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Short-Term Radon Measurements in the Workplace

Key Words
Indoor radon
Envelope-type radon monitor
Short-term radon measurements
Spark counter
Annual dose

Abstract
A novel envelope-type radon monitor has been used for short-term (as little as 1 week) radon concentration measurements in a workplace environment. The commercially available LR-115 type II damage track detector was used in this study and the chemically etched sheets were spark counted. The measurements were made over a period of 1 year in a workplace consisting of three adjacent rooms situated in the lower ground level of a multistorey office building in Rome, Italy. The variations of the radon concentration are from ~ 20 to ~ 300 Bq m^{-3} with averages of 130, 81 and 73 Bq m^{-3} for the three different rooms resulting in annual doses of ~ 3.8, ~ 2.4 and ~ 2.2 mSv, respectively.

Introduction

Measurements of indoor radon concentrations have attracted much attention since the early 1980s. Although both the individual and the collective doses of radiation from radon are higher than those from almost any other sources [1], the correlation between the incidence of lung cancer and high background radon concentration has not yet been fully established, nor has any satisfactory relation been found between the occurrence of earthquakes and volcanic eruption and anomalous concentrations of radon [2]. There is a variety of radon detectors and dosemeters for indoor and outdoor radon measurements. Damage track detectors have proved to be very successful for their ability to integrate over long periods of time, ranging from weeks to several months [3]. However, for screening surveys, short-term exposure periods as little as one week are always required [4]. This paper describes the results of weekly radon concentration measurements in a workplace environment, using a sampling device for short-term exposure periods.

Experimental Methods

The radon monitor used in this work was an envelope-type [4] passive dosemeter. Its principle of operation is based on the exposure of bare track detector material in air. The detector registers the alpha particle emission both from the decay of ^{222}Rn and the decay products of ^{214}Po and ^{218}Po. The commercially available LR-115 type II damage track detectors with the area of 9 × 12 cm^2 were used in this radon sampler as shown schematically in figure 1. When the envelope is closed, the strippable LR-115 detector does not register any alpha particle activity and the monitor is in the 'off' state. When the envelope is opened, only half of the LR-115 sheet is exposed, the second half of the detector, being protected by an aluminium foil which stops all alpha particles, is then used for the sheet background estimate. At the end of the exposure period, the LR-115 sheets were

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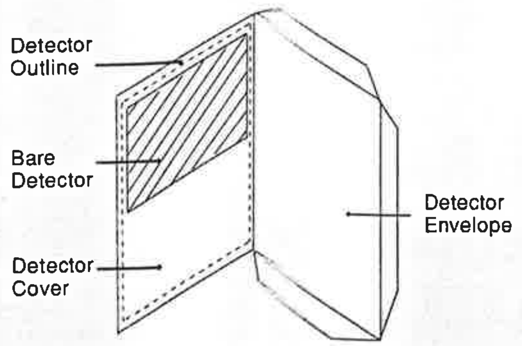

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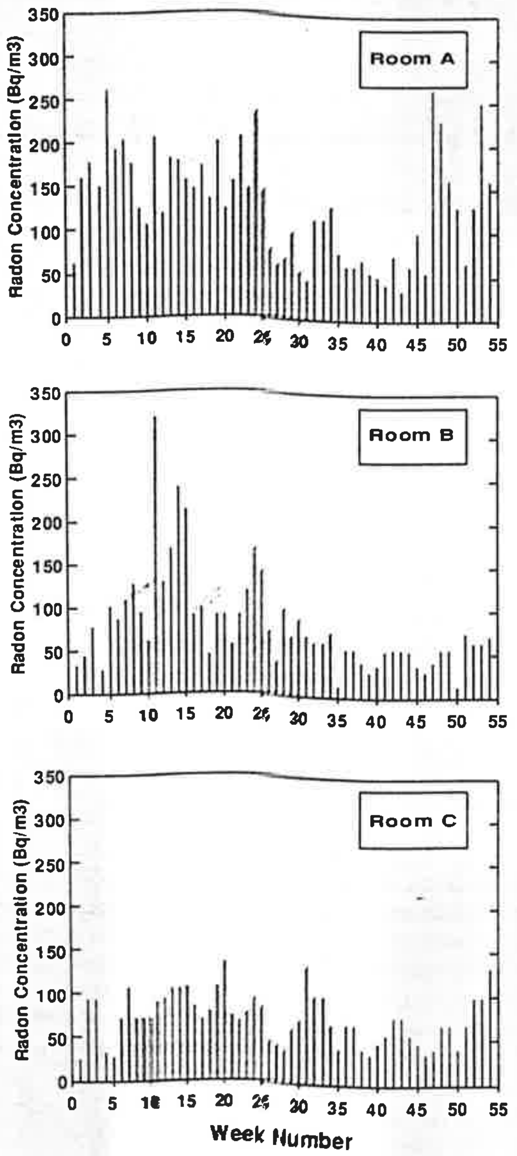

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chemically etched in 2.5 N NaOH solution at 60 °C for 110 min and then spark counted [5]. The radon concentrations were calculated using the sensitivity coefficient of $\varepsilon = 2.03 \pm 0.07$ tracks cm^{-2} per kBq h m^{-3} determined separately, following a calibration exposure in a radon chamber [4].

Results

The weekly radon concentrations in the lower ground level of a multistorey office building in the south of Rome, Italy, were measured using the envelope-type radon monitor. (The data were collected when the author was affiliated with the Direzione Centrale Sicurezza Nucleare e Protezione Sanitaria (ENEA-Disp), Rome, Italy). The workplace consisted of three adjacent rooms served by forced ventilation system throughout the year. The ventilation was effected by a closed-loop air circulation system with virtually no air exchange with the outside of the building, which provided either heating or cooling of the premises according to the season.

The volumes of the rooms B and C are almost the same and about half of that of room A. The measurements were made over a period of one year with no interruption. The variations of the weekly radon concentrations for the three different rooms are shown in figure 2. The indoor radon concentration varied from ~20 Bq m^{-3} to ~300 Bq m^{-3}. The average radon concentrations were 130, 81 and 73 Bq m^{-3} for the three rooms of A, B and C, respectively. The standard error of any single measurement did not exceed ~ ± 10%, with the mean of all the values being ~ ± 4%.

Discussion

The sensitivity of LR-115 has little dependence on the equilibrium factor [6]; for example, when the equilibrium factor varies by one order of magnitude, there is a change of only ~22% in its sensitivity. It follows from this that within the experimental error, the sensitivity of the envelope-type radon monitors would be the same for radon and its daughter products. The envelope-type radon monitor is, therefore, a passive radon gas detector. The measured radon gas concentrations can be used to estimate

Fig. 1. Envelope-type radon sampler for short-term radon measurements.

Fig. 2. Variation of weekly radon concentration in the workplace environment. Week 1 relates to the first week of January 1988.

the annual dose by employing the concentration-to-dose conversion factor of 29.5 μSv y^{-1} per Bq m^{-3} for non-occupational radon exposure [8]. The resulting annual dose of radon in rooms A, B and C are 3.8, 2.4 and 2.2 mSv, respectively. However, it has been shown [8, 9] that the radon daughter equilibrium factor of 0.485 for indoor air used in the above conversion factor may overestimate exposure by some 40%.

Conclusion

The envelope-type radon sampler in conjunction with a spark counter provides a convenient and simple method for short-term (as little as one week) radon measurements.

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