

Radon Levels at a Norm Storage Site

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Abstract. At the Instituto de Pesquisas Energéticas e Nucleares (IPEN), São Paulo, Brazil, there is a facility dealing with great uranium and thorium concentrations, the nuclear materials storage site. In order to estimate afterwards the effective committed dose for the workers due to radon inhalation, it was assessed the radon concentrations through the passive method with SSNTD (Makrofol E) at the place. The radon concentration results, covering the period from December 2004 to September 2006, varied from $648 \pm 42 \text{ Bq/m}^3$ to $1227 \pm 505 \text{ Bq/m}^3$.

1. Introduction

It is well known that NORM (naturally occurring radioactive materials) is hazardous to health and it has long been recognized that work with NORM can rise significantly the exposure in the workforce [1-2].

There are two types of naturally occurring radioactive waste: discrete and diffuse. The first, discrete NORM, has a relatively high radioactivity concentration in a very small volume, such as a radium source used in medical procedures. Estimates of the volumes of discrete NORM waste are imprecise, and the Environmental Protection Agency is conducting studies to provide a more accurate assessment of how much of this waste requires attention. Because of its relatively high concentration of radioactivity, this type of waste poses a direct radiation exposure hazard. The second type, diffuse NORM, has a much lower concentration of radioactivity, but a high volume of waste. This type of waste poses a different type of disposal problem because of its high volume.

The sources of most of the radioactivity are isotopes of uranium (U-238), thorium (Th-232) and their decay progeny, specially radon (Rn-222). Because radon is so short-lived, and alpha-decays to a number of daughter products which are solid and very short-lived, there is a high probability of its decay when breathed in, or when radon daughter products in dust are breathed in. Alpha particles in the lung are hazardous. Inhalation of radon (^{222}Rn) represents the main contribution to the effective dose received by the workers [3-4].

At the Instituto de Pesquisas Energéticas e Nucleares (IPEN), São Paulo, Brazil, there is a facility dealing with great uranium and thorium concentrations, the nuclear materials storage site. In order to estimate afterwards the effective committed dose for the workers due to radon inhalation, it is being assessed the radon concentrations at the place.

Radon measurements have been carried out through the passive method with SSNTD (Makrofol E), due to their simplicity and long-term integrated read-out. The detectors exposure period is three months, covering December/2004 to September/2006.

2. Materials and methods

The ^{222}Rn concentration was obtained by the passive detection method with solid state track detectors into diffusion chambers. Circular pieces (2 cm of diameter) of Makrofol-E were used as detector. As a diffusion chamber, a hemispherical housing of 1.5 cm radius with a

filter membrane was selected. This glass filter membrane allowed approximately 98% of the radon to diffuse and suppressed thoron gas to 0.5%.

After exposure for approximately 3 months, the detectors were collected and replaced by fresh ones. The detectors were etched in PEW₄₀ solution at 70°C for 2 hours in a constant temperature bath. After etching, the detectors were washed, dried and scanned under a Carl Zeiss microscope for track density measurements. The background is 1500 tracks per cm². Using a calibration factor of $0.0234 \pm 0.0045 \text{ tr} \cdot \text{cm}^{-2} \text{ per Bq} \cdot \text{m}^{-3} \cdot \text{d}$, obtained with Pylon model RN-150 calibrated radon gas source, the track density is converted to radon concentration in the environment.

The radon concentration was calculated through the following equation [5]:(Mayya, 1998):

$$C = \frac{D}{k \cdot t} \quad (1)$$

where:

- C is the radon concentration (Bq/m³)
- D is the track density (tr/cm²)
- K is the calibration factor (tr/cm² per Bq/m³ · d)
- t is the exposure time (d).

3. Results and conclusions

The contribution from ²²²Rn inside the nuclear materials storage site was determined through the passive method with solid state nuclear track detectors (Makrofol E) using equation (1). Fifteen points were monitored at place with two detectors in each point. Table 1 shows the results of average radon concentration and standard deviation at the ipen nuclear materials storage site obtained from December/2004 to September/2006.

According to table 1, elevated levels of radon at the ipen nuclear materials storage site were observed, specially at the first monitored period (December/2004 to March/2005). At the period between March/2005 to June/2005 it was obtained the lower value of average radon concentration due to high ventilation rates.

Results obtained shows that the radon concentration at place should be continuously monitored.

Table I. Average ^{222}Rn concentration at nuclear materials storage site

Average air ^{222}Rn concentration ($\text{Bq}\cdot\text{m}^3$)	
Dec/2004 to Mar/2005	1227±505
Mar/2005 to Jun/2005	648±42
Jun/2005 to Sep/2005	993±274
Sep/2005 to Dec/2005	947±77
Dec/2005 to Mar/2006	1020±401
Mar/2006 to Jun/2006	1019±394
Jun/2006 to Sep/2006	1025±271

4. References

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