ELLiot LAKE TECHNICAL NOTE NO. 7

conversion of average radon concentration
to average working level

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FIGURE 1 - Distribution of Equilibrium Fraction

FIGURE 2 - Variation of Equilibrium Fraction with Season
1. INTRODUCTION

The remedial action level laid down by the AECB is a long term average of 0.02 WL. To establish this accurately using spot sampling techniques requires a large number of measurements over a long period, with samples taken so that all the conditions in the house have an equal probability of measurement. This would include sampling at night, and at week-ends, as well as during the day. A more convenient and practical method is to use some kind of integrating sampler.

Integrating radon samplers are relatively easy to design, and two types are now in use at Elliot Lake. They are the pump and bag sampler (PAB) and the CRNL-designed passive radon monitor (TRIM). These units are being used to estimate the average radon concentrations in houses. The purpose of this note is to document how the average radon concentration will be used to determine if a house requires remedial work.

Questions of statistical confidence in the average concentration will not be dealt with here; it is being assumed that the average is known 'accurately enough'.

2. CONVERSION OF AVERAGE RADON CONCENTRATION TO AVERAGE WL

2.1 Equilibrium Fraction

The equilibrium fraction is defined as 100 x Working Level/Radon Concentration for simultaneous samples, and if known, enables us to convert from radon concentration to working level. As we have over 1,700 simultaneous samples taken over more than a year, we may assume that the distribution of these equilibrium fractions is representative of the general distribution of equilibrium fractions at Elliot Lake.

2.2 Radon Measurements

The cells used for radon measurement have a sensitivity of 0.6 to 0.9 counts/min/pCi/litre, have a background of less than 1 count/min and are counted for 10 minutes. The statistical standard deviation is about 30% at 2 pCi/litre. Equilibrium fractions have been calculated only for radon concentrations greater than 2 pCi/litre. Prior to April 1978 a single sensitivity factor of 0.60 counts/min/pCi/litre was used for all cells. After that date cells were individually calibrated, and assigned one of 3 sensitivities - 0.60, 0.75, 0.90 counts/min/pCi/litre.
2.3 Distribution of Equilibrium Fractions

The cumulative frequency distributions of the equilibrium fraction for both individually calibrated and uncalibrated cells are plotted on log-normal graphpaper in Figure 1. The distribution is almost log-normal for both groups with geometric mean equilibrium fractions of 0.35 for calibrated cells and 0.37 for uncalibrated cells. The effect of measurement uncertainties is shown by a larger geometric standard deviation for the uncalibrated group. The best estimate mean equilibrium fraction for these distributions is 0.4 for calibrated cells and 0.45 for uncalibrated cells.

These readings were taken over a period of 18 months, and so these best estimate means are reasonable estimates of the annual average equilibrium fraction.

2.4 Variation of Equilibrium Fraction with Season

The variation of equilibrium fraction with season was investigated by comparing the cumulative frequency distribution for all equilibrium factors obtained during the summer and heating season for 33 houses where a number of measurements had been made in each season. The distributions are shown plotted in Figure 2. The only significant difference is that there are slightly fewer high equilibrium fractions in the summer than in the winter. This may be an artefact, as calibrated cells were used during the summer, and most winter measurements were made with uncalibrated cells.

The best estimate means for these two distributions are both approximately equal to 0.42. This indicates that there is no major change of equilibrium fraction from summer to heating season.

3. CONCLUSIONS

From the above analysis it is believed that the best estimate mean equilibrium fraction at Elliot Lake does not change significantly from season to season. A constant value of approximately 0.4 can therefore be used to convert average radon concentrations to average WL's.
On this basis, we believe that an average radon concentration of 5 pCi/litre is equivalent to an average daughter concentration of 0.02 WL.

In the absence of other information, houses with an average radon concentration in excess of 5 pCi/litre will be regarded as candidates for remedial action.
**FIGURE 1**

**DISTRIBUTION OF EQUILIBRIUM FRACTION**
FIGURE 2
VARIATION OF EQUILIBRIUM FRACTION WITH SEASON