Radon (^{222}Rn) activity concentration indoors and its relation to atmospheric pressure changes in Põlva

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Figure 1. Radon Eye RD200

Abstract. As a result of uranuim decay a radioactive gas called radon is formed. This gas can migrate indoors and concentrate. Radon activity concentration measurements in Põlva (Estonia) showed 3.0 times higher radon activity concentration in cellars that in living space. In some caces the difference was much higher (22.5 times). Furthermore, continuous measurements with Radon Eye RD200 showed big variation in radon activity concentration in one place, where measured minimum and maximum value were different 11.4 times (Figure 4). This variation was caused by atmospheric pressure changes, radon activity concentration and atmospheric pressure correlation was -0.93.

Keywords: Radon (^{222}Rn), indoor, atmospheric pressure, Põlva, Radon Eye

1. INTRODUCTION

In ground and soil can be always found naturally occuring uranuim. As a result of uranuim decay is formed radioactive gas radon.

According to Council Directive 2013/59/Euratom, epidemiological findings from residential studies have demonstrated a statistically significant increase of lung cancer risk from long-term exposure to indoor radon at levels of the order of 100 Bq/m^3. For that reason it is important to evaluate the health risk caused by radon. Radon level indoors can be affected of many things. Our present survey discovered very strong radon activity consentratsions indoor air dependence of atmospheric pressure in some cases.

2. EXPERIMENTAL

Air radon concentration measurements where carried through using pulsed-ionization chamber Radon Eye RD200 (BLE) by Radon FTLab (Korea). To control the results reliability, a comparison measurement was carried on using 3 radon activity consentration measurement devices: AlphaGUARD, Radon Monitor RM3-B 415 (Alnor) and Radon Eye RD200 SN0011. Comparisson measurements showed a bit higher (11%) radon activity concentration level measured by Radon Eye during the measurement than our reference device AlphaGUARD. The correlation between these devices was 0.97 which is very strong correlation.

Measurements in homes were carried through using Radon Eye RD200's with serial numbers SN0011 and SN0024. During the measurements devices were placed at height range 0,5 … 1,5 m, mostly up to 1 m. As a Polish study at kindergardern showed [1], the radon activity concentration at height 50 cm and 100 cm above the floor have almost the same radon activity concentration and thats why results were used directly.

In living space Radon Eye was plugged into 220V power grid and that caused some variation in measurement conditions. Devices were not placed into doorway and not onto window sill [2]. Measurement periood was at least 36 hours. In cellars usually powerbank and USB DC 5V to DC 12V step up cable were used.

3. RESULTS AND DISCUSSION

During these measurements 28 places were measured (Figure 2) with average periood 53 hours (mediaan 46 hour). 13 of all measurements were cellar's radon activity concentration measurements. Two cellars were on ground floor, but inside the hill. 13 measurements were made in living space, 1 in sauna with cellar filled with water and 1 in garage, which is part of house and has lower height than living room in that house.

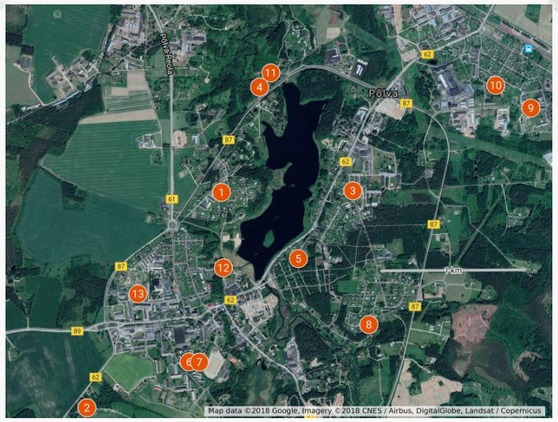

Figure 2. Measurement locations in Põlva. Parallel cellar and living space measurements: 1, 3, 4, 7, 8, 10, 11, 12, 13.

The arithmetic mean radon activity concentration in living space was 74.8 Bq/m^3 (arithmetic standard deviation $s_a = 59.3$ Bq/m^3) with geometric mean 54.6 Bq/m^3 (geometric standard deviation $s_g = 2.3$) and in cellars arithmetic mean was 225.7 Bq/m^3 ($s_a = 175.9$ Bq/m^3) with geometric mean 174.2 Bq/m^3 ($s_g = 2.1$).

There were two types of houses: with cellars (7) and without cellar (4). The arithmetic mean radon activity concentration in living spaces with cellar was 54.0 Bq/m^3 ($s_a = 30.0$ Bq/m^3) with geometric mean 44.7 Bq/m^3 ($s_g = 2.0$) and without cellars arithmetic mean 98.9 Bq/m^3 ($s_a = 77.9$ Bq/m^3) with geometric mean 69.0 Bq/m^3 ($s_g = 2.5$).

In 6 cases Rn-activity concentration had strong dependance on atmospheric pressure (correlation < -0.7) (2 cases in Figure 3 and 4).

These measurements showed that radon activity concentration can vary within broad range and maximum can have more than 5 times higher value (Figure 2) than the measured minimum value. All this shows that shorttime measurements can indicate the radon activity level indoor, but depending on the house, atmospheric pressure and inhabitants in it, the measured value can be many times different from the average value. In addition, radon activity concentration in cellars and in living spaces differ 3.0 times, but in some cases the difference can be over 22 times.

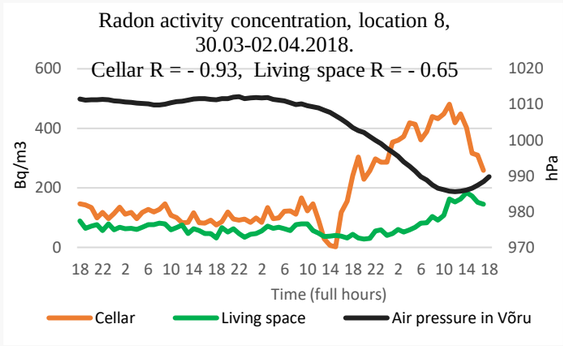

Figure 3. Radon activity concentration in single-family house

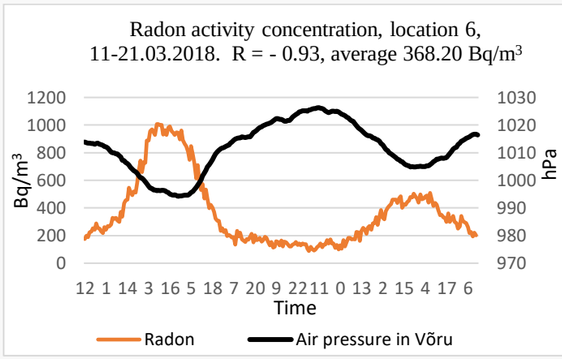

Figure 4. Radon activity concentration in apartment building cellar

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