

The Unfamiliar Killer

RADON



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Radon

The Unfamiliar Killer

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TABLE OF CONTENTS

Executive Summary	3
Introduction	5
The Health Effects of Radon.....	5
Remedial action to reduce the health risks posed by radon	7
Radon Guidelines: An International Comparison	7
Canada.....	8
United States	8
Europe	9
Australia	9
Comparative Analysis	9
The Proposed Canadian Guideline.....	10
Conclusion and Recommendations	11
ENDNOTES.....	13

Executive Summary

Radon is a ubiquitous, naturally occurring radioactive gas that comes from the decay of uranium, which is distributed throughout soil and rocks in Canada in varying concentrations. Although radon receives little public attention, it is one of the most toxic sources of indoor air pollution in Canada. Radon is the second leading cause of lung cancer in Canada after smoking. Recent studies have established that radon is the second most important cause of lung cancer after smoking, accounting for 9 to 15 percent of lung cancer deaths.

Radon seeps into buildings through cracks and other weaknesses in foundations and floors. To a much lesser extent, radon can enter homes through drinking water. The good news is that radon concentrations in a home can be measured inexpensively and effectively mitigated at a moderate cost, both in new home construction and in retrofitting existing buildings.

The bad news is that Canada has the weakest radon guideline in the industrialized world — two to four times weaker than European and Australian guidelines, five times weaker than the American guideline, and more than three times weaker than the intervention level recommended by the World Health Organization. The Canadian government admits that the current guideline means accepting the exposure of Canadians in their homes to the same annual amount of radiation as a uranium miner. To put these numbers in context, the number of radon-induced lung cancer deaths in Canada annually is greater than the combined total of deaths due to homicides, SARS, West Nile virus, accidental poisonings, drowning, and fire.

Health Canada is currently accepting public comments on a proposal to improve the Canadian guideline for radon. The David Suzuki Foundation applauds this initiative, but is gravely concerned that the proposed radon guideline is inadequate to protect the health of Canadians. Health Canada is proposing that the Canadian guideline for radon concentrations in homes and public buildings be lowered from 800 Becquerels per cubic metre (Bq/m³) to 200 Bq/m³.

Unfortunately, the governments' rationale for setting a new guideline of 200 Bq/m³ is flawed. Two comprehensive, peer-reviewed radon studies, from North America and Europe, provide compelling evidence that there is a significant increase in the risk of lung cancer at radon levels as low as 100 Bq/m³. The proposed guideline of 200 Bq/m³ is weaker than the existing guideline in the U.S. of 150 Bq/m³. The most disturbing aspect of the proposed radon guideline is that it would condemn thousands of Canadians to dying unnecessary and preventable deaths from lung cancer in the years ahead.

The David Suzuki Foundation believes that Canadians should enjoy a level of protection from environmental threats that is equal to or better than the highest standard enjoyed by

the citizens of other industrialized nations. Neither the current Canadian radon guideline nor the proposed Canadian guideline meets this test. Therefore we recommend that Health Canada strengthen the proposed guideline to provide the greatest practical level of protection for the health of Canadians. Based on the best available science, the David Suzuki Foundation recommends that the Canadian radon guideline should be set at a level of 100 Bq/m³. In order to effectively address the threat that radon poses to public health, a number of other government actions are required in addition to strengthening the proposed guideline.

The David Suzuki Foundation's five recommendations for reducing the terrible toll of radon on Canadians are as follows:

Recommendation #1

Health Canada should replace the proposed guideline of 200 Bq/m³ with a guideline of 100 Bq/m³. This recommendation reflects the best available scientific knowledge and seeks to provide Canadians with the strongest practical level of protection for their health.

Recommendation #2

Health Canada, together with territorial and provincial governments, should ensure that radon testing, and if necessary the implementation of radon protection measures, is undertaken in all schools, hospitals, long-term care facilities, and other public buildings.

Recommendation #3

Health Canada, together with territorial and provincial governments, should ensure that radon protection measures are incorporated into all building codes in Canada.

Recommendation #4

Health Canada, together with territorial and provincial governments, should develop and implement a subsidized radon testing and mitigation program for low-income Canadians.

Recommendation #5

Health Canada should conclude its national radon mapping project as quickly as possible and, together with territorial and provincial governments, plan a public education and outreach campaign for regions with high radon concentrations.

Introduction

Radon is a ubiquitous, naturally occurring radioactive gas without odour, colour or taste. It comes from the decay of uranium, which is distributed throughout soil and rocks in Canada and across the world in varying concentrations. Radon concentrations are generally low outdoors but can build up indoors, particularly in homes. For years, radon has quietly caused the deaths of tens of thousands of people due to lung cancer annually in western industrialized nations. The death toll in developing countries is unknown.

Finally radon is beginning to receive the attention it deserves. In 2005, the World Health Organization launched its International Radon project to generate awareness around the world.¹ Also in 2005, the U.S. Surgeon General issued a strongly worded national health advisory on radon, urging Americans to test their homes for radon and take remedial action if required.² Finally, 2005 saw the publication of two comprehensive, peer-reviewed international studies on radon that provided new insights into the magnitude of the problem.³

In Canada, radon has rarely appeared on the radar screen of governments, environmental groups, or the public. Yet radon is among the most serious indoor air pollution problems in Canada, causing thousands of deaths annually. The current Canadian guideline for radon concentrations in a home is badly outdated. In fact, Canada has the weakest guideline in the industrialized world—two to four times weaker than European and Australian guidelines, five times weaker than the American guideline, and more than three times weaker than the intervention level recommended by the World Health Organization. The Canadian government admits that the current guideline means accepting the exposure of Canadians in their homes to the same annual amount of radiation as a uranium miner.⁴

There are signs that Canada's nonchalant attitude toward radon is beginning to change. The media is beginning to exhibit interest in the problem.⁵ Health Canada is currently accepting public comments on a proposal to improve the Canadian guideline for radon.⁶ The David Suzuki Foundation applauds this initiative, but is gravely concerned that the proposed updated radon guideline is inadequate to protect the health of Canadians.

The Health Effects of Radon

It has now been established, beyond any reasonable doubt, that residential exposure to radon substantially increases the risk of lung cancer. The International Agency for Research on Cancer classifies radon as a known human carcinogen.⁷ The World Health Organization states that “no safe level of exposure can be determined,” a position confirmed by the U.S. National Academies of Science.⁸ When inhaled into the lungs, radon causes cellular DNA damage. The carcinogenic properties of radon have been confirmed by cellular mutagenesis studies, research experiments with animals, and epidemiological studies of underground miners exposed to high concentrations of radon.⁹

Exposure to radon is the dominant source of an individual's exposure to ionizing radiation in most countries, including Canada.¹⁰

Two major international studies, published in 2005, provide compelling evidence of the magnitude of the health problems caused by radon.¹¹ A North American study, led by a Canadian researcher, assessed the evidence from seven case-control studies involving a total of more than 8,500 individuals. The North American study concluded that every 100 Becquerels per cubic metre (Bq/m³) increase in radon increases the risk of lung cancer by 11 per cent.¹² The study also concluded that radon concentrations as low as 100 Bq/m³ cause a significant increase in the risk of lung cancer.

A European study involved nine countries, more than 7,000 individuals with lung cancer, and a control group of more than 14,000 individuals. The European study concluded that every 100 Becquerels per cubic metre (Bq/m³) increase in radon increases the risk of lung cancer by 16 per cent, and that there is clearly an increased risk of lung cancer at radon concentrations below 200 Bq/m³.

Both of these studies agree that radon is the second most significant cause of lung cancer after smoking tobacco, and accounts for approximately 9 to 15 per cent of lung cancer deaths. Furthermore, both studies confirm that the dose-response relationship between radon exposure and lung cancer is linear, and there is no safe threshold for radon exposure. In other words, any level of radon exposure results in some degree of increased risk of lung cancer.¹³

The preceding conclusions are consistent with the findings of a major study on the health effects of radon by the U.S. National Research Council, and an assessment of the evidence of radon's health effects by the World Health Organization.¹⁴ According to leading British experts on radon and cancer, "around 90 per cent of radon-induced deaths in the United Kingdom probably occur as a result of exposures to radon concentrations below the currently recommended action level of 200 Bq/m³."¹⁵

Based on the scientific estimates that radon causes 9 to 15 per cent of lung cancer deaths, exposure to radon will result in between 1,700 and 2,900 deaths in Canada in 2006.¹⁶ Even the lower end of the range of estimates means that the number of radon-induced lung cancer deaths in Canada annually is greater than the combined total of deaths due to homicides, SARS, West Nile virus, accidental poisonings, drowning, and fire.¹⁷

In the U.S., radon exposure is responsible for about 21,000 lung cancer deaths every year.¹⁸ About 2,900 of these deaths occur among people who have never smoked, meaning radon is the number one cause of lung cancer among non-smokers. It is well established that there are synergistic effects between radon exposure and smoking, so that the risks of lung cancer due to radon exposure increase at a much higher rate for smokers and ex-smokers than for non-smokers.

Remedial action to reduce the health risks posed by radon

Radon seeps into homes through cracks and other weaknesses in foundations and floors. To a much lesser extent, radon can enter homes through drinking water.* The good news is that radon concentrations in a home can be measured inexpensively and effectively mitigated at a moderate cost, both in new home construction and in retrofitting existing buildings.¹⁹

Radon can be detected with a simple test and fixed through well-established sealing and ventilation techniques. The test costs less than \$50 if conducted by a radon protection company, or do-it-yourself testing kits can be ordered for \$10 to 20 US.²⁰ Radon levels in indoor air can be lowered in a number of ways. According to experts, the main methods of reducing radon concentrations in a building are: sealing floors and walls; improving ventilation in the house and avoiding the transport of radon from the basement into occupied rooms; increasing ventilation below the building; installing a radon sump system in the basement; and installing a positive pressurization system. High levels of radon in drinking water can be reduced by aeration (either by spraying or open air storage).

Radon safety should also be considered when new buildings are built, particularly in areas with high radon concentrations. In Europe and the United States, the inclusion of radon mitigation measures in new buildings has become routine for some builders. In some European countries radon protective construction is mandatory, as requirements are incorporated into building codes. Moreover, some radon mitigation measures are also effective in preventing seepage of other volatile compounds into buildings (e.g. at old contaminated sites.)

Based on experiences in British Columbia in renovating a limited number of homes and schools, Health Canada estimates that it will cost roughly \$1,000 to complete the renovations required to reduce the risk from radon in an average home, and approximately \$18,000 per school.²¹ Because the number of affected buildings is not currently known, it is difficult to make a reliable estimate of total radon remediation costs for Canada.

Radon Guidelines: An International Comparison

All industrialized nations have some kind of guideline for addressing the health threat posed by radon. The following international assessment compares guidelines in Canada, the United States, Europe, and Australia.

* This happens when water is obtained from aquifers in close proximity to rock containing natural uranium. However, the greatest cancer risk resulting from radon in the household water supply is due to inhaling air borne radon released from the water rather than from drinking the water. The increased level of indoor radon from water is generally small compared with the level of indoor radon that originated in the soil.

Canada

In 1988, Health Canada, the provinces, and the territories developed a radon guideline for Canada. The guideline recommended that remedial action be taken when the level of radon in the air in a home exceeds an annual average concentration of 800 Becquerels per cubic metre (Bq/m³). The guideline has not been updated since 1988. Even at that time, in 1988, the new Canadian guideline was much weaker than the guidelines in other nations, generally set at 200-400 Bq/m³.

The current Canadian guideline for residential radon levels is two to four times weaker than European and Australian guidelines, more than five times weaker than the American guideline, and more than three times weaker than the World Health Organization recommendation.

Canada has no drinking water guideline for radon. Although other jurisdictions, including the U.S., Australia, and Europe, recognize that radon in drinking water contributes to the health threat posed by radon generally, Canada's Federal-Provincial-Territorial Committee on Water claims that no numerical parameter is necessary for radon in drinking water because "currently available data indicate that it poses no health risk."²²

United States

The U.S. Environmental Protection Agency (EPA) recommends that interventions to address radon be instigated when the level of radon measured inside a building exceeds 150 Bq/m³. As mentioned earlier, this guideline is more than five times as stringent as the current Canadian guideline of 800 Bq/m³. Although this is not a legal standard, the EPA has extensive programs to assist homeowners facing radon problems.²³

Radon has a much higher profile in the United States compared to Canada, due largely to a variety of government policies and programs. The EPA has a national public information campaign, a comprehensive map of areas where radon is most likely to be found in high concentrations, and offers a useful citizen's guide about radon. January is National Radon Action Month in the U.S., and the EPA runs public service announcements on television, warning of the health risk posed by radon and explaining that solutions are readily available. The EPA recommends that all Americans test their residences for radon.

The EPA estimates that one in fifteen homes in the U.S. has radon concentrations above the recommended action level. The U.S. Surgeon General has repeatedly issued health advisories warning Americans about the health risk from exposure to radon in indoor air, and urging Americans to test their homes to find out how much radon they might be breathing. The Surgeon General also emphasizes the need to remedy the problem as soon as possible when the radon level is 150 Bq/m³ or more. The U.S. National Safety Council

sells discount radon-testing kits that can be used by homeowners to determine if they have a radon problem.

The U.S. EPA is proposing a drinking water standard of 150 Bq/L.

Europe

The recommended level for remedial action in the European Union is annual average radon concentrations greater than 200 Bq/m³ in the construction of new buildings, and radon concentrations greater than 400 Bq/m³ in older buildings.²⁴ The recommended action levels in Europe are somewhat dated because they are based on a 1987 report by the International Commission on Radiological Protection.

According to a more recent report from the World Health Organization (WHO), the recommended level for remedial action in all European buildings should be an annual average radon concentration greater than 250 Bq/m³. The WHO acknowledges that even this level of protection will still result in some excess deaths from cancer.²⁵

A number of European nations have established national guidelines for radon, ranging from 200 Bq/m³ for both existing homes and new construction (e.g. United Kingdom, Sweden, Norway, Spain) to 400 Bq/m³ for existing homes and 200 Bq/m³ for new construction (e.g. Finland, Germany, Greece, Italy).

In Europe, the recommended action level for radon in drinking water is 1000 Bq/L.

Australia

In Australia, the recommended intervention level is 200 Bq/m³, the same as what Canada is proposing for a new guideline.²⁶

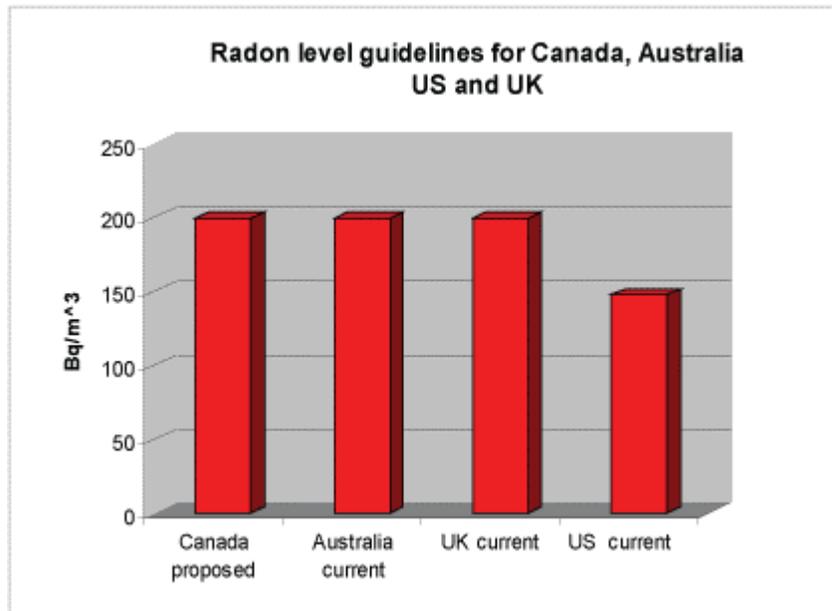
The Australian Drinking Water Guidelines state that “based on a consideration of the potential health impact from radon released from tap water to the air inside a dwelling, the concentration of radon-222 in drinking water should not exceed 100 Bq/L.”²⁷

Comparative Analysis

Canada currently has the weakest radon guideline of any industrialized nation. Although Switzerland sets a higher intervention level than Canada (1,000 Bq/m³), it is a legally binding standard and therefore quantitatively different than the voluntary Canadian guideline. Canada’s action level for radon is five times weaker than the U.S. action level, two to four times weaker than the European action level, four times weaker than the Australian action level, and more than three times weaker than the World Health Organization’s recommendation.

The Proposed Canadian Guideline

In 2004, Health Canada published a discussion paper recommending that the Canadian guideline for radon concentrations in homes and public buildings be lowered from 800 Bq/m³ to 200 Bq/m³.²⁸ A federal-provincial-territorial working group was appointed to study the recommendation, and eventually endorsed Health Canada's proposal. Health Canada is currently seeking public comment on the proposal to lower the Canadian guideline to 200 Bq/m³.²⁹ Comments must be received by June 22, 2006.



Unfortunately, the governments' rationale for setting a new guideline of 200 Bq/m³ is flawed and fails to adequately protect Canadians.³⁰ To begin with, the first point of the rationale refers to "recent scientific evidence of a health-based risk associated with radon exposure at 200 Bq/m³." This statement is incorrect, and is contradicted in the following paragraph of the rationale, which states that the recent North American and European studies "indicate a measurable risk of lung cancer at radon levels as low as 100 Bq/m³." The latter statement is correct. The North American and European studies provide compelling scientific support for setting the new Canadian radon guideline at 100 Bq/m³.

It is vital to understand that Health Canada formulated the proposed guideline in 2004, prior to the publication of either the North American or the European studies that concluded there is a significant risk to health at radon concentrations of 100 Bq/m³. Further support for establishing an action level for radon concentrations of 100 Bq/m³ is provided by British experts who estimate that 90 per cent of the lung cancer deaths in the United Kingdom are caused by exposure to radon at concentrations below 200 Bq/m³.³¹ Thus, the Canadian guideline should be updated to acknowledge the advance in scientific understanding and risk assessment.

The second flaw of the rationale for the proposed Canadian guideline is a reference to the need for international harmonization. This is important since Canada's current radon guideline has been embarrassingly out of line internationally. Inexplicably, the rationale fails to mention that the U.S., Canada's neighbour and largest trading partner, has a stronger guideline than Canada is proposing. The American guideline for radon is 150 Bq/m³.

The international comparison of radon guidelines demonstrates that Health Canada's proposal would merely change the Canadian guideline to a level that has been in effect in other nations for decades—at a time when new scientific evidence clearly suggests that the existing guidelines elsewhere must be strengthened.

It is also important to understand that what Health Canada is proposing is a voluntary guideline, not a legally enforceable regulation. At a minimum, Canadians deserve a guideline that fully informs them of the magnitude of the risk they are facing, rather than a guideline that cultivates a false sense of security in residents whose radon concentrations may be below 200 Bq/m³ but still pose a significantly increased risk of lung cancer. It would be preferable to set the guideline at 100 Bq/m³, not only to accurately reflect the risk, but also to enable citizens to make informed choices about the risk trade-offs they are facing.

Conclusion and Recommendations

It is the position of the David Suzuki Foundation that Canadians should enjoy a level of protection from environmental threats that is equal to or better than the highest standard enjoyed by the citizens of other industrialized nations. Neither the current Canadian guideline, nor the proposed Canadian guideline meets this test.

Radon poses a significant health risk from lung cancer in Canada and represents a major public health burden, both in human and economic terms. The level of preventable deaths is particularly unconscionable in light of the fact that there are simple, relatively low-cost solutions to the radon problem. The current Canadian guideline is out of date and puts the health of Canadians at unnecessary risk.

Sadly, the same criticisms can be directed at the proposed Canadian guideline, providing a compelling case for strengthening the guideline. The first problem is that a guideline of 200 Bq/m³ is out of date. This is the level of the radon guidelines established by many countries twenty years ago. The recent North American and European radon studies published in 2005 make it clear that there is a significant increase in the risk of lung cancer from exposure to radon at concentrations of 100 Bq/m³. The risk of cancer due to radon exposure under the proposed guideline would continue to be far higher than the level of acceptable risk for other chemical and radiological hazards in Canadian society. For example, the Guidelines for Canadian Drinking Water Quality for naturally occurring contaminants such as arsenic are based on much lower levels of acceptable risk.

The second reason for the inadequacy of the proposed Canadian guideline is that it is substantially weaker than the existing American guideline. If the current proposal to lower Canada's radon guideline is approved, the new guideline (200 Bq/m³) will be significantly higher than the U.S. guideline (150 Bq/m³). In an era where international harmonization is recognized as an important Canadian objective, particularly in the North American context, there is no justification for failing to match the American guideline. There is no reason why Canadians should receive an inferior level of protection than Americans.

The third and most important reason why the proposed Canadian guideline for radon is inadequate is that Canadians will still die unnecessary and preventable deaths from lung cancer caused by exposure to radon in their homes. The increased risk of lung cancer associated with the proposed radon guideline would result in the deaths of thousands of Canadians.

In light of these facts, the David Suzuki Foundation concludes that it is unacceptable for Canada to propose a guideline that fails to adequately protect the health of Canadians. We urge the federal, provincial, and territorial governments to implement the following recommendations. The health, and indeed the lives, of many unsuspecting Canadians depend on government action by strengthening the proposed radon guideline.

Recommendation #1

Health Canada should replace the proposed guideline of 200 Bq/m³ with a guideline of 100 Bq/m³. This recommendation reflects the best available scientific knowledge and seeks to provide Canadians with the strongest practical level of protection for their health.

Recommendation #2

Health Canada, together with territorial and provincial governments, should ensure that radon testing, and if necessary the implementation of radon protection measures, is undertaken in all schools, hospitals, long-term care facilities, and other public buildings.

Recommendation #3

Health Canada, together with territorial and provincial governments, should ensure that radon protection measures are incorporated into all building codes in Canada.

Recommendation #4

Health Canada, together with territorial and provincial governments, should develop and implement a subsidized radon testing and mitigation program for low-income Canadians.

Recommendation #5

Health Canada should conclude its national radon mapping project as quickly as possible and, together with territorial and provincial governments, plan a public education and outreach campaign for regions with high radon concentrations.

ENDNOTES

¹ World Health Organization. 2005. International Radon Project http://www.who.int/ionizing_radiation/env/radon/en/index.html

² The Surgeon General's statement is found on the U.S. Environmental Protection Agency's radon website. www.epa.gov/radon

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⁵ M. Gillis. 2006. Radon: the invisible threat," *Ottawa Sun*, May 28, 2006.

⁶ Public Consultation on Radon www.hc-sc.gc.ca

⁷ International Agency for Research on Cancer. 2001. IARC Monographs, Vol. 78, Radon-222 and its decay products. www.iarc.fr

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¹⁰ World Health Organization. 2000. Air Quality Guidelines for Europe, 2nd ed. Copenhagen: WHO Regional Office for Europe.

¹¹ S.C. Darby, D. Hill, A. Auvinen, et al. 2005. "Radon in houses and risk of lung cancer: collaborative analysis of data from 13 European case-control studies." *British Medical Journal* 330: 223-26. D. Krewski, JH Lubin, JM Zielinski, et al. 2005. "Residential radon and risk of lung cancer: a combined analysis of 7 North American case-control studies." *Epidemiology* 16(2): 137-45.

¹² When the data are limited to individuals exposed to radon in their homes for an extended period, the level of increased risk rises to 18% per 100 Bq/m³. D. Krewski, JH Lubin, JM Zielinski, et al. 2005. "Residential radon and risk of lung cancer: a combined analysis of 7 North American case-control studies." *Epidemiology* 16(2): 137-45.

¹³ S.C. Darby, D. Hill, A. Auvinen, et al. 2005. "Radon in houses and risk of lung cancer: collaborative analysis of data from 13 European case-control studies." *British Medical Journal* 330: 223-26.

¹⁴ National Research Council, Board of Biological Effects of Ionizing Radiation of the National Academy of Sciences. 1999. BEIR VI Report: The Health Effects of Exposure to Indoor Radon. Washington, D.C.: National Academy Press. World Health Organization. 2000. Air Quality Guidelines for Europe, 2nd ed. Copenhagen: WHO Regional Office for Europe.

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- ¹⁵ S. Darby, D. Hill, and R. Doll. 2002. Radon: A likely carcinogen at all exposures. Oxford University. www.dnva.no/geomed/groenn-serie/2002/11-darby.pdf
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- ¹⁷ Report of the Radon Working Group on a New Radon Guideline for Canada. 2006. Submitted to the Federal-Provincial-Territorial Radiation Protection Committee. www.hc-sc.gc.ca
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- ¹⁹ J.M. Samet, J. Spengler, and C. Mitchell. 1998. "Indoor Air Pollution," in William N. Rom, ed. Environmental and Occupational Medicine. Philadelphia: Lippincott-Raven Publishers, p. 1533.
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