Changes in Polish law related to the implementation of COUNCIL DIRECTIVE 2013/59/EURATOM of 5 December 2013

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Abstract. Radon is an invisible, naturally occurring radioactive noble gas. According to the WHO report, it is the most important cause of lung cancer after smoking [1]. Recent epidemiological studies show that a statistically significant increase in the risk of lung cancer already occurs as a result of prolonged exposure to radon inside rooms where the concentration is at 100 Bq/m^3 and increases by 16% per 100 Bq/m^3 increase (considering a prolonged exposure period). For this reason, the Council Directive 2013/59/Euratom (BSS) [2] establishing the basic safety standards for the protection against the hazards related to ionizing radiation, that was passed in 2013, pays particular attention to issues related to radon exposure . BSS reduce radon concentration limits in workplaces to 300 Bq/m^3. According to the regulations in force, the BSS must be implemented in the Polish Atomic Law no later than 6th February 2018.

1 Radon

Radon is an invisible, odourless, and tasteless naturally occurring radioactive noble gas. It could be found in all components of the natural environment - rocks, soil, atmospheric air and water. Radon has no stable isotopes. Thirty seven different radioactive isotopes of radon have been described. The most important, however, from radiation protection point of view, is ^{222}Rn. It has a half-life of 3.8 day and is generated by the radioactive decay of radium ^{226}Ra – the decay product of uranium ^{238}U in the earth's crust. Radon has a relatively high solubility in water so it can also be found in ground and drinking water. It is a part of natural radioactive chain and as an alpha-emitter leads to creation new particles called short-lived radon progeny. Radon is a noble gas so it is non-reactive but it merges into radioactive aerosols by combining with ambient particles in the air.
The concentration of radon in the air is not constant and depends on many different factors as geological structure (uranium content, permeability), location. Seasonal changes have been observed as well.

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Radon enters the building through cracks in the foundation and accumulates inside enclosed rooms. Therefore, the indoor radon concentrations are several times higher than outside. High levels of radon in the water supply can also increase indoor radon concentrations, as well as some kinds of building materials (a.e. granites). In Poland the mean radon concentration is about 10 Bq/m^3 in the open air whereas the average indoor concentration is about 40 Bq/m^3 [3]. Radon levels are usually higher in basements, than on the upper floors of buildings.

According to the WHO (World Health Organization) report radon is considered to be the main cause of lung cancer among non-smokers. As estimated, between 3–14% of all lung cancer is caused by radon exposure. It depends on the average level of radon concentration and the smoking prevalence in a country [1]. The report released by the President of the National Atomic Energy Agency in 2016 indicates, that the statistical resident of Poland received an annual effective dose of 3.55 mSv. About 69% of the total dose is associated with natural sources and almost 34% from exposure to radon and its decay products [4].

2 Atomic law in Poland before the implementation of the Council Directive 2013/59/EURATOM.

The Atomic LawbAct of 29 November 2000, which entered into force on 1st January 2002, is a main parliament act governing all nuclear activities- nuclear safety and radiological protection of workers and general public in Poland. The most recent consolidated text of the Atomic Law Act was published in the Dziennik Ustaw on 17.03.2017.

Main provisions of the Atomic Law Act regard activities with the use of ionizing radiation or activities which involve exposure to ionizing radiation, powers of the President of National Atomic Energy Agency to control and supervise these activities. The Act also identifies other tasks of the PAA President, assessment of national radiation situation and procedures, that should be applied in radiation emergency.

The basic national legal regulation establishing the doses limits is the Decree of the Council of Ministers of 18 January 2005 [5]. According to this regulation the annual dose limit for general members of the public, expressed as effective dose, is 1 mSv, and should include external and internal exposure. However, the exposure due to occurrence of radon and its progeny in the residential buildings is excluded as established by the Atomic law act.

3 Basic Safety Standards

On 5 December 2013, Council Directive 2013/59/Euratom establishing the basic safety standards for the protection against the hazards related to ionizing radiation was passed. The new Directive repeals the existing legal acts contained in Directives 89/618/Euratom, 90/641/ Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom as of 6 February 2018 and at the same time indicates that date as the deadline for the implementation by the Member States of the European Union of the parliamentary acts, executive and administrative provisions necessary to comply with it.

Contrary to previous legal regulations, a number of provisions in the new directive concern the so-called "radon hazard" associated with the occurrence in the air of radon ^{222}Rn and its short-lived progeny such as ^{218}Po, ^{214}Pb, ^{214}Bi and ^{214}Po. Although for the sake of simplicity it is spoken in the context of "radon hazards", the directive explicitly states that this means exposure to "short-lived radon progeny" because their contribution to the dose is predominant and reaches 99%.

The risk associated with radon is especially for those places where ventilation is poor, for example such as caves or underground mines. The largest exposed population, however, are people living or working in rooms, especially in the winter when elevated concentrations of radon occur due to poor ventilation. The presence of radon in buildings results primarily from its penetration from the ground.

In order to ensure the safety and optimization of radiological protection, Member States should establish national reference levels for radon concentrations in rooms. In the case of residential buildings, the reference levels for the average annual radon concentration in air may not be higher than 300 Bq/m^3. A similar value is recommended in the Directive for radon concentrations in indoor workplaces. In this case, however, an increase in the national reference level is allowed if this is reasonably justified by existing national conditions, and the relevant document will be submitted to the European Commission.

By assuming a reference level, it is important to be aware that a statistically significant increase in the risk of lung cancer already occurs as a result of prolonged exposure to radon inside rooms where the concentration is at 100 Bq/m^3. The Directive also indicates that this risk is significantly increased if the radon hazard is associated with smoking.

The implementation of the new directive will require, in addition to the amendments to the legal regulations, the cooperation of many entities including ministry responsible for health and construction, the chief sanitary inspectorate, investors, building owners, employers and measurement laboratories.

4 Propositions of changes in The Atomic Law Act.

4.1 Definitions

The 8th of March 2017 the bill of The Atomic Law Act was published. In this version new definitions were apply, among others that "radon" means the radionuclide ^{222}Rn and its progeny, and "exposure to radon" means exposure to radon progeny. Apparently the simple definition changes a lot in approach to radon measurements by indicating potencial alpha energy concentration (PAEC). In compliance with the new regulations to estimate the annual average radon concentration, it is necessary to perform at least one month countinous measurement. In this case the most appropriate and easy is to use alpha track detectors CR-39 chips and diffusion chambers (Fig. 1). After exposure, the CR-39 chips are etched in 6.25N NaOH at 70 °C for four hours. Typical and clear alpha tracks can be observed with a microscope. The relationship between alpha track density and radon accumulation concentration is proportional (r>0.9990).

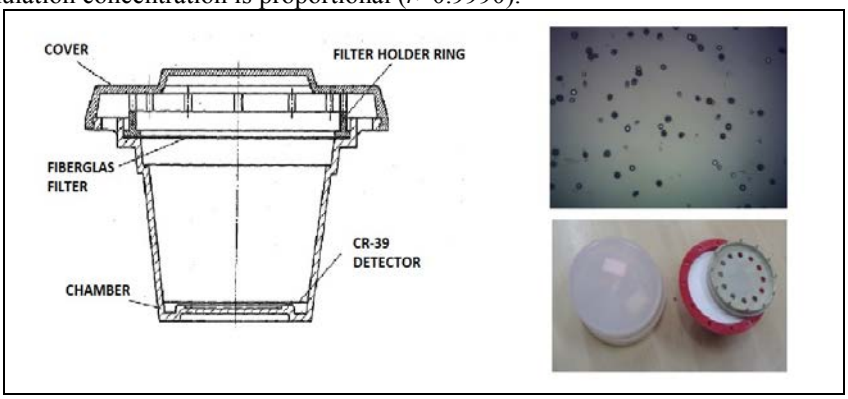

Fig. 1 Karlsruhe-type passive time integrating radon detector

Next important definitions are Radon Potential of a building site (RP) and Radon Index (RI). RP is the value expressing the radon index of the building site, calculated according to the formula:

$$RP = (C_{Rn} - 1)/(- \log k - 10) \quad (1)$$

where C_{Rn} is the radon concentration in soil gas (kBq/m^3) and k is permeability of the soil expressed in (m^2). If RP < 10, then radon index is assumed low, if $10 \leq RP < 35$, then radon index is assumed medium, and high if $RP \geq 35$. RI indicates the level of risk of radon release from bedrock, and can be expressed numerically as the radon potential of a building site. The categories are low, medium, and high.

4.2 Workplaces

Important change in new regulations is that doses related to radon are included to exposure. As a consequence, exposed workers should be categorized. To match the methods of exposure assessment to the anticipated exposure level , two categories of workers were established, depending on the exposure level. The Category A was chosen for workers who may be exposed to an annual effective dose exceeding 6 mSv and category B, if such doses are greater than 1 mSv and not greater than 6 mSv.

In compliance with the new version of Atomic law employers must make sure, that an appropriate measurement strategy and mitigation of radon exposure was implemented. They are obliged to:

- ensure radiation protection employee exposed to radon,
- make notification in case exceeding the limit 300 Bq/m^3 in workplaces,
- make sure, that a good measurement strategies and mitigation of radon exposure was implemented,
- in case of workplaces located in:
  - ground floor or basements levels, on the areas where high level of radon concentration is possible,
  - underground workplaces,
  - places related to the treatment of water extracted from underground sources

  ensure measurements of radon concentration in air or potential alpha energy concentration
- optimize the exposure of workers working in the mentioned above workplaces,
- inform workers in writing about:
  - increased exposure to radon,
  - results of measurements of radon concentration in air or potential alpha energy concentration,
  - the ionizing radiation dose they received,
  - action taken to reduce radon exposure in the workplace.

If there is a possibility of exceeding the reference level of 300 Bq/m^3 or obtain dose higher than 1 mSv per year, the employer shall take measures to reduce the exposure of workers to radon.

4.3 Homeowners

In compliance with new regulations the seller or lessor of the building shall at the request of the purchaser or tenant of such building provide information on the average annual radon concentration in air in the building. This information shall include:

- average indoor radon concentration in the air,
- comparison measurements results to the reference value of the annual radon concentration in air - 300 Bq/m^3,
- the actual basis for drawing up the information, in particular the results of the measurements and the entity that carried them out.

The above obligation does not apply to non-business renters. When new administrative buildings (hospitals, schools) are planned investor must specify the radon index of the building site. If radon index is medium or high, technical measures shall be taken to prevent radon entry into the building.

If an investor in the construction project has provided measures or technical solutions that prevent radon penetration into the building the above obligation are not required.

4.4 Responsibilities and competences

In new regulations responsibilities and competences of the Chief Sanitary Inspector and minister responsible for construction are similar. Among others they are responsible for organize campaigns promoting the use of measures to reduce concentration of radon, provides information, education and training activities on available measures to limit indoor radon concentrations, monitors the application of measures to limit the average annual concentration of radon, cooperates with the professional councils of architects and construction engineers and other professional organizations and associations, local government bodies and specialists in the field of protection against ionizing radiation, publishes information on instruments used to finance measures aimed at reducing the average annual concentration of radon. Main difference is, that activity field of minister responsible for construction concerns only on new building and Chief Sanitary Inspector's all other buildings designed to accommodate people.

4.5 National Action Plan for Radon Exposure

The ministry responsible for health in cooperation with the Chief Sanitary Inspector will be responsible for developing "National Action Plan for Radon Exposure" an action plan for long-term hazards arising from exposure to radon in dwellings and workplaces. The goal of the action plan is to ensure appropriate long-range strategy for eliminating avoidable risks from radon exposures in dwellings, buildings with public access and workplaces for any source of radon ingress, whether from soil, building materials or water. In line with the new regulations, the National Action Plan should specify:

- strategy for conducting surveys of indoor radon concentrations or soil gas concentrations for the purpose of estimating the distribution of indoor radon concentrations, for the management of measurement data and for the establishment of other relevant parameters (such as soil and rock types, permeability and radium-226 content of rock or soil),
- approach, data and criteria used for the delineation of areas or for the definition of other parameters that can be used as specific indicators of situations with potentially high exposure to radon,
- identification of types of workplaces and buildings with public access, such as schools, underground workplaces, and those in certain areas, where measurements are required, on the basis of a risk assessment, considering for instance occupancy hours,
- the basis for the establishment of reference levels for dwellings and workplaces,
- assignment of responsibilities (governmental and non-governmental), coordination mechanisms and available resources for implementation of the action plan,

- strategy for reducing radon exposure in dwellings,
- strategies for facilitating post construction remedial action,
- strategy, including methods and tools, for preventing radon ingress in new buildings, including identification of building materials with significant radon exhalation,
- strategy for communication to increase public awareness and inform local decision makers, employers and employees of the risks of radon, including in relation to smoking,
- guidance on methods and tools for measurements and remedial measures,
- where appropriate, provision of financial support for radon surveys and for remedial measures, in particular for private dwellings with very high radon concentrations,
- long-term goals in terms of reducing lung cancer risk attributable to radon exposure (for smokers and non- smokers),

The National Action Plan should be review and update at least once every four years.

5 Conclusions

The impact of the changes in Polish Atomic Law will be important in many areas of life, since it implies for the first time an obligation to develop a regulatory frame to actively work on reducing the radon exposure not only of workers, but also of the general public and lowering the reference level for the annual average activity concentration in air to a maximum value of 300 Bq/m^3.

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