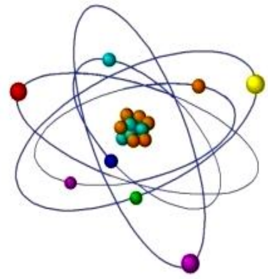
# DETERMINATION OF RADON CONCENTRATIONS IN MTATSMINDA DISTRICTS OF TBILISI



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ABSTRACT**:** *Radon concentrations in the Mtatsminda region of Tbilisi was measured. Radon concentrations in the air inside buildings can vary greatly among different regions and different homes. In addition, they are characterized by a wide range of time variations. Due to the fact that radon eminence occurs from the soil under the house, the highest concentrations of radon in buildings are observed in basements and apartments located on the lower floor. Preliminary results of radon concentrations in residential and public areas in some districts of Tbilisi show that further investigations are needed that will involve larger-scale measurements and more extensive studies of this problem.*

*Ionizing radiation ionizes the environment as it passes through it. In general, ionizing radiation is an integral part of scientific and technical progress. Nuclear and radioactive materials are used for medical, industrial and scientific-research purposes. There are natural (cosmic and terrestrial, building materials, radon, food) and artificial (X-ray machine, pharmacological and industrial radioisotopes) sources, the scope of which is gradually expanding and playing an important role in everyday life. However, radiation has a negative biological effect - it causes cell damage, and in some instances, cancer. it is necessary to protect humans from the harmful effects of ionizing radiation.*

*During Radon decay, non-evaporated radioactive products (Po, Bi and Pb isotopes) are formed, which are quite difficult to remove from the body. Thus, an increase in radon concentration in buildings poses an additional threat to the population and increases the potentially harmful risk to human health.*

**Key words:** radon**,** exposure, radiation, carcinogen.

## INTRODUCTION

By World Health Organization's International Agency for Research on Cancer (IARC) radon was classified as an A-class carcinogen [1]. Radon is responsible for approximately half of the average annual personal effective dose from all-natural sources of ionizing radiation [2]. The risk of lung cancer caused by radon exposure to the human body increases with increasing radon concentration. In particular, at a concentration of 100-200 Bq/m$^3$ in residential apartments and working buildings, the risk of lung cancer increases by 20%, at concentrations of 400-799 Bq/m$^3$ by 40%, and at concentrations above 800 Bq/m$^3$ by ~100%. Also, this risk depends on the duration of exposure to radon and its decay products.

Radon is a naturally occurring gas that is released from mountain rocks and soil. Radon is created from uranium, which is the part of the Earth's crust since its creation. The rate of its release from the soil is highly variable, partially because the uranium content in the soil significantly varies by location. Radon is released from the soil into the open atmosphere. Due to the movement of gases in the soil under the buildings, it reaches the air of the buildings. The air outside buildings usually contains very small amounts of radon concentrations, but inside buildings where it has no way to dissipate, radon can be presented at quite high levels [3].

Although radon is chemically inert and electrically neutral, it is a radioactive substance, which means that its atoms spontaneously decayed and transform into other atoms in the air. The resulting atoms, called decay products, are electrically charged, so they can stick to dust particles in the building's air. By inhalation, these particles may enter the lung and settle on its inner surface. The settled atoms decay and transform into other atoms by emitting alpha particles that damage lung cells.

Radioactive gas radon enters public and residential buildings from the Earth's crust. Its penetration into the buildings occurs from cracks, building materials, water and as a result of gas combustion. In basements and lower floors, its rate is particularly high and decreases towards the upper floors. In a poorly ventilated room, it accumulates and increases the risk of lung cancer. Therefore, buildings should be constantly and well ventilated.

The problem is relevant in Georgia, mostly because the geologic formations of the country are characterized by a high content of uranium, and many buildings are constructed with local materials [4, 5, 6]. Exposure to radon inside the buildings in Georgia requires attention. In some districts of Tbilisi, we carry out measurements of radon concentrations in residential and public areas [7, 8].

**Experimental**

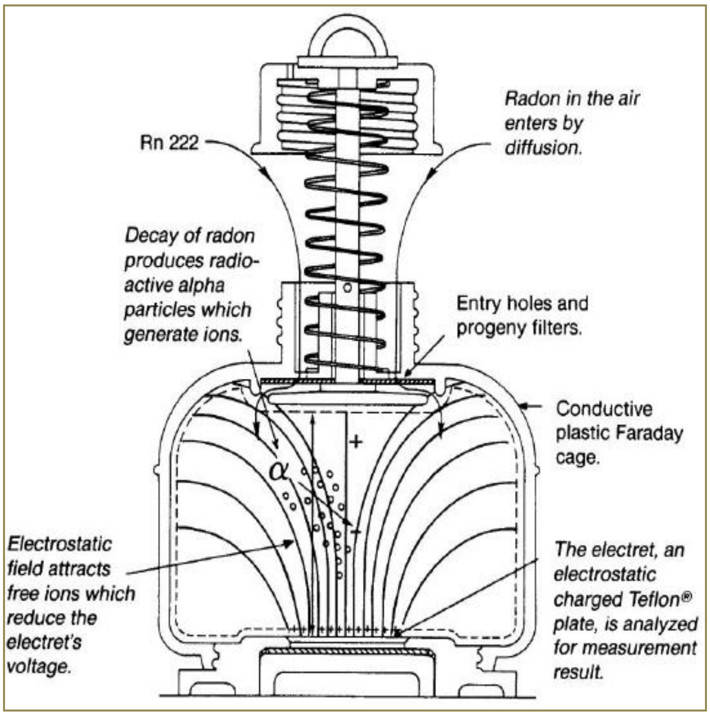


*Fig. 2. E-PERM electret ion chamber.*

Radon measurement and data processing are carried out using the Electret Ionization Chamber, E-PERM. An electret ionization chamber is made of electrically conductive plastic and has a special shape that determines the chamber's preferred use for this or that type of ionizing imaging and for measuring the characteristics of its source. An electret (charged phone disk) is attached to the camera, which is both the source of the electrostatic field and the sensor (sensitive element) necessary for the operation of the camera. Penetrating the chamber or by the influence of ionizing radiation arising in it the ions are formed, which, under the influence of the electrostatic field, meet on the surface of the electret and change (reduce) its charge. Using the charge changes, exposure (irradiation time) and a number of additional parameters, the characteristic values of this or that type (α, β or γ) of ionizing radiation and its source are calculated (e.g., absorption dose, radionuclide concentration, etc.),(fig. 1) [9].

An electrostatically charged disk-shaped detector (electret) is placed inside a small container (ionization chamber). During the measurement period, radon penetrates into a hole covered by a filter via diffusion inside the chamber, where ionization occurs due to the fission of radon and its daughter products reducing the voltage applied to the electret. The calibration coefficient is determined by the relationship between the change in voltage and the radon concentration.

To determine the radon concentration in the environment, we take two values of voltage, namely the value of the electret ($V_i$) voltage before irradiation and ($V_f$) after irradiation. Using the voltage difference ($V_i - V_f$), time of irradiation and experimentally determined calibration factor (CF) for a given electret and ion chamber configuration, we obtain data on radon concentration.

Radon concentration in air is calculated by the formula:

$$C_{Rn,A} = \frac{V_i - V_f}{CF \times T_A} - 0.087 \times R.$$

Where $T_A$-testing time; $R$ - exposure dose strength at the test site and calibration factor (CF) is calculated by the formula:

$$CF = A + B \times \frac{V_i + V_f}{2}$$

A and B are the constants depending on the construction of the E-PERM system.
And the complete measurement error is calculated as follows:

$$\Delta C_{Rn,A} = \sqrt{E_1^2 + E_2^2 + E_3^2}$$

Where the $E_1$ error is related to the parameters of the system components, such as camera volume, electret thickness, etc. Experiments have shown that this error is equal to about 5%.

Error $E_2$ is related to the reading of the voltage of the electret. Both the initial and final voltage reading error is 1 volt. The error of these two different readings will be the square root of the sum of their squares which is 1.4. The relative error is calculated by the formula: $100 \times 1.4/(V_i - V_f)$.

$E_3$ The error is related to the gamma background uncertainty, which is about 10%.

In order to eliminate any short-term effects on average concentration measurements caused by changes in weather conditions, we are taking these measurements over a period of several months. Typically, a three-month test. Short-term tests are also available (7-8 days) where long testing is impractical.

RESULTS AND DISCUSSION

For evaluation of the radon concentrations, the "action level" of 148 Bq / m$^3$ by the World Health Organization (WHO) was used. We carry out measurements in the Mtatsminda districts of Tbilisi. Radon concentration in the air varied within (12 - 712) Bq / m$^3$ in the air of the private apartments, and the residential and public areas (Fig. 1).

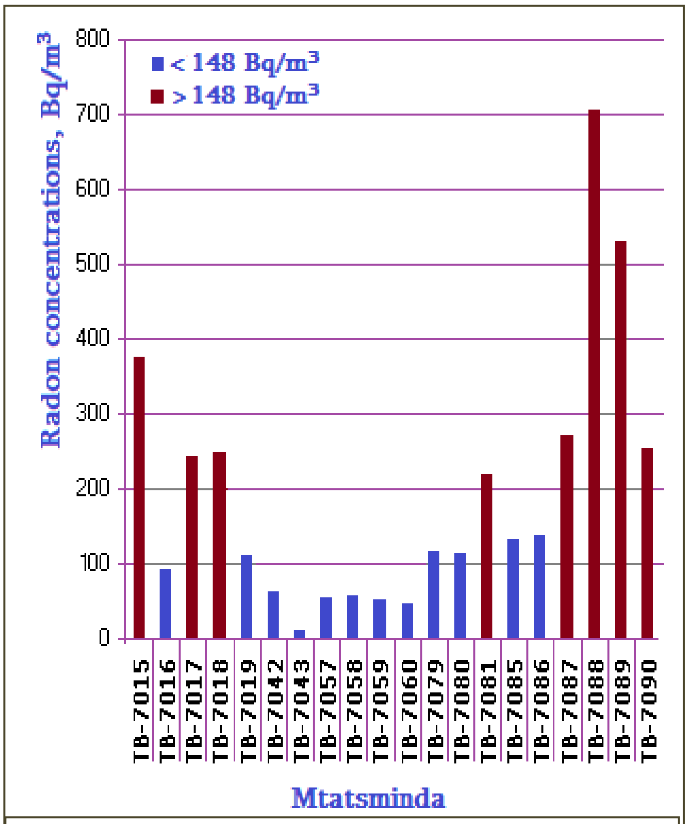


**Fig. 1 Distribution of radon concentrations into the air of the private apartments, residential and public areas in Bq/m$^3$. (148 Bq/m$^3$ is the "action level")**

As we see the results of the research are important and require attention. In particular, a number of measures need for lowing these indicators to the "action level".

In addition to detailed measurements and determination of radon concentrations, it is necessary to carry out rehabilitation works. Rehabilitation measures are different and is depending on specific circumstances. Clearly, elevated radon levels in above-ground areas are caused by radon penetration through cracks and other openings in the floor due to pressure differences. Another way is through the diffusion of the soil in contact with the foundation of the building. Causes may be diffusion from building materials also. Rarely, as a result of radon content in the water. For all these cases, developed rehabilitation measures for residential houses can be used [10].

fig. 2 is presented Radon concentrations in the soil gas in Mtatsminda district of Tbilisi. As we see variation range of radon concentrations is from $1.8 \cdot 10^3 Bq/m^3$ to $12.7 \cdot 10^3 Bq/m^3$.

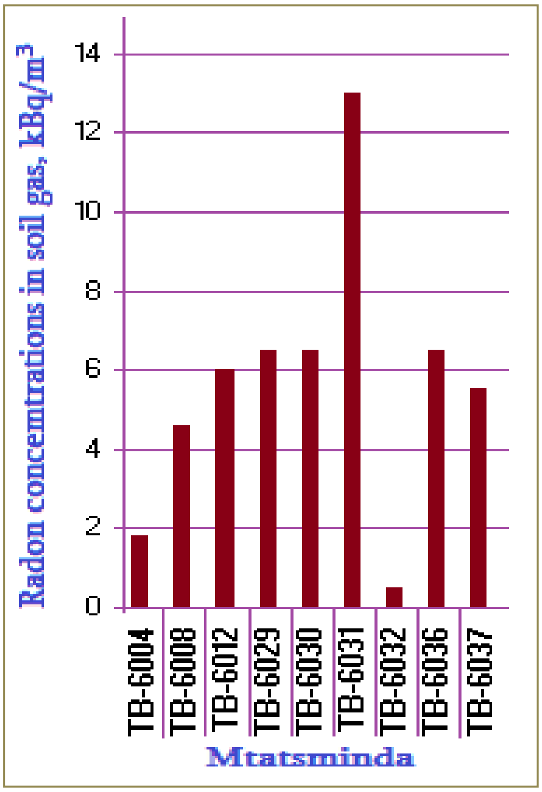


Fig. 2. Radon concentrations in the soil gas in Mtatsminda district of Tbilisi.

CONCLUSION

We measure the radon concentrations in the private apartments, the residential and public areas of the Mtatsminda district of Tbilisi– a total of 20 sites. 40% of them are with high content of radon concentrations. Also, we measure Radon concentrations in the soil gas in the same district. Mtatsminda is arranged at the end of the Trialeti ridge. The tectonic structure of its territory is quite complex. Radon, a by-product of the natural radioactive decay of Uranium, occurs widely in soil and rock. It can escape upwards to the shallow crust by diffusing and dispersing in permeable soils, or by migration upward along preferential pathways, such as cracks and defects.

High-risk areas based on our measurements require detailed investigations.

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