Abstract

The work focuses on the scientific and technical challenges related to monitoring the potential alpha energy concentrations of radioactive decay products of radon and thoron in the air, for which a method for simultaneous measurement of this quantity was developed. The first chapter of the work introduces the issue of exposure to ionizing radiation, particularly exposure to radon and thoron progeny, and, simultaneously, justification for the choice of the work topic. The second chapter contains basic information on radon and thoron and their decay products, the behaviour of these isotopes in the atmosphere, the processes of radioactive aerosol formation, and their impact on people's health. In addition, it discusses the quantities that are key to the quantitative assessment of radiation hazards. The last part of the chapter describes the impact of radon and thoron on human health. The third chapter reviews European and national legal regulations that concern radon and thoron hazards, including the method of assessment, limitations, and responsibilities of managers of organizational units where such hazards occur. It also presents recommendations formulated in the European Commission and the International Commission on Radiological Protection (ICRP) publications. The next part of the work presents methods used to measure the concentration of radon and thoron decay products. Considering the previously discussed places of radon and thoron hazards, legal regulations regarding their monitoring, and the purpose of the work, this chapter presents significant limitations in the application of available measurement methods. From the perspective of routine applications, the desired measurement methods and devices must be easy to use. They should not require the user's special training (competence), often a mine staff member. Chapter five describes the developed measurement method, enabling simultaneous measurement of the potential alpha energy concentration of radon and thoron decay products. The first part of the chapter describes the construction of the meter used, while the next part presents the method of assessing the concentration of potential alpha energy of radon and thoron decay products and statistical analysis. The subsequent chapters present the results of the tests that were conducted. Chapter six describes the course of the meter calibration procedure and the obtained results. Particular attention was paid to the behaviour of radon and thoron decay products in the climatic chamber and the reference method used to determine the standard concentration of potential alpha energy. In addition, the results of the free fraction measurement in the chamber and the influence of the aerosol separation systems, the so-called micro cyclones, on the measurement were presented. Calibrations were performed in the radon chamber of the Silesian Center for Environmental Radioactivity of the Central Mining Institute (GIG-PIB). Chapter seven presents

the results of measurements of the potential alpha energy concentration of radon and thoron decay products in situ. The measurements were carried out in the Historic Silver Mine in Tarnowskie Góry, the Barbara Experimental Mine of the Central Mining Institute (GIG-PIB), the Nero House Museum in Rome, and the Baths of Diocletian in Rome. The main premise for selecting the measurement locations was that these facilities are characterized by increased natural radioactivity. Based on the measurements of the potential alpha energy concentration of radon and thoron decay products, the effective doses that employees could receive were calculated, and actions that could be taken to reduce exposure to radon and thoron decay products were proposed. The last part of the chapter presents the results of interlaboratory studies conducted in situ in the Historic Silver Mine in Tarnowskie Góry. The last chapter of the work is a summary presenting the most important achievements and conclusions from the work. Further directions for improving the developed method are proposed. Appendix 1 of the work presents functions describing the systematic radioactive decay of radon and thoron decay products on the filter. These functions were used to calculate the reference values of potential alpha energy concentration.