#4509

THE GUIDELINE FOR RADON IN CANADA - AN EXTENDED INTERPRETATION

Roger S. Eaton
Environmental Radiation Hazards Division
Bureau of Radiation and Medical Devices
Department of National Health and Welfare
775 Brookfield Road
Ottawa, Ontario, Canada
K1A 1C1

Late in 1988, Deputy Ministers of Health of both the federal and provincial governments approved the following guideline for radon in Canada:

> It is recommended that remedial measures be taken where the level of radon in a home is found to exceed 800 Bq/m^3 as the annual average concentration in the normal living area. Because there is some risk at any level of radon exposure, home owners may wish to reduce levels of radon as low as practicable.

This guideline is the product of two years of negotiation and is a compromise between those who feel that radon is a significant health problem and those that do not. It's therefore unlikely to change in the near future unless there are significant new data. Fortunately, the wording of the guideline is sufficiently flexible that it can be interpreted in such a way that the guideline will remain valid as our understanding of environmental radon increases. This paper is intended to assist with this interpretation.

In the first sentence, the numerical component of this guideline is based on data derived from the exposure of uranium miners to underground atmospheres of high radon concentration. Such data have been extensively studied and have produced a risk factor that is generally accepted as representing the real situation. As this is the only quantitative body of data it is used to estimate risk to occupants of homes. However, there are a number of differences between a house and a mine that indicate that this risk factor cannot be applied to environmental as opposed to occupational exposures to radon. In general, as we do not observe the number of lung cancers that we would intuitively expect, we believe that the risk in homes may be less than that received by miners for the same exposure.

Because of this uncertainty and the lack of data at environmental levels, it was decided to set a limit for housing at which the risk to health is considered to be sufficiently high to warrant remedial action even though the concrete number is derived from the possibly inappropriate uranium miners' data.

Since we are using exposure data as a surrogate of the dose, this upper limit is further qualified by the requirement that the exposure be averaged over a year in a normal living area. This then is the rationale for the first sentence of the guideline.

The second sentence of the guideline acknowledges that there is a risk at any level of radon exposure. This reflects our understanding of the induction of cancer caused by ionizing radiation. As with all radiation injury, the currently accepted explanation is that cell damage is a chance phenomenon , i.e. stochastic, and the risk of damage is related to the level or degree of exposure. This relationship is believed to be linear. This leads to the conclusion that zero risk can only be achieved if there is zero exposure, i.e. the only safe level for radon is zero.

It is this linear-no-threshold relationship that prohibits the setting of the limit of radon exposure below which a homeowner can feel safe in his own house. How then can guidance be offered to a homeowner on what level is acceptable?

The best way to answer this question is to start off by asking what is an acceptable risk if it is not possible to have a zero risk. For this we turn to the experience gained by that part of our department that deals with small amounts of toxic chemicals.

As part of its work on substances that contain trace quantities of toxic materials, the department has found that it is generally acceptable to take the position that such toxic agents should not occur in concentrations that pose a risk of death of more than one in one million over a 70-year lifetime. This is based on a judgement that an individual will accept this additional risk when all of the other risks to life are taken into account.

Using the range of risk factors from the uranium miners' data and assuming the linear-no-threshold hypothesis, the concentration of radon, equivalent to the one-in-a-million risk over 70 years, is calculated to be from 0.12 to 1.5 Bq/m^3. To simplify, let us use 1 Bq/m^3 as the level of radon equivalent to the risk deemed acceptable to the public based on the judgement noted above.

However, it is known that the ambient outdoor level of radon exceeds this low value.. Outdoor levels measured in the USA have a mean value of 7 Bq/m^3 (NCRP 1989).. The ambient levels of radon in outdoor air for Canada have not been measured in a systematic way, but other measurements of radon outdoors in Canada taken to provide baselines for related studies strongly suggest that the mean value outdoors in Canada is the same as the USA.

This value has little practical meaning however. Our Cross Canada Survey has indicated for indoor radon a range of median values in nineteen cities of 5 to 57 Bq/m^3. As the source of radon in these cities is the soil under the houses, it can be postulated that the outdoor ambient levels will reflect the same variation in the inner range of values. A conservative assumption that the outdoor median would not exceed the indoor median, and is probably less, suggests that the range of 5 to 57 Bq/m^3 could be used to estimate risk and its variation for ambient air across Canada. Thus ambient outdoor radon concentrations are five to sixty times higher than the levels estimated to correspond to a risk that the public may be able to accept when using the risk factor derived from the uranium miners' data.

While we do not know the actual risk of fatal cancer from exposure to radon in our homes, pending the determination of this risk, we should be conservative and try to minimize the exposure of the public. Since the outdoor ambient level of radon appears to be the minimum level that can be achieved, we believe that, for the near future, it is reasonable to strive for this level as a goal for radon concentrations in housing.

This level will vary from city to city probably in proportion to the mean levels measured in the Cross Canada Survey. The current limitation to bringing the radon concentration in all housing in Canada toward an ambient level is not a problem of setting an acceptable health level but is one of finding ways of modifying houses to reduce their radon concentrations. The lowest possible level will be determined by the local outdoor ambient level although some account may have to be taken of the contribution from building materials as more information is gained at these levels. For the immediate future, the acceptable level must be a practical one based on the ability of the building industry to modify older buildings or initially construct new buildings to make them more radon resistant than current construction techniques provide. While there has been some experience in reducing the radon concentration in houses, remedial measures and new building techniques need further development and testing before consistently and adequately low levels of radon can be provided for a known price. Whether new techniques can provide radon concentration reduction to the ambient level will depend on presently unavailable experience.

Pending a better understanding of the actual risk and of the cost of mitigation techniques, an individual homeowner must make a decision to mitigate or not as a matter of personal choice. This choice will be influenced by the amount of money available for remedial action and the perception of what is an acceptable level. There is a more difficult situation in a landlord-tenant relationship where the risk is not borne by the person who makes the cost-effectiveness decisions. The landlord is then faced with the problem of deciding what concentration of radon he can afford and this may be in conflict with the risk that will be acceptable to his tenants.

This proposal to use the ambient concentration of radon as the goal for Canadian housing recognizes that there is no safe level of radiation exposure. An examination of what is required to reach this goal must therefore be shifted to the construction industry to see what levels of radon in a house can be provided at a reasonable cost. Hopefully, this paper will initiate this shift and the ability to reach for an outdoor ambient level inside a house will be available on a national basis in the near future.

The actual risk from domestic radon exposure has not been forgotten but must await the results from epidemiological studies that are being carried out in a number of countries. Not the least of these studies is that now under way in Winnipeg under the direction of the Health Protection Branch of the Department of National Health and Welfare.

This is a 750 pair case-control study of lung cancer and domestic exposure to radon which is nearing completion. First results should be available in 1992.

Readers will note that the position described in this paper is essentially the same as the United States Environmental Protection Agency. Indeed there is no difference between our two points of view other than our recommending action when a certain radon concentration is exceeded. The United States Environmental Protection Agency sets limits, the lowest of which is based only on the building industry's capability to affect remedial action. Thus, this lowest limit is not a safe health limit but one dictated by the cost of remediation.