Dependence of the effective dose due to radon and its short-lived progeny inhalation on indoor air parameters

SUMMARY

The aim of this study was to examine the influence of changes in indoor air parameters on the effective dose due to radon and its short-lived progeny inhalation - *E*. This dose was determined for currently calculated values of *F* and *DCF* coefficients. The measurements of radon and both fractions of its decay products were carried out in an auditorium at the Environmental Engineering Faculty (Lublin University of Technology, Poland). Additionally, the measurements of quantitative and mass concentrations of aerosol particles (present in the indoor air) as well as measurements of indoor climate parameters (temperature, pressure, humidity) were performed.

The auditorium is equipped with an advanced air-conditioning system - AC. The presence of the air-conditioning system and the change of its operating modes made it possible to control the composition of the air tested (expressed by the degree of air recirculation) and air flow rate. The effect of these parameters' changes on the calculated inhalation dose *E* and on the change of other indoor air parameters (aerosol concentration, indoor climate parameters) has been examined.

Additionally, in the laboratory room at the Institute of Nuclear Physics PAN measurements of the impact of additional aerosol sources (eg tobacco smoke) on the increase of concentration of radon decay products, and thus the increase of dose *E* were made.

The analysis of collected results lead to conclusion that there is a need to measure not only radon concentration, but also both fractions of its decay products, in order to accurately determine the effective dose *E* due to these isotopes inhalation. Such comprehensive measurements will give information about the actual values of both: *F* equilibrium factor and the *DCF* dose conversion factor. Assuming fixed constant values of *F* and *DCF* can lead to underestimates or overestimates of the values of dose *E*. If, for some reasons, measurements of radon progeny concentration aren't possible, it is recommended to use the currently adopted values of the *DCF* coefficient, which are determined based on dosimetry modeling.

Measurements in the air-conditioned auditorium showed that different modes of air-conditioning operation and change of its parameters can significantly influence the dynamics of changes in the radon concentration values and, above all, both fractions of radon decay products and thus values of inhalation dose *E* due to these isotopes.

Based on these results it is possible to propose an air-conditioning mode that will guarantee the users of the auditorium (or any other air-conditioning office or living room) the lowest possible exposure to radon and its decay products. In other words, the inhalation dose obtained due to these isotopes will be the lowest. This mode of AC operation will be the continuous mode – AC ON with the air recirculation system turned off and the highest possible value of the air flow rate supplied to the auditorium. The constant supply of external air with a low concentration of radon and its progeny will guarantee that the inhalation dose due to these isotopes will be as low as possible, even if relatively large amounts of atmospheric aerosols will enter the room from outside. In the case when the continuous mode of AC operation is unfavorable, eg for economic reasons, its mixed mode AC ON/OFF should be used (parameters related to recirculation and flow rate should be set at the same level as in the AC ON continuous mode described above). Measurements showed that the values of the effective dose *E* due to radon and its short-lived progeny inhalation are several times lower during the day when air-conditioning is working than during the night when AC is turned off.