KASLO & DISTRICT PUBLIC LIBRARY

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Radon is a naturally occurring radioactive material (NORM) that is produced from rock deposits containing traces of uranium or thorium which decays over time to produce radium. The radium in the ground decays to produce radon which is released into the atmosphere in extremely small amounts. It is estimated that there are 150 atoms of radon in each ml of air.

Because of its low concentration it is very difficult to detect radon chemically in the atmosphere. Instead it is measured using the radiation given off as it decays. Typically, concentrations are expressed in terms of Becquerels per cubic metre (denoted by Bq/m^3). The Becquerel (denoted by Bq) is defined as the number of radon atoms that decay per second and is in direct proportion to the number of radon atoms present.

Typical domestic concentrations are of the order 10~20 Bq/m^3 outdoors and 100 Bq/m^3 indoors. Canada's original guidelines, introduced in 1988 for acceptable radon levels in a house were 800 Bq/m^3 and were reduced to 200 Bq/m^3 in revised guidelines published in 2007[1]. These are "lower than or equal to those in place in most every other major industrialized country" and are within the range 100 ~ 300 Bq/m^3 recommended by the World Health Organisation.

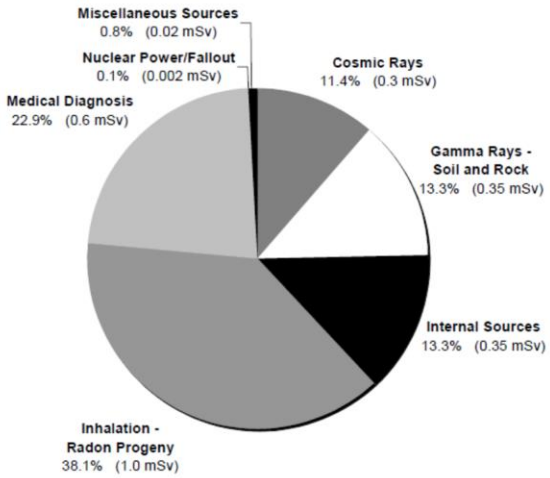
In order to quantify the health risk posed by radiation, the dosage from various forms of radiation is expressed in terms of the Sievert (symbol Sv). Results are typically quoted in the milliSievert (as in millimeter and denoted by the symbol mSv. It is defined such that 1000 x 1.0 mSv =1.0 Sv). Expressing dosages in Sv (or mSv) allows not only for a quantitative comparison of the level of risk from different sources and types of radiation but also the estimation of the combined dosage from several different sources. The formula used by Health Canada to convert radon concentration expressed in Bq/m^3 to dosage mSv is taken from Ref [2] and may be expressed in the following form

$$1\ Bq/m^3 = \frac{0.4 \times 9}{1{,}000{,}000} mSv/h$$

This conversion formula may be understood in the following manner that if I sat in a room with a radon concentration of 1 Bq/m^3 for 1 hour I would receive a dosage of $0.4 \times 9/1{,}000{,}000\, mSv = 3.6 \times 10^{-6}\, mSv$. For longer times and higher concentrations dosage may be calculated simply by scaling the above result accordingly.

Average Annual Radiation Dose to Canadians
(Average Total Dose of 2.62 mSv per year)

Figure 1



Source: Canada; Living with Radiation, AECB, 1995.

To provide some context data showing Canadian estimates of the contribution annual radiation dosage from various sources of naturally occurring radiation material are presented in Figure. 1. Note that the radon inhalation constitutes 38.1% (1.0 mSv) of the total (2.62 mSv). The actual dosage values from various sources of naturally occurring radiation material vary significantly with geographic location, ranging from a value of 1.2 mSv in Vancouver to 3.2 mSv in Winnipeg [1]. The dosage values also vary seasonally and are typically higher in winter than summer.

The report by Interior Radiation Protection Services show radon densities in the library that depend on location and range from a high of 359 Bq/m^3 in the south rear vault to a low of 311 Bq/m^3 in the mechanical room. The Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM) [Ref 1] states that

Where the estimated annual average concentration of radon gas in an occupied area is more

than 200 Bq/m³ but less than 800 Bq/m³, the NORM Classification is NORM Management. Steps to reduce this exposure should be taken and include:

- introduction of public and incidentally exposed worker access controls;
- changes in work practices; and
- reducing the radon concentration levels to below 200 Bq/m³.

The work site should be reviewed periodically to verify that conditions have not changed.

These concentration values are based on dosages calculated from the conversion formula cited above assuming 2000 hours of occupational exposure per year. Applying the above conversion formula to consider the case of 2000 hours in an workplace with a radon concentration of 200 Bq/m^3 I obtain an value of $2000 \times 200 \times 9 \times 0.4/1{,}000{,}000 = 1.44\ mSv$, which rounding to the first decimal gives an annual radiation dose equal to that cited in Table C.5 of Ref. 1.

Based on 2016 data provided by Eva I have calculated the annual dosage that our staff, volunteers and patrons would receive assuming an average radon density of 350 Bq/m^3 based on the conversion formula given by Eq. [1] and used by Health Canada. The numbers are included in the Table below.

	Director	Assistant Director	Volunteers	Users
Hours/Year	1600	1270	100 ~ 200	25~400
Annual dosage	2.0 mSv	1.6 mSv	0.25~0.125	0.03~0.5mSv

To provide some context for these values of annual dosages in the case of volunteers and users it is useful to compare them with the dosages obtained in the following situations Ref. [2]

- Cross Canada flight 0.02 mSv
- Chest x-ray 0.1 mSv
- Screening mammography 3 mSv
- Chest CT scan 7 mSv

Except in the case of the extremely heavy users (greater than 300 hours per year) the dosage values calculated for both volunteers and users are consistent with the guidelines of an appropriate annual dosage of 0.3 mSv suggested by the International Commission on Radiological Protection [3] for members of the public. I therefore do not feel that the radon densities in the library represent a significant health risk to our users and volunteers. In

addition, since receiving the report, the Board has made the decision to inform members of the public of the radon levels in the library and of the implications and guidelines relating to radon exposure in order that they can make their own decision regarding their use of the library.

Of more concern are the calculated annual dosages for the two part-time staff members from occupational exposure which are somewhat higher than the 1.4 mSv that a worker receives from working 2000 hours in a radon concentration of 200 Bq/m^3 and the limit of 1 mSv that is suggested both by the International Commission on Radiological Protection and the International Atomic Energy Agency [3,4] for "Incidentally Exposed Workers"[5].

While the degree of occupational exposure for the two staff members is a cause of concern, the recommendation contained in Neil Smith's letter to Joe that we "suspend any regular occupation of the radon impacted area until a mitigation has been planned and executed" is a drastic response that is neither required nor recommended under the Health Canada Guidelines and is not, I submit, in the best interests of the residents of Kaslo as it would essentially require the library to cease operations until early 2018.

Before the library could relocate to new premises the board would have to be absolutely sure that the radon levels in the new location are below the 200 Bq/m^3 specified by Health Canada. This, in all probability would require testing. In his report Paul Muntak states that Health Canada recommends that tests be of a duration of a minimum of 3 months. In addition, because radon levels are lower in the summer than in winter, the testing would have to be done in the winter. This means that we would not know if the radon levels in the new location within the limits recommended by Health Canada until February or March of 2018.

The steps recommended by Health Canada, and listed above, to reduce workplace exposure provide for a number of options. In addition, the consultant Paul Muntak, who carried out the testing, points out in his report that for public buildings with radon concentrations between 200 and 600 Bq/m^3, Health Canada recommends taking steps to reduce the radon level to acceptable levels within a period of 2 years[6].

The council is aware of the fact that the Library Board has for several months been seriously exploring the option of relocating the library in order to better meet the current and future needs of residents of Kaslo and the surrounding district that it supports. This suggests a more constructive approach would be for the library to remain in its present location while the board continue to actively seek funding for new premises while, with the cooperation of the Village

Council, taking any reasonable steps to reduce workplace exposure in the current premises. Over a period of one year the board will formulate a plan to transition to new premises that could be incorporated into a mitigation plan by the Village within the two-year period suggested by the Health Canada guidelines and as recommended in the report by Paul Muntak.

John Whitehead, PhD
Kaslo & District Public Library Trustee

References:

1. http://www.hc-sc.gc.ca/ewh-semt/radiation/radon/faq_fq-eng.php#radon
2. http://nuclearsafety.gc.ca/eng/resources/radiation/introduction-to-radiation/radiation-doses.cfm
3. *The 2007 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 103, Annals of the ICRP, Vol. 37, No. 2-4, 2007.
4. *International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources*, IAEA Safety Series No. 115, 1996.
5. Incidentally Exposed Workers are defined as employees whose regular duties do not include exposure to NORM sources of radiation. They are considered as members of the public who work in an occupational exposure environment and, as such, the annual effective dose limit for these workers is 1 mSv.
6. http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radon_building-edifices/index-eng.php