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Research Paper

Radon – Risks and Solutions

Social Science

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ABSTRACT

Irrespective of the fact that both European and national legal regulations include radon, the public is mostly unaware of the risk of daily radon exposure. An appropriate system needs to be established for reducing significant exposures, but emergency action is mainly undertaken in order to reduce exposure of the most vulnerable groups to radon descendants but not the action for exposure reduction of the overall population. Investment in the knowledge of citizens and informing them on radon, its activity and ways of protection should become the priority for all familiar with harmful effects of this gas. In this paper relevant opinions on radioactive gas radon and its effect on the environment and individuals all over the world together with proposals for protection are presented.

I Introductory considerations

Ionizing radiation is a powerful ecological factor which influences the environment in large doses. Adverse effect of ionizing radiation on the human body was observed before ionizing radiation was known of. At the beginning of the 16th century, unusually frequent lung diseases were observed in workers of cobalt mines in Saxony and pitchblende mines Jachymov in the Czech Republic. At that time, people were not aware that the diseases, and deaths of those miners, were the consequence of inhaled radon products released from uranium minerals in the mine rocks. Compared to the situation in mines, potential effect of radon on the onset of lung cancer was discovered much later.

The exposure to radon is the most important exposure of humans to natural sources. If it is accepted that about 40% of the total irradiation of population originate from inhaling radon and its short-lived descendents, such a big share of radon in the total dose means the potential for causing lung cancer, which attracted a great interest in the middle of the last decade and which still lasts.

The statement that radon can cause lung cancer can be counteracted by the following argument: radon has always been present in the atmosphere, people have always inhaled it together with its descendants and „that" has never had any adverse effects. Why would the health aspect of the issue become more relevant now? Answers to these questions have to do with certain human activities. It is, first of all, the reduction of natural ventilation in closed spaces for energy saving purposes leading to increased concentrations of radon and descendants. In addition, prefabricated waste materials from industry and mining are used for construction. Such materials often contain increased levels of radioactive elements, radium being one of them which is „a parent" of radon, which leads to increased radon levels in closed areas. (1) Furthermore, the man nowadays spends much of their time in closed spaces, which also contributes to increased irradiation levels induced by radon and its short-lived descendants.

It is obvious that the question "how safe is it" is political rather than legal issue. The states with higher nuclear interests show a tendency toward higher allowed level and fewer public discussions of the matter, while the member states with strong ecological movements, because of the pressure exerted by the public, have a tendency toward lower allowed levels. (2)

II World experience and the case of Serbia

The first measurements of radon concentrations in the closed space air, in residential buildings, were conducted in 225 residential buildings in Sweden. The obtained results were published in 1956. That study, initiated by Rolf Sievert, showed that, in several houses built with porous Ra-226 rich concrete, radon levels had been much higher than in other buildings. However, the results of that study were not looked at with significant attention, internationally because they were considered a Swedish problem. Only twenty years later did a more intense measurement of radon levels in closed space start and the obtained results were summarized in UNSCEAR reports while the interest in such measurements has constantly increased in recent years. (1)

Systemic measurements of radioactivity of construction materials and dose calculations for residential buildings started in the eighties of the last century. (3) The majority of European countries as well as the USA and Canada adopted the recommendations on emergency levels for radiation doses in closed areas and concentrations of individual radionuclides, primarily radon, in construction materials, residential and public buildings. According to those recommendations, the annual radiation received by the population should not exceed 0.7 mSv from construction materials. The majority of the European countries adopted those recommendations; however, Sweden and other Scandinavian countries, due to climatic and geological conditions, allow significantly higher radon levels in residential buildings – for future construction up to 200 Bq/m^3, with the emergency level of as high as 800 Bq/ m^3. (3) Measured radon concentrations in thousands of residential buildings in Finland and Sweden are several thousand Bq/m^3, while the common radon concentrations in houses in the EEC countries are in the interval of 20-50 Bq/m^{-3}. (4)

Commission Recommendation of 21 February 1990 on the protection of the public against indoor exposure to radon 90/143/ Euratom (Official Journal L 080, 27/03/1990. p. 0026 – 0028.) introduces reference and design levels for indoor radon. It is, however, the responsibility of national authorities to implement a radon mitigation policy for the protection of the public, in the framework of an overall concern for the public health.

In many Member States there is increasing awareness of the significance of indoor exposure of the population to radon. For example, environmentally occurring radon gas is recognized in the United Kingdom as a major cause of cancer. Several countries already have or are drawing up dose-control policies because exposure to radon is not a new phenomenon and epidemiological studies of various groups of minors exposed to elevated concentrations at work have revealed an excess of lung cancer deaths.

By the recent International Commission on Radiological Protection (ICRP) Recommendations for reducing radon exposure it was stressed that emergency action should include modifications of the residential buildings and working areas or behavior change of the occupants. The Commission suggests the use of action-emergency levels for making decisions on emergency action. However, systematic screening of working areas in which exposure has not been defined as professional, is still very rare excluding certain categories of public buildings such as schools and kindergartens. Handling the issue in this way, the International Radiation Protection Commission suggests that only emergency action is undertaken in order to reduce exposure of the most vulnerable groups to radon descendants but not the action for exposure reduction of the overall population. (5) In

the most recent ICRP Recommendations on radon protection, the Commission, contrary to its previous Recommendations and EEC Recommendations, proposes that no difference is made between the existing houses and working facilities and buildings under construction or in plans when specifying emergency levels.

The Commission has carried out a survey of levels of natural radioactivity in Member States which was published in the form of an Atlas (6) and it continues to collect information from national surveys. Ireland is an interesting case where a system has been introduced to provide support to families, in terms of costs, in order to solve the problem of radon exposure in their homes. Written question E-0867/01 by John McCartin (PPE-DE) to the Commission on radon gas levels in schools and homes in Ireland (Official Journal C 318 E, 13/11/2001. p. 0138 – 0138.) shows that according to a recent study carried out by the Radiological Protection Institute of Ireland one-quarter of Irish schools and 91 000 homes throughout Ireland have high levels of radon gas which put the safety of the public at risk.

Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation (OJ L 159, 29.6.1996. p. 1–114) sets a framework for controlling exposures to natural radiation sources arising from work activities. Title VII of the Directive applies to work activities within which the presence of natural radiation sources, including radon, leads to a significant increase in the exposure of workers or of members of the public. Member States are required to identify work activities which may be of concern e.g. in spas, caves, mines, underground workplaces and aboveground workplaces in identified areas (Title VII, Article 40). The Group of Experts set up under Article 31 of the Euratom Treaty has provided technical guidance for the implementation of Title VII of Directive 96/29/Euratom. The member states should consider the level to which the intentional use of radon-containing water is justified, due to its potential therapeutic action, by economic, social and other benefits compared to compromised health it can cause. (7)

Commission Recommendation of 20 December 2001 on the protection of the public against exposure to radon in drinking water supplies (Official Journal L 344, 28/12/2001. p. 0085 – 0088) concerns the radiological quality of drinking water supplies regarding radon and long-lived radon decay products. The recommendation specifies limit values for radon in water for public consumption and the citizens are entitled to proper information on the quality of drinking water, including radon levels. In this case, the respective public information system plays an important role. Member states should adopt guidelines on different available methods for eliminating radon and its long-living decomposition products from water. Flexible approach is needed to allow Member States to apply the concept of optimization, while ensuring protection of the most highly exposed part of the population.

The adoption of the Law on Ionizing Radiation Protection and Nuclear Safety (Official Gazette of the Republic of Serbia. No. 36/2009, 93/2012) in Serbia is a major contribution to our safety.

Serbia has a long tradition of radon measurements. In particular, this refers to radon assessment in spas and uranium and non-uranium mines. Such measure is important for safety of employees in mines and spas with radon-rich water who are additionally exposed (5), and for linking low-dose irradiation and end effects. (1) Therefore, radon concentrations were monitored for several decades in uranium mines Kalna and Zirovski vrh in Serbia (in 10 pits), which was later extended to 13 pits on non-uranium metal mines.

Geological formations in Serbia, in which radioactive elements can be found in contents representing environmental risks, are many. Such risks can be high especially in densely populated areas and agricultural regions such as Barbeski basin in the south-east Serbia, and Garaši site (1) on Bukulja mountain in Šumadija. In those areas geochemical anomalies of uranium, radium and/or radon were found in water, soil and/or air. Further research of the occurrence and content of such elements is needed in our country as well as the relevant geochemical and evaluated environmental risks.

Unfortunately, any action needed to be implemented on the majority or the overall residential houses or working areas of one country would be extremely expensive. (1)

The following radon reduction measures are recommended:

1. Sites with increased content of Ra-226 (25 to 50 Bq/kg) and/or increased level of external gamma radiation should be carefully assessed before the decision is made to construct residential buildings in them;
2. Having in mind radon health effects, the number of old apartments, houses and their occupants should be assessed for Belgrade and evaluate the representative sample for radon concentrations;
3. In compliance with the new recommendation, the apartments and houses with the annual average content of radon exceeding 200 Bq/m^3 are indicated for the implementation of cheap remediation measures, and those with radon content exceeding 600 Bq/m^3 are indicated for expensive remediation measures proposed by the team (an architect, a physicist specialist in ionizing radiation and a construction technician);
4. The following cheap measures are considered: sealing damaged surfaces and filling cracks on the floor, wall and connections, and next to installations, covering floors and walls with a plastic material (polyamide, PVC and others), or painting, in three layers, with grease paint for ten-fold reduction of radon emission;
5. For the energy saving program, the risk of radon increase in residential and other building should be avoided;
6. Novel construction materials should be systematically monitored for radionuclide levels and especially implement efficient monitoring of imported construction and other materials (marble, plaster, novel construction products, phosphorus used for the production of fertilizers etc.);
7. If a higher percentage of old houses and apartments with increased radon levels is found out, the epidemiological studies of lung cancer should also include the level of radon in residential areas. (1)

According to the Rulebook for on the establishment of the Program for systematic environmental radioactivity investigation (Official Gazette of the Republic of Serbia. No. 100/2010), exposure levels in residential areas are tested by measuring radon levels in the air. Although the Republic of Serbia ratified the Aarhus Convention - Convention on access to information, public participation in decision-making and access to justice in environmental matters (Official Gazette of the Republic of Serbia - International Contracts. No. 38/2009), it seems that our public is still insufficiently aware of radon and its associated risks.

IV Conclusion

Too long, in many countries, the legislation concerning the protection of the environment has been limited, unsatisfactory and out-dated and thus incapable of meeting contemporary demands of the protection of the environment. Irrespective of the fact that both European and national legal regulations include radon, the public is mostly unaware of the risk of daily radon exposure.

When radon and its degradation products provide the greatest contribution to radiation risks of all natural radiation sources, in order to avoid or at least mitigate the consequences of increased radon levels, any available action should be taken for their minimization. Contrary to the natural sources that are practically constant in space and time and almost independent from human activity, radon is significantly dependent on human activities that can affect the degree of exposure. Considering that radon is a gas, its share in the total natural irradiation of

people can be reduced simply by ventilation.

One measure of radon reduction proposed by experts is to avoid the risk of increased radon concentrations in residential and other buildings. Novel construction materials should be systematically monitored for radionuclide levels and, if higher percentage of old houses and apartments with increased radon levels is found, epidemiological studies of lung cancer should include radon levels in residential areas. It is necessary that construction material manufacturers should provide data on their radioactivity. Such data should be provided or requested by investors, contractors or authorized inspection departments in the form of certificates issued by licensed institutions, as information. There is an increased interest in such data by citizens considering that environmental issues have become issues of public interest.

An appropriate system needs to be established for reducing significant exposures, but emergency action is undertaken in order to reduce exposure of the most vulnerable groups to radon descendants but not the action for exposure reduction of the overall population. In our country, there are neither standards nor metrological instructions for direct regulation of this area although it is indirectly and partially regulated by laws and by-laws related to environment protection, ionizing radiation and nuclear instruments.

The legal standards may be an important means for the containment of the phenomena which the uncontrolled development of contemporary technology threatens to bring about only if the legislative organs passing the legal standards were prepared to respond in time and if the executive organs were ready to apply the environment legislation. European or worldwide environmental legislation is necessary, but also the modern environmental education. Investments in the knowledge of citizens and informing them on radon, its effects and manners of protection should become the priority for all of us who are familiar with harmful effects of this gas.

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