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Monitoring of Indoor Radon Concentration in Some Elementary and Secondary Schools of Kosovo

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Abstract: Measurements of radon concentration were carried out at indoor air of 30 elementary and secondary schools in Kosovo. The aim of this study was to know the level of indoor radon concentration in these locations and to enhance the national radon survey. The main method for indoor radon measurement was direct sampling in alpha scintillation cells and continuous monitoring during some days. However, in cases with an increased instantaneous and continuous radon concentration the additional method of track-etech detectors were applied. The radon concentration was measured to be from 35 Bq m^{-3} to 814 Bq $m^{-3}$and the annual effective doses was calculated to be from 0,28 mSv $year^{-1}$ to 6,47 mSv $year^{-1}$. In most of the schools the concentration and annual effective doses for students and teachers exceeded the limit of ICRP recommendations but in three of them the concentration and annual effective doses are higher.

Key words: Indoor radon, Schools, Natural radioactivity, Concentrations, Effective doses.

Kosova'da Bazı İlköğretim ve Ortaöğretim Okullarında İç Mekan Radon Konsantrasyonun İzlenmesi

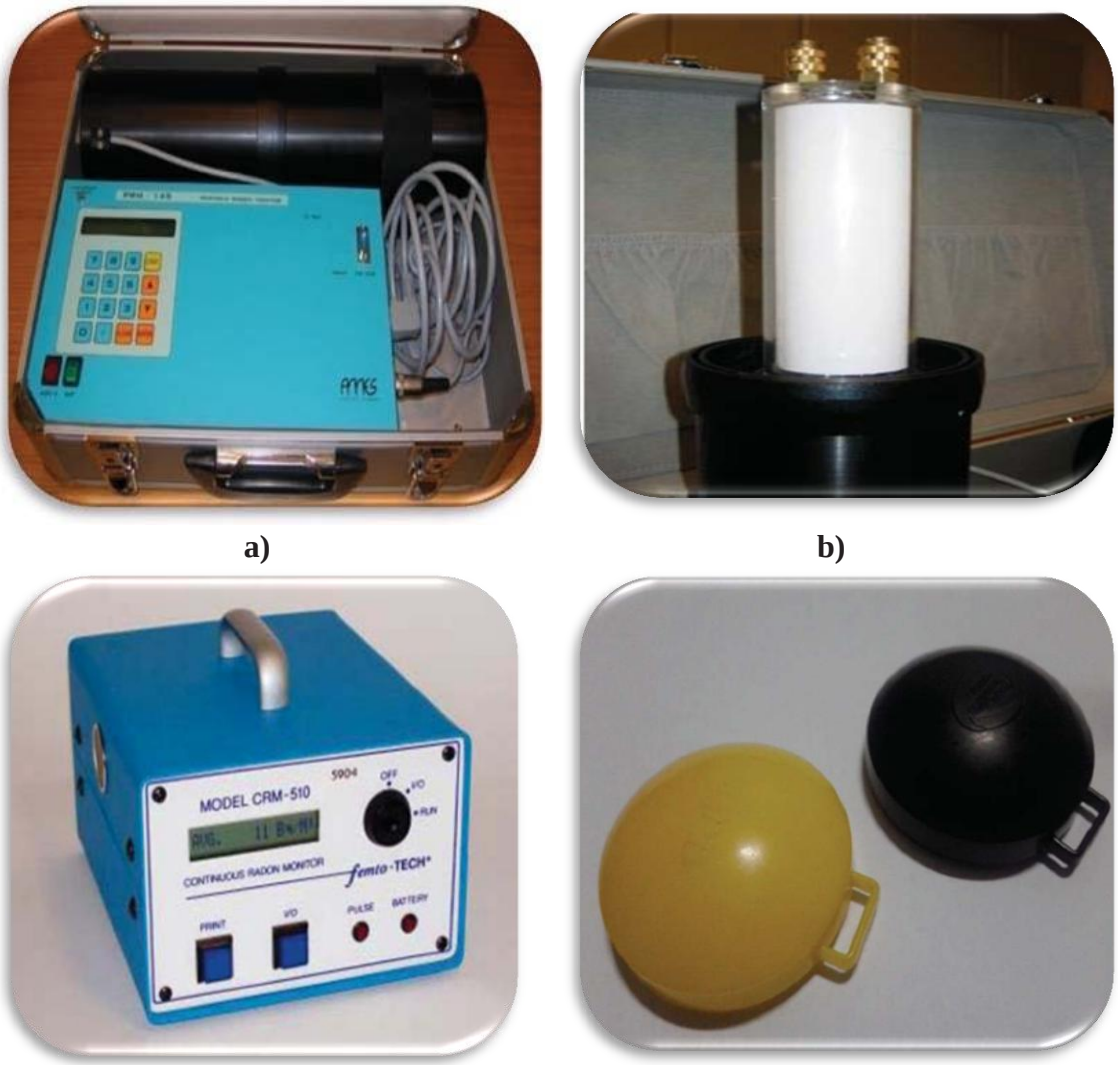
Radon konsantrasyonu ölçümleri, Kosova'da 30 ilköğretim ve ortaöğretim okullunun iç mekanlarında gerçekleştirilmiştir. Bu çalışmanın amacı, bu yerlerde bina içi radon konsantrasyon düzeyi hakkında bilgi edinmek ve ulusal radon anketini zenginleştirmektir. Kapalı radon ölçümü için ana yöntem, alfa parıldama hücrelerinde direkt örnekleme ve bazı günlerde sürekli izleme şeklinde olmuştur. Bununla birlikte artan anlık ve sürekli radon konsantrasyonu olgularında ek yöntem olarak track-etech dedektörleri uygulanmıştır. Radon konsantrasyonu 35-814 Bq/m^3 aralığında ölçülmüştür ve yıllık olarak etkili dozları 0.28-6.47 mSv/yıl aralığında hesaplanmıştır. Okulların çoğunda öğrenciler ve öğretmenler için konsantrasyon ve yıllık etkin doz, ICRP tavsiye sınırını aşmıştır ama bunların üçünde konsantrasyonu ve yıllık etkin doz yüksek bulunmuştur.

Anahtar kelimeler: İç mekan radon, Okullar, Doğal radyoaktivite, Konsantrasyonlar, Etkili dozlar.

Introduction

Radon and its short-lived decay products may contribute as much as one half of the total dose received by persons per year from all sources of natural radioactivity (Nazaroff,. and Nero, 1988). Therefore, radon and its decay products are a significant environmental cause of death. It has been estimated that approximately 5-15% of all current cases of lung cancer are attributable to radon worldwide (UNSCEAR, 2000). Because of this, the problem of indoor radon has attracted a great deal of attention worldwide and many countries have performed nationwide radon measurements. In Slovenia and neighboring countries systematic radon surveys were carried out since from 1990, and at least preliminary information on indoor levels in

kindergartens in Ljubljana (Vaupotič et al., 1992; 1994), Osijek (Vaupotič et al., 1992; Planinić et al., 1993), Belgrade (Planinić et al., 1993) and Sarajevo (Vaupotič et al., 1992) became available. In Kosovo, the first radon measurements were carried out in schools in the Malisheva and Suhareka (Bahtijari et al., 2006), Prizren (Bahtijari et al., 2006) and Sharri municipalities (Bahtijari et al., 2007) found out low radon levels, with only a few concentrations in Prizren exceeding 400 Bq m^{-3}, the level adopted from the International Commission on Radiological Protection (ICRP, 1993) as our national radon limit for old buildings. The aim of this paper is to complement the data of radon survey for schools in Kosovo and also to contribute to the European radon map. The area of study was not investigated before and results will upgrade the situation of indoor radon concentration. The annual effective doses were calculated according to the ICRP 65 methodology.



a) **b)**

c) **d)**

Fig.1. a) PRM 145 device with b) scintillation cells, c) CRM-510 device for continuous monitoring and d) track detectors used for radon measurements.

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Results and discussion

In Table 1 are presented the average concentrations and annual effective doses for monitoring of indoor radon in all measured schools. As we can see from the table 1, 80 % of the values are higher than 100 Bq m^{-3} and about 27 % of them exceed 200 Bq m^{-3} the limit adopted by our country for new buildings from ICRP (ICRP, 1993). In the figure 2.a are presented the values of concentrations although in Figure 2.b are presented the values of annual effective doses. As we can see from figure 2a most of values exceed the limit according to the ICRP and some of them are with high risk for the pupils presented in these areas. In figure 3 are presented the continuous radon monitoring in two schools with high radon concentrations. As we can see from figure 3 the concentration in school two is more continuous than in school one but in both of them the values during three days of monitoring are very similar by starting with lower value and increasing until one maximum value. The reason of lower value in the beginning of measurements was because in that time the doors were opened and after closing the doors the values were increased.

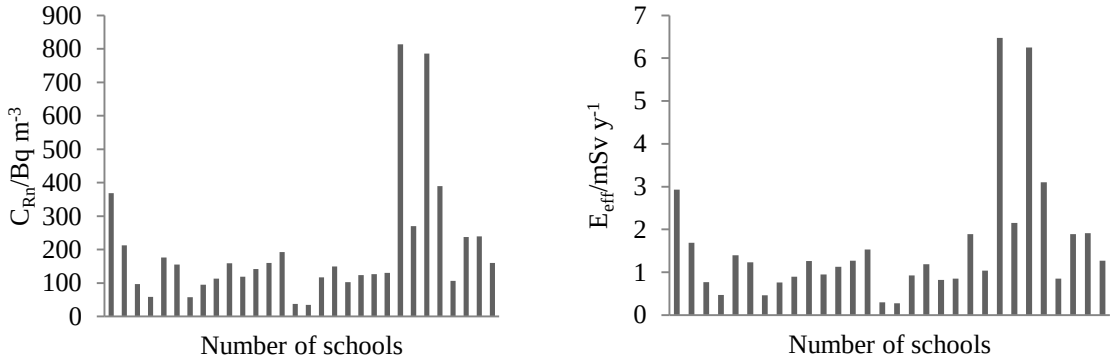

Fig.2. a) Radon concentrations recorded during instantaneous and continuous measurements and b) Annual effective doses.

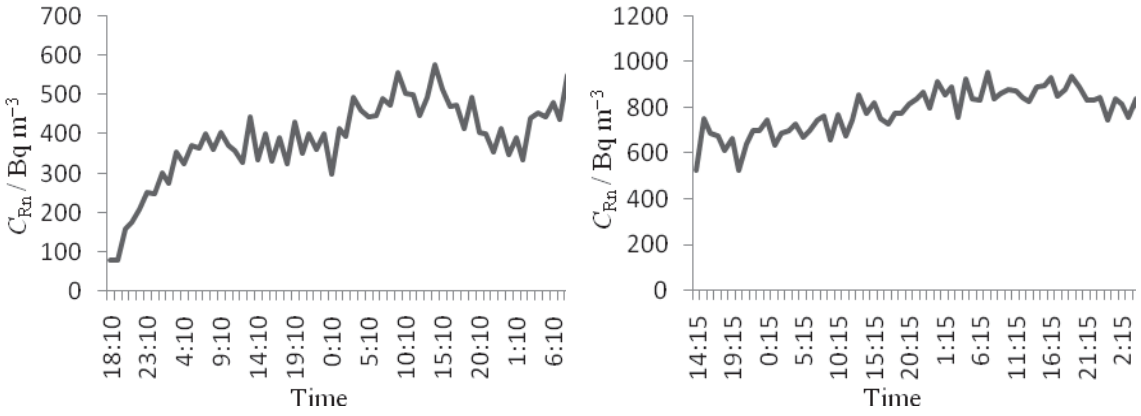

Fig.3. Radon concentrations recorded during continuous measurements in two schools with high radon concentration, measured in a period for three days.

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Conclusion

Radon concentration in the 45 % measured locations exceeds the limit adopted by our country from the International Commission on Radiological Protection.

The measurements were performed in the most locations with two methods and the values were similar with two of them. In the cases with high concentration the measurements were continued also with long-term methods. If the value will be high also with long- term measurements in these locations must do something for reducing the level of radon concentration. The investigation in these locations is continuing still.

Table.1. Results for radon measurements: rooms of measurements, average radon concentrations (Bq m^{-3}) and average annual effective doses (mSv y^{-1})

Nr.	Room	C_{Rn}– average (Bq m^{-3})	$E_{eff.}$ – average (mSv y^{-1})
1	Classroom	369	2,93
2	Classroom	213	1,69
3	Classroom	97	0,77
4	Classroom	59	0,47
5	Classroom	176	1,40
6	Classroom	155	1,23
7	Classroom	58	0,46
8	Classroom	95	0,76
9	Classroom	113	0,90
10	Classroom	159	1,26
11	Classroom	119	0,95
12	Classroom	142	1,13
13	Classroom	160	1,27
14	Classroom	193	1,53
15	Classroom	38	0,30
16	Classroom	35	0,28
17	Classroom	117	0,93
18	Classroom	150	1,19
19	Classroom	103	0,82
20	Classroom	124	0,85
21	Classroom	127	1,89
22	Classroom	131	1,04
23	Library	814	6,47
24	Laboratory	270	2,15
25	Classroom	786	6,25
26	Classroom	390	3,10
27	Classroom	107	0,85
28	Classroom	238	1,89
29	Classroom	240	1,91
30	Classroom	160	1,27

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