enjoyment including freedom from unreasonable disturbance, Decision-makers have ruled that a water ingress problem could be a latent defect which the landlord was aware of that was not apparent with the original inspection[77], others tobacco smoke [78]. However, noise from a downstairs neighbour will not constitute a breach absent inappropriate conduct or neglect on the part of the landlord.[79]

In BC, Residential Tenancies Branch archived decisions found no cases which make decisions on the basis of the presence of radon gas[80], nor formaldehyde or lead-based paint. Radon issues are neither mentioned nor implied in the Policy Guidelines that the RTB puts out.[81] However, other environmental health issues, especially mould have been successful: Decisions reflect the view that the presence of mould is a "major problem" which will require at minimum, cleaning and usually professional mould remediation.[82] Tenants have also been awarded amounts for loss of use of mould-affected rooms[83] or whole apartments,[84] as well as mould-affected possessions or discarded food.[85] Hearing officers have also been open to finding as problematic cockroach infestations,[86] and carpet beetles.[87] A bedbug infestation led one hearing office to state that "the presence of vermin would compromise the health, safety and housing standards." [88] Generally, then "There is no question that, under the Act, a landlord is responsible for pest control and a tenant is required to cooperate with the extermination process."[89]

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[77] http://www.housing.gov.bc.ca/rtb/decisions/2013/12/122013_Decision4367.pdf
[78] Lawrence v. Kaveh, 2010 BCSC 1403
[79] .Parhar Investments & Consulting Ltd. v. Brontman, 2015 BCSC 637 (CanLII)
[80] (Radon is mentioned in two cases, but it does not appear to have been central to the decision. See Decision 6972 July 31, 2017 http://www.housing.gov.bc.ca/rtb/decisions/2017/07/072017_Decision6972.pdf and Decision 2100 February 28, 2014. http://www.housing.gov.bc.ca/rtb/decisions/2014/02/022014_Decision2100.pdf
[81] c.f. Residential Tenancies Branch, 2004. Residential Tenancy Policy Guideline No. 1 Landlord & Tenant – Responsibility for Residential Premises. at https://www2.gov.bc.ca/gov/content/housing-tenancy/residential-tenancies/calculators-and-resources/policy-guidelines/policy-guidelines-listed-alphabetically
[82]
"http://www.housing.gov.bc.ca/rtb/decisions/2017/08/082017_Decision6553.pdf"http://www.housing.gov.bc.ca/rtb/decisions/2008/12/Decision1124_122008.pdf) http://www.housing.gov.bc.ca/rtb/decisions/2017/08/082017_Decision6553.pdf
[83]http://www.housing.gov.bc.ca/rtb/decisions/2015/06/062015_Decision6397.pdf
[84] http://www.housing.gov.bc.ca/rtb/decisions/2015/09/092015_Decision6775.pdf
[85] http://www.housing.gov.bc.ca/rtb/decisions/2011/04/Decision1961_042011.pdf
[86] . http://www.housing.gov.bc.ca/rtb/decisions/2009/08/Decision1265_082009.pdf
[87] http://www.housing.gov.bc.ca/rtb/decisions/2009/12/Decision1518_122009.pdf
[88] http://www.housing.gov.bc.ca/rtb/decisions/2012/12/Decision2619_122012.pdf
[89] http://www.housing.gov.bc.ca/rtb/decisions/2009/12/Decision1518_122009.pdf, see also http://www.housing.gov.bc.ca/rtb/decisions/2012/11/Decision2537_112012.pdf

Some cases, however suggest that the threshold concerns what is supplied by other law s at the time, such as building codes. Certainly, landlords must provide premises that comply with the law. This will extend to current building codes.[90] As such, failure to install a guard rail, as specified in the applicable Code, will show failure to uphold the relevant standards. [91] However, this leaves open whether the RTA goes farther, to allow adjudicators to impose standards beyond the law. In at least one case, counsel have accepted the principle that the RTA does not lead to the imposition of higher standards than apply to older buildings, (e.g. to make current National Building Code requirements for safety glass in doors apply retroactively).[92] However, there is interaction between the RTA and Occupier's Liability and there is reason to think the standards under the RTA and Occupier's Liability should not be different. As such, courts hold that a landlord's duty to inspect is part of the duty to provide and maintain residential premises in a reasonably suitable state under the RTA, as well as part of a landlord's duty to take reasonable care in carrying out the responsibility for repair of the premises under s. 6 of the OLA. A landlord with a duty to repair under the RTA has a duty to make reasonable inspections of the premises for defects, regardless of whether he or she has notice or actual knowledge of defects.[93] As such courts appear to simply read the duties under the Occupier's Liability Act and RTA as overlapping, implying an objective standard: "Standards in law" includes duties under the Occupier's Liability Act.

Precedent, Appeal and Judicial Review. BC's RTA provides few avenues for appeal or judicial oversight. Dispute resolution proceedings (or what is sometimes called the "statutory power of decision") are provided for in the *Residential Tenancies Act* in Part 5 (s. 58 onwards). Only in exceptional circumstances will the Supreme Court hear a dispute— such as claims over 35,000 dollars or where the dispute is intertwined with matters already before the matters of family violence (s. 58(2),(4)). *Stare decisis* is explicitly legislated away: The RTA provides, at s. 64 (2) that "The director must make each decision or order on the merits of the case as disclosed by the evidence admitted and is not bound to follow other decisions under this Part". As such, while the RTB does publish decisions in a searchable database,[94] individual decisions do not, normally, involve recitation of previous cases in the manner of superior courts. A party to a dispute resolution proceeding can apply for a review, but only on grounds of being unable to attend the original hearing, new and relevant evidence surfacing, or evidence that the original decision was obtained by fraud (s. 79). This is an issue that has been a long-standing concern of non-profit and civil society organizations in the province who argue for the need for a meaningful statutory review process.[95] Moreover, BC superior courts apply a "patently unreasonableness" standard for review.[96] This means the courts can only interfere in findings of fact or law by the RTB if they are exercised arbitrarily or in bad faith, is exercised for an improper purpose, is based entirely or predominantly on irrelevant factors, or fails to take statutory requirements into account.[97] They must be "openly, evidently, clearly" unreasonable.[98]

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[90] *Tolea v. Ialungo*, 2008 BCSC 395 (CanLII)
[91] *Zavaglia v. MAQ Holdings Ltd.* (1986), 1986 CanLII 919 (BC CA), 6 B.C.L.R. (2d) 286 (C.A.)).
[92] *Jakobsons v. Wall Financial Corp.*, [1998] B.C.J. No. 1641
[93] *Zavaglia v. MAQ Holdings Ltd.* (1986), 1986 CanLII 919 (BC CA), 6 B.C.L.R. (2d) 286 (C.A.)*Klajch (Guardian ad litem of) v. Jongeneel*, 2002 BCCA 14 (CanLII), 174 B.C.A.C. 184 Tolea v. Ialungo, 2008 BCSC 395
[94] http://www.housing.gov.bc.ca/rtb/search.html
[95] Milne, K. and Cooper, K. 2014. Suggested Amendments to BC's Residential Tenancy Act. Community Legal Assistance Society. available at https://drive.google.com/file/d/0B8CaGg3N3aZdVzR1Y0ZOS3diUkU/view (accessed Feb 2, 2018; and on file with author). at p. 23
[96] by working of s. 58 (2) of the *Administrative Tribunals Act*, see *Schaper v. Beachamp*, 2011 BCSC 833 (CanLII), upheld on appeal at 2012 BCCA 208 (CanLII), see also Bennett v. Wamboldt, 2012 BCSC 1251
[97] s. 58 (3) of the *Administrative Tribunals Act*
[98] *Havey v. 0697418 B.C. Ltd.*, 2014 BCSC 130

Associated Public Health Regulations. There is no general purpose 'nuisance clause' in the Public Health Act, SBC 2008, c 28 (apart from reference to health hazards, discussed elsewhere). The he Health Hazards Regulation, BC Reg 216/2011 does have specific provisions for rental accommodation, but they are narrowly constructed in relationship to potable water, airspace volumes per tenant, and windows that open. (s. 7)

Yukon

Application and Exclusion: *Residential Landlord and Tenant Act,* SY 2012, c. 20. The Act applies broadly to tenancy agreements, rental units, and other residential property (2(1). There are exceptions for units occupied for business purposes, education institutions renting to students, roommates (e.g., where the tenant shares bathroom or kitchen facilities with the owner of that accommodation), emergency shelters and transitional housing (less than six consecutive months), vacation or travel accommodation; residential care and treatment facilities, community health centres, hospitals, correctional facilities (s.3). The Regs also exclude group homes and out of home care.[99] The Act binds the Government of Yukon (s. 5). Landlords and tenants may not avoid or contract out of the Act or the regulations (s. 6). Certain provisions relating to rent increases, notice and subletting do not apply to housing agencies—e.g. social housing provided by Yukon Housing Corporation (s. 1), and Kwanlin Dun First Nation and Grey Mountain Housing Society (regs, s. 12; see also Act, s. 35(4), 38)

Relevant provisions for radon: The standard terms are terms of every tenancy agreement (s. 12): quiet enjoyment including reasonable privacy, freedom from unreasonable disturbance (s. 27A); and maintenance of property in a condition that complies with health, safety and housing standards and makes it suitable for occupation (s. 33(1)). Standard terms are provided in the Schedule, Minimum Rental Standards. They have the overall purpose of ensuring that the rental units are safe, sanitary and fit for human habitation (s.1). The landlord must provide buildings and other structures in good repair and free from conditions that would reasonably be expected to create a health, fire, or safety hazard. (s.5). Cellars, basements, crawl spaces and foundations must be in good repair "such that they are reasonable weather tight" (s. 14); and walls, ceilings and floors should be structurally sound and reasonably free from major cracks, crevices, holes and defects (s. 15). There must be sufficient ventilation so as not to create…a potential health hazard (s. 24(1)).

Remedies. If a landlord fails to comply with a material term, the tenant can end the tenancy (with notice) (s. 46(1)). Disputes can go to the Director of Residential tenancies (s. 65 (1)).

Inspections. 72(1) Upon receiving an application for dispute resolution the director may conduct any investigation into the matter that the director considers necessary.(2) If an investigation is conducted, the director must make reasonable efforts to give the person under investigation an opportunity to respond.

Precedent, Appeal and Judicial Review The director must decide disputes unless it surpasses the monetary limit, or is substantially linked to a matter before the Supreme Court, but generally matters

[99] Residential Tenancies Regulation, O.I.C. 2015/193

under the jurisdiction of the Director of Residential Tenancies are not to be heard by the court (s. 65). There are limited provisions for the director to review decisions (s. 84)

Northwest Territories and Nunavut

Application. The *Residential Tenancies Act*, RSNWT 1988, c R-5 applies to rental premises and tenancy agreements, with a list of exceptions similar to other RTAs (s. 6) Section 8 explicitly binds both the Government of the Northwest Territories and its agents where it is a landlord or a tenant of rental premises; and a housing association and a housing authority as defined in the Northwest Territories Housing Corporation Act (e.g. social housing).

Relevant provisions re Radon: section 30. (1) A landlord shall: (a) provide and maintain the rental premises, the residential complex and all services and facilities provided by the landlord, whether or not included in a written tenancy agreement, in a good state of repair and fit for habitation during the tenancy; and (b) ensure that the rental premises, the residential complex and all services and facilities provided by the landlord comply with all health, safety and maintenance and occupancy standards required by law. This applies even (even where a tenant had knowledge of any state of non-repair before the tenant entered into the tenancy agreement (s. 30(3)). Section 34 is headed "Quiet enjoyment" and states that, (s. 34(1)) No landlord shall disturb a tenant's possession or enjoyment of the rental premises or residential complex. Cases were found where mould was a problem (with officers not always being specific why), [100] but not for radon, formaldehyde, mice, asbestos, lead paint, radiation, pollutant or pollution.

Remedies. The Act sets out, at s. 30 (4) that where, on the application of a tenant, a rental officer determines that the landlord has breached an obligation imposed by this section [concerning good state of repair], the rental officer may make an order(a) requiring the landlord to comply with the landlord's obligation;(b) requiring the landlord to not breach the landlord's obligation again;(c) authorizing any repair or other action to be taken by the tenant to remedy the effects of the landlord's breach and requiring the landlord to pay any reasonable expenses associated with the repair or action;(d) requiring the landlord to compensate the tenant for loss that has been or will be suffered as a direct result of the breach; or(e) terminating the tenancy on a date specified in the order and ordering the tenant to vacate the rental premises on that date. Tenants have to give reasonable notice of breaches (s. 30(5)). The landlord and tenant can agree that the tenant will ensure a good state of repair and habitability (s. 31 (1)). The provisions on quiet enjoyment (s. 34(1)) have a separate remedies provision (at s. 34(2)): Where, on the application of a tenant, a rental officer determines that the landlord has breached the obligation imposed by subsection (1), the rental officer may make an order (a) requiring the landlord to comply with the landlord's obligation; (b) requiring the landlord to not breach the landlord's obligation again; (c) requiring the landlord to compensate the tenant for loss suffered as a direct result of the breach; or (d) terminating the tenancy on a date specified in the order and ordering the tenant to vacate the rental premises on that date. After a hearing, a rental officer make any order or decision that has been applied for, or that could have been applied for, that he or she considers justified in the circumstances and may include in any order or decision the terms and conditions that the rental officer considers appropriate in the circumstances (s. 83. (1)).

[100] *Kotaneelee Housing Association v. Northwest Territories Housing Corporation*, 2007 CanLII 46124 (NWT RO), *Orchard v NPR Limited Partnership*, 2014 CanLII 37236 (NWT RO); *Northwest Territories Housing Corporation v Porter*, 2015 CanLII 80110 (NWT RO), notably finding tenants mould breached landlords quiet enjoyment.

Procedure and Review. Applications can be made to rental officers to hold hearings, or alternatively and both parties agree, to a territorial judge or to a Supreme Court judge (s. 69). Judges have broader powers to grant relief (s. 70(4)). There is an appeal as of right from the Rental Officer decision to the Supreme Court (s. 87. (1). A judge of the Supreme Court hearing an appeal may receive new evidence (87 (5)).From there further appeals are possible. (s.90). Where the Rental Officer acts within the scope of his jurisdiction or the appeal involves a question of fact, the standard is that of reasonableness. Where the issue is one of law, jurisdiction or procedural fairness, the standard is that of correctness. [101]

Investigations. Rental officers, along with receiving complaints, can also investigate complaints (74(1)). They have general powers to investigate allegations of contraventions of the Act or the regulations and enter rental premises at any reasonable time, after giving reasonable notice, for the purpose of discharging his or her duties under this Act or the regulations (s. 74(1) When an officer receives a complaint he or she can "conduct any inquiry or inspection that the rental officer considers necessary" (s. 76(2)(a)).

Associated regulation and standards. None found.

[101] Inuvik Housing Authority v. Alunik, 2014 NWTSC 37 at para. 14

Appendix 5: Radon Testing in Schools and Child Care Centres - by Province and Territory

CONTENTS

The following is a summary, organized by Province/Territory of the national survey conducted by CAREX Canada of the status across Canada of any radon in schools. It also notes any additional information that could be found about radon testing in child care centres.

Newfoundland

257 (98%) public schools identified that they did not test for radon. Data were unreported or unknown for 2% of public schools. The schools that have not tested for radon indicated that a province-wide radon testing policy or program is needed to meet the Health Canada guideline.[1] We heard reports, but were unable to finding confirming evidence, that the Newfoundland Government is starting a school testing program in 2018.[2]

We received no leads concerning child care testing or mitigation.

Nova Scotia

Nova Scotia has tested all public schools at least once as part of its provincial radon testing program, and remediated all public schools with levels above the Health Canada guideline. As well, the province

[1] CAREX, 2017. Radon in schools: A summary of testing efforts across Canada. Available at https://www.carexcanada.ca/en/announcements/radon_in_schools/ Accessed May 20, 2018.
[2] correspondence with Lance Richardson-Prager, Health Canada, April 12, 2018

conducted follow-up tests after remediation to ensure that radon levels had been lowered.[3] The Department of Transportation and Infrastructure created new mandatory clauses in the 2010 edition of the Design Requirements Manual. [4] These specify, for all provincial building projects, that there be environmental assessments that test for radon, and if high levels are found, mitigation systems are required. [5]

We received no leads concerning child care testing or mitigation.

New Brunswick

New Brunswick tested all schools for radon in the 1990s and substantially redid that process after 2008 in response to new Health Canada Guidelines. The Department of Education and Early Childhood Development and the Department of Health have thus tested 325 sites including schools and district offices, and remediated 49 schools. New Brunswick's Office of the Chief Medical Health Officer states that no provincial legislation or regulation requires radon testing in all schools; however, there is a province-wide radon testing protocol based on Health Canada's guideline. Schools that were remediated or recorded levels of radon above the guideline are retested annually, as are schools that were recently renovated. Retesting in Fall 2017 and Winter 2018 is planned for 49 mitigated schools. Testing schedules extend to Winter 2021. New Brunswick identified cost as a key challenge in continuing its testing program. [6]

We received no leads concerning child care testing or mitigation.

Prince Edward Island

The Ministries of Education and Health initiated a program to test for radon in all schools in 2008 in collaboration with C-NRPP experts. The Government of Prince Edward Island (PEI) assumed all costs from the initiative, leaving the school boards no financial burden. Results and remediation guidelines are publicly available in the Radon Survey at Selected Sites Across Prince Edward Island report.[7] In 2009, Phase 2 tested all remaining schools, and retested the schools that had been remediated. The results were again made publicly available in the Phase 2 - Radon Survey at Selected Sites Prince Edward Island report.[8] As a long-term impact of this program, the Government of PEI is now testing and mitigating to reduce radon levels in any new construction of school buildings.[9]

We received no leads concerning child care testing or mitigation.

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[3] CAREX 2017, ibid.
[4] Province of Nova Scotia, Department of Transportation and Infrastructural Renewal. 2010. Design Requirements Manual, 2010 Edition. DTIR Document DC350. Available at https://novascotia.ca/tran/works/dc350/Part1.pdf accessed may 20, 2018.
[5] ibid. In Division 31, Earthwork, is 31.21.00 "Off-Gassing Mitigation," where Clause 31.21.1.0 states: "Where Phase 1 Environmental Assessment indicates a presence of Radon, TPH or other radioactive waste at contaminating levels, or as directed by the Department, provide for design and installation of a vapour extraction system." Clause 31.21.1.2, states: "Unless recommended by the Phase 1 Environmental Assessment, or directed by the Department, design a vapour extraction system for radon as a passive system with provision for future activation".
[6] CAREX 2017 ibid.
[7] PEI Department of Health, 2008. Radon Survey at Selected Sites Across Prince Edward Island .Project No. 7108. Available at http://www.gov.pe.ca/photos/sites/infopei/7108%20Radon%20Final%20report%20(rev).pdf accessed May 20, 2018.
[8] PEI Department of Health, 2009. Phase 2 - Radon Survey at Selected Sites Prince Edward Island . Project No. 8612. Available at http://www.gov.pe.ca/photos/sites/health/file/Radon%20Report%20Phase%202.pdf Accessed May 20, 2018.
[9] CAREX 2017 bid

Quebec

In 2011, the Quebec Ministry of Education mandated testing of all schools by 2014.[10] In 2014, the Institut national de santé publique du Québec (INSPQ) gathered all reported radon information and collated the results, with 57% of schools complying with radon testing and 124 tests presented radon levels above the Health Canada guidelines.[11] The Commission Scolaire de Montreal has confirmed that radon gas is still a problem in some of its schools. Saint Marc and Notre Dame du Foyer in Rosemont-La Petite Patrie have radon levels above the norms set out by Health Canada. Parents of students at the affected schools have been informed. [12]

Childcare. In 2015 a radon testing initiative was conducted in two regions under the auspices of the provincial Ministry of Health and Social Services in collaboration with the Ministry of Families Nearly all of the recruited facilities (which also received free test kits and guidance) successfully completed the testing. There was also an up-front commitment to fund remediation if elevated radon levels were detected. Two of the 36 child care centres (5.5%) had at least one test result above the Canadian guideline.[13]

Ontario

CAREX found that the Ontario's Ministry of Education has no province-wide radon testing policies or programs in place. Any radon testing in schools is at the discretion of Infrastructure Ontario as the crown agent of owners for each building. CAREX staff contacted all 84 public school boards in the province. Of the schools contacted, 854 (18%) schools reported that they have tested for radon and 1,230 (25%) schools confirmed that they have not tested for radon. Of the schools that had tested, two school boards overseeing 601 schools indicated that they had remediated schools with levels above Health Canada's guideline. They did not provide the actual number of schools with elevated readings. In 61 school boards, accounting for 2,807 (57%) schools, radon testing was not reported or is unknown.[14]

We received no leads concerning child care testing or mitigation.

One potential bright light is that the Ministry of Health recently updated its Ontario Public Health Standards. This change might lead individual Health Units to take initiatives to test child care centres within their jurisdictions.

Manitoba

Manitoba has no rules mandating testing in schools or daycares. Winnipeg's Pembina Trails School Division participated in 2011 with a research project with the University of Manitoba to test for radon

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[10] Gagnon F, Poulin P, Leclerc J-M, Dessau J-C, Abab A, Arsenault P, El-Turaby F, Lachance-Paquette G, Vézina F-A. 2016. Implementation of a radon measurement protocol and its communication plan by child care centre managers in Québec. Can. J. Public Health. **107**(3): e319-e325; 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.

[11] CAREX 2017 ibid.

[12] CTV News, 2016. Radon detected in CSDM schools. September 30, 2016, Montreal. https://montreal.ctvnews.ca/radon-detected-in-csdm-schools-1.3096738

[13] Gagnon et al. 2016 ibid.; Phipps, et al. 2017 ibid.

[14] (CAREX 2017 ibid.)

gas in schools with basement-level classrooms. The final results revealed that the levels in all buildings were below Health Canada requirements.[15]

In 2017 CAREX contacted all 39 public school boards in the province. Of these, 76 (8%) schools confirmed testing for radon, and 33 (3%) schools confirmed testing had not been done. Of the schools that reported testing, none were above the Health Canada guideline. Thirty-two school boards, which oversee 831 (88%) public schools, did not provide any data.[16]

The Manitoba School Board Association initiated a digital monitor loan program in response to the CAREX report and will look into long term testing depending on results."When the CAREX summary came out, there was obviously some need for improvement. And I took it upon my office to say, 'OK, let's get some testers out there and let's get these answers,'" Darren Thomas, the risk manager for the Association told journalists. He said that about five minutes after he emailed a memo to all the province's school divisions, saying there were six kits up for grabs, they were all gone.The association then bought four more kits, at about $200 apiece, to shorten the wait list. The results of the screenings will not be made public unless the school divisions wish to make them so, he said. Thomas said he doesn't think the province needs to legislate mandatory screening tests for radon, adding school divisions are handling the issue appropriately.[17]

Child Care. In 2014, led by the Canadian Partnership for Children's Health and Environment (CPCHE) and the Canadian Child Care Federation (CCCF), with support from Health Canada, six child care facilities in Winnipeg took part in a radon-testing initiative. They were given free kits to test their facilities for radon, as well as outreach materials to help raise awareness.[18]

Saskatchewan

The province has full testing of public schools and has been able to remediate and retest all buildings that recorded radon levels above 200 Bq/m^3.[19] We received no leads concerning child care testing or mitigation.

Alberta

CAREX contacted all 85 public school boards in Alberta to investigate radon testing efforts. Only 61 (3%) schools reported testing for radon, and 198 (8%) confirmed that radon testing has not been done. Ninety-five schools reported they would be interest in, or are planning to begin testing in 2018. Radon testing efforts are unknown or unreported for 2,129 of the 2,388 schools in Alberta.[20] Alberta Infrastructure is doing radon testing at selected schools in Alberta.[21] The Calgary Board of Education has done some school testing, however, the project is on hold until further approval from superintendents and principals and is expected to resume in response to Bill 209.[22] Calgary Catholic

[15] Botelho-Urbanski, J. 2018. Province's schools snap up radon test kits. Winnipeg Free Press, March 7, 2018 Available at https://www.winnipegfreepress.com/local/provinces-schools-snap-up-radon-test-kits-476079913.html accessed May 20, 2018.
[16] CAREX 2017 ibid.
[17] Phipps, E. 2014. Child Care Professionals Lead by Example by Testing Their Centres for Radon *Interaction*, 28, 2, p. 7
[18] Phipps, E. 2014. Child Care Professionals Lead by Example by Testing Their Centres for Radon *Interaction*, 28, 2, p. 7
[19] CAREX, 2017 ibid
[20] CAREX 2017 ibid.
[21] Danny Da Silva, Building Environment Unit Manager, Infrastructure Alberta, April 16, 2018. This was confirmed by Robyn Luff April 13, 2018
[22] Murina Krahn, Indoor Environmental Quality Supervisor,

School District has tested 40 schools already and expects to test another 10-13 schools tested in the 2018/19 school year depending on the budget.[23]

We discussed Alberta's Bill 209 at section 4.7 but can reiterate the main points here. The Radon Awareness and Testing Act was passed in 2017 as a private members bill and is waiting to be signed.[24] At section 3, there are mandatory testing requirements for child care facilities. The bill has no budget attached, leaving it to individual ministries to find resources to implement it. [25]

British Columbia

As of 2017, British Columbia (BC) still does not have a province-wide program for testing in schools. CAREX contacted all 60 public school districts in BC to obtain a more accurate understanding of current testing efforts. CAREX found that 133 (8%) public schools have been tested for radon, and 283 (18%) public schools have not. Data were unreported or unknown for 45 school districts, which account for 1,150 (73%) public schools. Most school districts that reported radon testing in schools had levels below 200 Bq/m3. In schools that reported levels over 200 Bq/m3, remediation was either completed or is underway. Seven school districts, totalling 134 public schools, reported they would be interest in, or are planning to begin testing in 2018.

Childcare. As noted in section 4.7 above, the Interior Health Authority has had an ongoing program of targeting child car providers, first with a program of mailing free test kits to 800 providers in 2014 followed with repeat contact to many .[26] The Health Authority also took the novel step of ordering child care facilities to test for radon in 2017.[27] However, rather than relying on the Public Health Act—which was felt to be too vague and uncertain, the Authority used the Community Care and Assisted Living Act, S.B.C. 2002, c. 75 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).[28]

Yukon

The Government of Yukon's Department of Education initiated radon testing in all schools between 2016 and 2017. It created guidelines to monitor radon levels in public buildings, including schools, regularly. It has also developed guidelines to remediate schools with radon levels above Health Canada's guidelines. The Yukon has made all recorded radon levels in school buildings publicly available online.[29] The current results indicate that three facilities have recorded levels above the Health Canada

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[23] (Christina Fok, relating conversations with Sahar Ashtiani, Occupation Health, Safety and Transportation Officer, Calgary Catholic School Board. Also see Ashtiani's presentation to CARST's 2018 Conference here: http://www.carst.ca/resources/Conference%202017/Presentations%202017/CARST%20School%20Testing.pdf, accessed May 20, 2018.

[24] The Bill is available here: http://www.assembly.ab.ca/ISYS/LADDAR_files/docs/bills/bill/legislature_29/session_3/20170302_bill-209.pdf.

[25] Robyn Luff, telephone interview, April 13, 2018)

[26] 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.

[27] Nicol, A-M, Ma, L, and Baytalan, G. 2017. Knowing leads to doing: The radon testing imperative. News for the Canadian Institute of Public Health Inspectors. Fall 2017. available at http://ciphi.bc.ca/downloadable/BC_Page/2017/BC%20Page%20-%20Fall%202017.pdf Accessed May 11, 2018. See also Interior Health, 2017. News and Resources from Licensing – May 2017. available at http://www.carst.ca/resources/Documents/May%20News%202017%20-%20Interior%20Health.pdf accessed May 11, 2018.

[28] interview with G. Baytalan April 11, 2018

[29] Government of Yukon, 2018. Radon Monitoring in Schools. Available here http://www.education.gov.yk.ca/radon-monitoring.html accessed May 20, 2018.

guideline. The Government of Yukon stated that it is following through with mitigation action in these three schools.[30] The Yukon government has also announced it would mandate testing in child care facilities.[31] No draft bill is available, but a press release from October, 2017 states that "over the coming months, the government will be working with licensed child care facilities to determine how this requirement will be implemented".[32]

Northwest Territories

The Northwest Territories has some school buildings that are constructed on pile foundations that elevate the buildings off the ground. These buildings do not require testing because the space and airflow between the underside of the building and the grade below it allow radon to escape into the atmosphere instead of accumulating into the building above. The Northwest Territories' Ministry of Infrastructure indicated that schools are tested where concerns about radon have been raised. Ministry records show that one school reported levels above the Health Canada guideline, and this school has since been remediated for radon.[33]

We had no leads on issues relating to radon and child care facilities in Nunavut.

Nunavut

In Nunavut all schools are constructed above ground on stilts or piles that elevate the buildings. These buildings do not require testing because the space and airflow between the underside of the building and the grade below it allow radon to escape into the atmosphere instead of accumulating into the building above. The Government of Nunavut's Department of Health identified that none of the schools had been tested for radon due to this construction method.[34]

We had no leads on issues relating to radon and child care facilities in Nunavut.

[30] CAREX, 2017, ibid.
[31] CBC News, 2017. Radon testing will be mandatory for Yukon daycares, a 1st in Canada. October 17, 2018.http://www.cbc.ca/news/canada/north/radon-testing-daycares-mandatory-yukon-1.4361468 accessed May 18, 2018.
[32] Government of Yukon, 2017. October 18, 2017 Radon testing to become a requirement for child care centres and family day homes. Available at http://www.gov.yk.ca/news/17-221.html
[33] CAREX, 2017. ibid.
[34] CAREX, 2017. ibid.