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INDOOR RADON MEASUREMENTS IN SOME INDIAN CITIES

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ABSTRACT

Potential alpha energy concentration (PAEC) due to radon and its progenies has been measured in dwellings of three different cities in India; namely *Allahabad* (in north central region), *Vishakapatnam* (in south eastern region) and *Shillong* (in north eastern region), The measurements were carried out by a passive, time-integrated method, using LR 115 (Type II) detector in bare mode. The geometric mean of potential alpha energy concentration in dwellings of Allahabad, Vishakapatnam and Shillong has been estimated to be 10.1 mWL, 3.9 mWL and 11.3 mWL, respectively. The results obtained for dwellings in these three cities are discussed in the light of exposure limits set by the International Commission on Radiological Protection (ICRP).

KEYWORDS

AEDE; PAEC level; LR 115; indoor radon; ICRP.

INTRODUCTION

The detrimental effects of radon exposure on the health of general population are well known (Durrani, 1993; Jönsson, 1995) and appreciable correlation has already been established between radon exposure and lung and skin cancers besides kidney diseases (Henshaw *et al.*, 1990; Pershagen *et al.*, 1993). Large scale radon surveys were carried out in advanced countries in Europe, and in the USA, but relatively few surveys were done in Asian countries, including India. Subba Ramu *et al.* (1990) and Kumar *et al.* (1991) have reported indoor radon levels in dwellings in a few towns of India, and recently Srivastava *et al.* (1996) have extended this study to some more towns of north eastern India. In the present work a number of dwellings in three different cities, namely Allahabad (in north central India), Vishakapatnam (in south eastern India) and Shillong (in north eastern India) were selected for measurements on potential alpha energy concentration (PAEC) due to radon and its progeny. The measurements were carried out by passive, time-integrated method, using LR 115 (Type II) detectors in bare mode. The results are discussed in the light of exposure limits set by the International Commission on Radiological Protection (ICRP).

EXPERIMENTAL

The solid state nuclear track detector LR 115 (Type II) which is a cellulose nitrate film available commercially from Kodak Pathe, France, was mounted on cards and placed inside different houses keeping a distance of at least 10 cm from any surface. The bare detectors were exposed to indoor radon and its progeny for a period ranging from 60-90 days. The LR 115 film is thin enough for most of the incident alpha particles in the energy range of 0.1 - 4.0 MeV to penetrate through it, forming observable tracks. After exposure the detectors were dried for one hour in hot air maintained at 50°C and then transferred to a desiccator. Later the tracks were developed by chemical etching in 2.5M NaOH at 60°C for 100-110 minutes.

The measurements of track density were performed using a Leitz optical microscope. The tracks were counted randomly all over the detector to obtain a representative value. The surface area viewed under the graticule of one square centimetre area consisting of 100×100 grids was 8.125×10^5 $(\mu m)^2$ at 150x magnification. The PAEC level in terms of mWL was obtained from the track density of the actual indoor radon detector using a calibration factor as 0.252 ± 0.032 tr cm^{-2} d^{-1} which corresponds to a radon level of 1 mWL. This calibration factor was obtained in a separate experiment using the calibration facility available at the Environmental Assessment Division Laboratory in Bhabha Atomic Research Centre, Bombay. The details of the standard calibration method are described elsewhere (Ramachandran *et al.*, 1990 and Srivastava *et al.*, 1996).

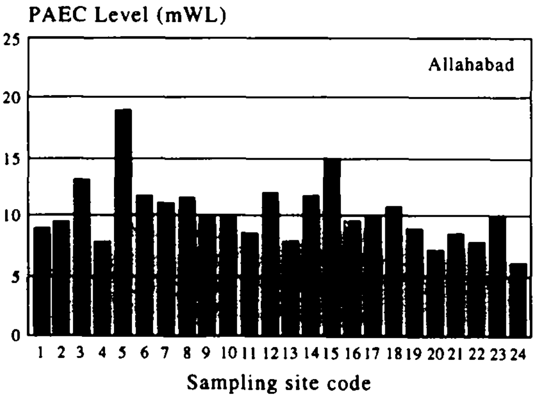

Fig. 1. PAEC levels in different dwellings in Allahabad

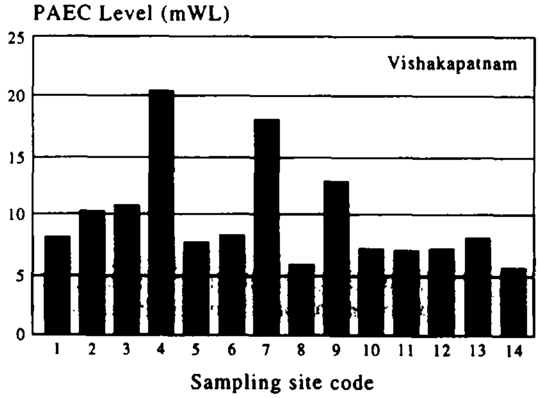

Fig. 2. PAEC levels in different dwellings in Vishakapatnam

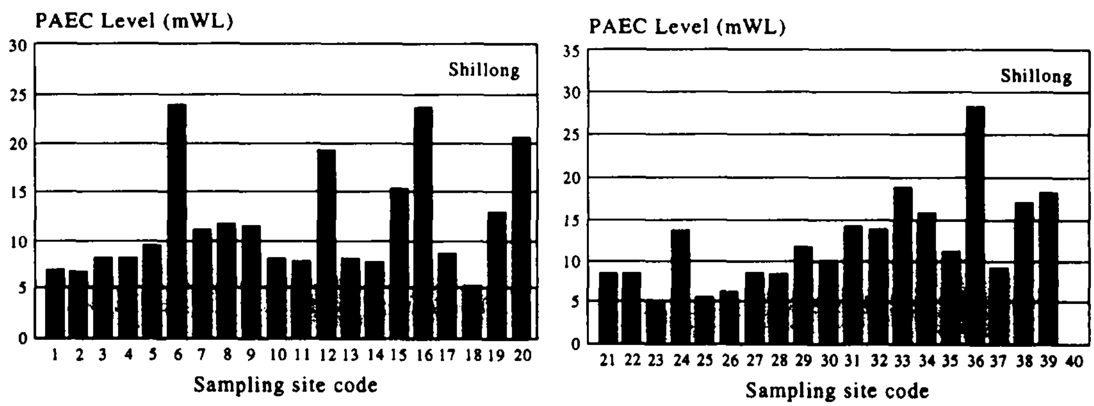

Fig. 3. PAEC levels in different dwellings in Shillong

RESULTS AND DISCUSSION

The potential alpha energy concentration levels due to radon and its progeny in different dwellings in Allahabad, Vishakapatnam and Shilllong are shown in Figs. 1-3, respectively. The minimum and maximum PAEC level obtained for dwellings in Allahabad is 4.5 mWL and 21.6 mWL. In Vishakapatnam it varies from 2.2 mWL to 8.2 mWL and in Shillong from 5.0 mWL to 28.5 mWL. The geometric means of PAEC levels for the cities are : Allahabad 10.1 mWL (GSD=1.3), Vishakapatnam 3.9 mWL (GSD=1.1) and Shillong 11.3 mWL (GSD=1.5).

The ultimate objective of such work is to ascertain the radiation dose received by the inhabitants. Therefore, the PAEC levels obtained in the present work have been converted to annual effective dose equivalent (AEDE) which is expressed in terms of mSv. The mean AEDE values for Allahabad, Vishakapatnam and Shillong have been found to be 1.7 ± 0.2, 1.9 ± 0.3 and 0.6 ± 0.1 mSv, respectively.

The general principles of the system of dose limitations recommended by the International Commission on Radiological Protection (ICRP) apply for protection against exposure to radon and its progeny. The ICRP-65 Report (ICRP, 1993) states that remedial measures against radon in dwellings are always justified above a continued annual effective dose equivalent (AEDE) of 10 mSv, but action levels should be set by regulatory authorities within a range of 3-10 mSv. It is observed in the present work, that, in general the AEDE is well below the remedial level, but there are a few dwellings, where the AEDE is slightly on the higher side; that is, in the range of action level. These dwellings are mostly in Shillong which is a colder place in comparison to other two cities. The dwellings in Shillong, may have poor ventilation due to the habit of inhabitants keeping their doors and windows closed for warmth. It is recommended that the soil around those houses, which have higher radon levels, be analysed for uranium contents to identify the source of radon.

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