



Radon measurements for the assessment of IAQ

Associate Professor PhD. Eng. Tiberiu CATALINA
PhD student Eng. Andrei ISTRATE

Programul Operațional Competitivitate 2014-2020, Axa prioritară POC-A1-A1.1.4-E-2015
Titlul Proiectului: Sisteme inteligente privind siguranța populației prin controlul și reducerea expunerii la radon corelate cu optimizarea eficienței energetice a locuințelor din aglomerații urbane importante din România - SMART-RAD-EN
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Beneficiar: Universitatea „Babeș-Bolyai” din Cluj-Napoca
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CONTENT

Context

VOC and RADON

Experimental campaign

Results

Conclusions

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02/15



Context

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Study reports

- Children spend around 25% of their time in classrooms.



- Schools present a much higher occupancy than any other public buildings.

- There aren't any ventilation system to ensure the quality of the air inside the classrooms. **This problem persists in aprox. 98% of Romanian schools.**



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03/15



Context

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- It is vital to have an indoor climate that will not affect the comfort, health or intellectual performance of the students.

- Published guideline in Europe (Flanders) regarding **indoor air quality in public buildings** recommends for formaldehyde and acetaldehyde the threshold levels of 10 $\mu\text{g}/\text{m}^3$ and 46 $\mu\text{g}/\text{m}^3$. CO2 concentration exceeds the recommended of ASHRAE, to be maintained at or below 1000ppm, it achieve up to 4500ppm in some classrooms.



- Radon legislation: **new Basic Safety Standards - EU Directive 2013/59/EURATOM** radon reference level of 300Bq/m³ in homes and workplaces.

- To develop and implement an economic system to provide all the parameters of IAQ - **it is crucial for health and performance of the children.**



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04/15

VOC (volatile organic compounds)

- Are emitted as gases from certain materials: solids or liquids.
- General sources: - building materials, materials used for insulation, furniture, flooring, wall wallpaper, cellulosic materials etc.
- **Formaldehyde** - is one of the most common **carcinoger pollutants** of indoor air.
- Over exposure to **formaldehyde and acetaldehyde** increases the risk of leukaemia and brain cancer.



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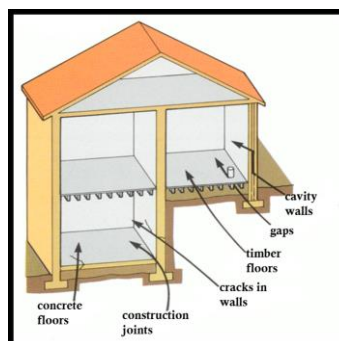
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05/15

RADON

- Radon is a naturally occurring colourless and odourless **radioactive gas** generated by the radioactive decay of radium which derives from uranium.
- Uranium is found in minute quantities **in all soils** and rocks and also **in all buildings material**.
- **RADON** - Main environmental factor causing **lung cancer**. Studies were conducted worldwide on the impact of residential radon on lung cancer.
- In the air from public buildings or residential homes radon concentration can be more high (**100-10.000 Bq/mc**)



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06/15

Studied classrooms

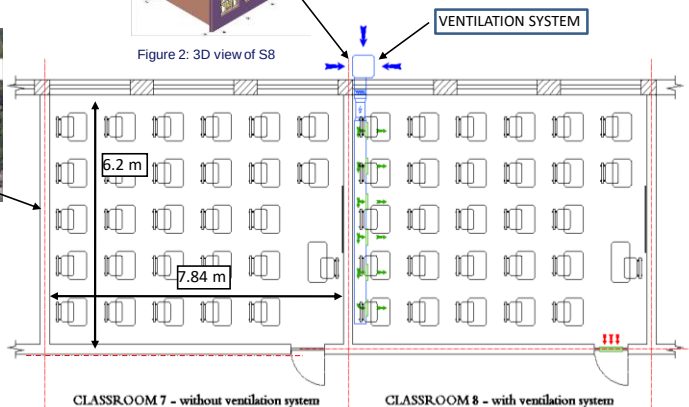


Figure 1: Studied school

Exterior walls were recently thermal insulated with 10cm of polystyrene.



Figure 2: 3D view of S8



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07/15

Ventilation prototype system

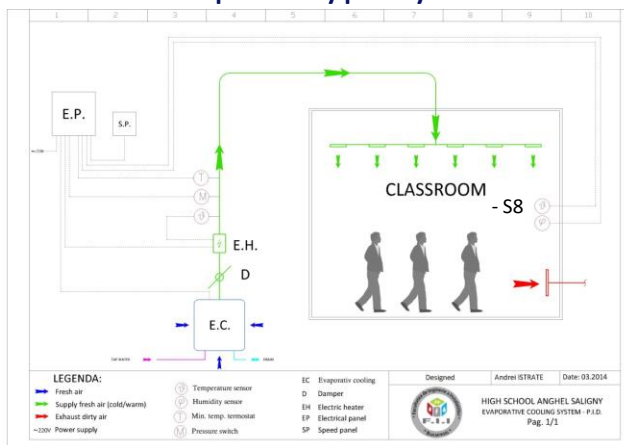


Figure 3: Outside fresh air ventilation system



Figure 4: Inside fresh air distribution system

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08/15

Measurement instruments



Figure 5: RADON detector

RADON detector

 Measurement Range 0 ... 10 MBq/m³

Internal Sensors for:

- Relative humidity (0 .. 100%)
- Temperature (-20 .. 40°C)



Figure 6: VOC sampler

VOC sampler



The DSD-DNPH sampler is comprised of a porous polyethylene tube, which acts as the diffusive membrane, to which is attached a small polypropylene syringe used for the elution of the analytes from the adsorbent.

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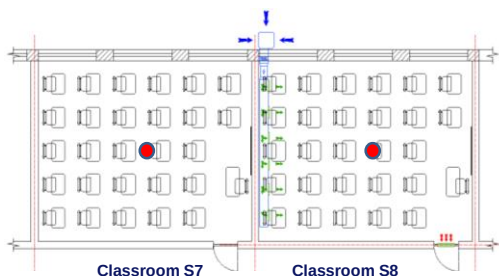
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09/15

Measurement protocol

- Classroom 7:
- 1 sample
- Classroom S8:
-3 samples
- Measurement location



Classroom S8		
m ³ /h/pers		
60	0	25

Classroom S7
m ³ /h/pers
0

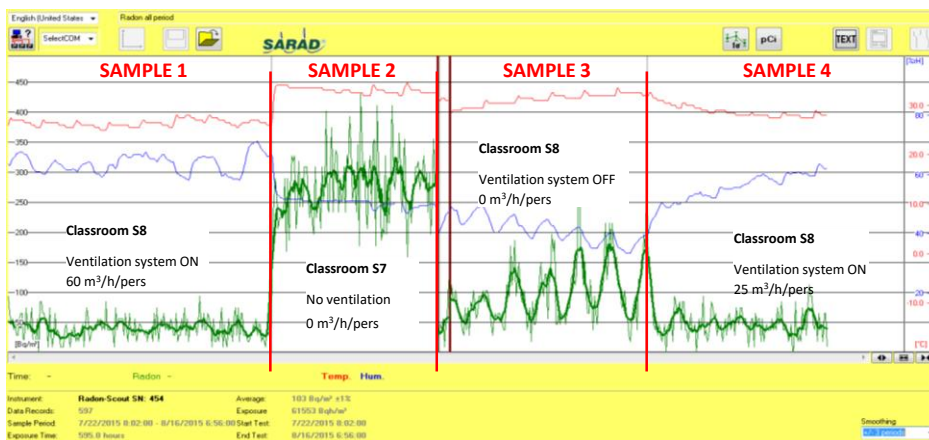
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10/15

Measurement results of RADON



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11/15

Measurement results

•Table 1. Comparison of VOC and radon concentrations between the two studied classrooms

Location	Type of ventilation	Formaldehyde	Acetaldehyde	Acetone	Radon
		(µg/m³)	(µg/m³)	(µg/m³)	(Bq/m³)
RECOMMENDED LIMITS		10	46	-	300
Classroom S7	No ventilation	86.68	45.16	59.37	320
Classroom S8	Mechanical ventilation	5.32	1.65	1.95	40

VOC

RADON

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12/15

Measurement results

$$R = \frac{C_{before} - C_{after}}{C_{before}} \times 100$$

$$RF = \frac{C_{before}}{C_{after}}$$

•Table 2. Results of radon concentration before and after mitigation and reduction factors.

Location	C _{before} (Bq/m ³)	C _{after} (Bq/m ³)	R (%)	RF (-)
Classroom S8	150	40	73	3.8

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13/15

- Our pilot study show that in Romanian schools the indoor air quality lacks and could cause long term repercussions on children health.
- Concentrations of radon, formaldehyde, acetaldehyde and acetone in indoor air are much higher if there is no ventilation.
- The most of measured values were above the recommended guidelines which may represent a **serious health problem** for the exposed students.
- In classroom with the ventilation system, the levels were lower than classroom without any ventilation system.
- Thermally rehabilitated buildings, increase energy consumption often leads to a decrease of indoor air quality.

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14/15



Thank you for your attention!

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