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DOSES OF INTERNAL HUMAN RADIATION FROM RADON DURING HEATING OF RESIDENTIAL BUILDINGS WITH NATURAL GAS IN THE CONDITIONS OF THE NORTH

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Some sources contain information [1,2] that natural gas may contain radon, but there are no detailed studies of the emission of radon from network natural gas, and this problem of radon emanation from natural gas is of important practical importance in connection with the implementation of the gasification program for populated areas points of Yakutia [3]. Radon is one of the main causes of cancer, including most often lung cancer. Studies conducted in different countries have shown that even low concentrations of radon detected in residential areas create health risks and contribute to the development of lung cancer. It is known, that prolonged exposure to radon with an average concentration increased by 100 Bq/m3 increases the likelihood of developing lung cancer by 16% [4]. This paper presents the results of experimental studies of equivalent equilibrium volumetric activities (EEVA) of radon 222Rn and maximum annual dose loads for the heating season (from September to May) in residential premises of the city of Yakutsk, the central regions of the Republic of Sakha (Yakutia). The measurements were carried out using radon radiometers RRA-01M-03 and Alpha Guard PQ2000. Calculation of the individual annual effective dose of internal irradiation of residents of a populated area due to short-lived daughter products of radon isotopes in the air is carried out according to the data of measurements of EEVA of radon isotopes 222Rn in indoor and outdoor air using the following formula [5]:
E_(internal.Rn)=9.5·〖10〗^(-6)·t·(0.2·〖EEVA〗_outdoor+0.8·〖EEVA〗_indoor),mSv/N,
where 9.5·10-6 is the dose coefficient (in units (mSv·m3)/(hour·Bq)); t –number of hours in one month; 0.2 and 0.8 –the proportion of time spent indoors and outdoors, respectively; if there are no EEVAout values for the outside air on the territory of a populated area, then for calculations of radiation doses it is necessary to take EEVAout = 6.5 Bq/m3 in accordance with data on the world average EEVAout values of radon isotopes in the ground layer of atmospheric air, N is the number of months of the heating season (N=9 months).
The EEVA of radon for a nonequilibrium mixture of short-lived daughter decay products in the air is calculated using the following formula [6]:
EEVA_Rn=VA_Rn·F
where VARn is the volumetric activity of radon, F is the equilibrium coefficient between radon and its decay products, which can take values from 0 to 1. In the absence of experimental data on the average value of this coefficient, F=0.5 is taken.
The table provides examples of the results of calculated dose load readings depending on the season.
Table. Dose loads
Locality Gas boiler type VARn, Bq/m3
(max, value) EEVARn , Bq/m3
(max, value) Einternal, mSv/N

Yakutsk, three-story residential building Rinnai (made in Japan) 205±50 102,5±25,0 5,2
Oy village, Khangalassky ulus Wolf (made in Germany) 126±36 63,0±18,0 3,2
Oy village, Khangalassky ulus AOGV (made in Russia) 229±53 114,5±26,5 5,7
Oy village, Khangalassky ulus KSG-10 (made in Russia) 73±24 36,5±12,0 1,9
Oy village, Khangalassky ulus KSG-7 (made in Russia) 103±32 51,5±16,0 2,6

To assess the possibility of an increase in radon concentration due to emanation from the soil, the release of radon from soils selected from the subfloor of houses was measured using semiconductor gamma spectrometry and using a test chamber. Measurements have shown that radon emanation from the underground (24 Bq/m3) makes an insignificant contribution to the concentration of radon in residential premises.
The results of the studies show that the dose load from radon does not exceed the permissible value (10 mSv/year). Basically, the obtained values of VARn > 200 Bq/m3 and EEVARn > 100 Bq/m3 exceed the standard values that are recommended for residential premises under construction. As can be seen from the examples of results shown in the dose load table, there is a dependence of VARn and EEVARn on the types of boilers: dose load readings correspond to standard values only in the case of using Russian-made KSG-10. In accordance with the data obtained, EEVA values may depend on several factors, such as ventilation systems, thermal insulation, on which the volume of gas used depends, on types of boilers, etc. Thus, there is a need to control

EEVA in residential premises to prevent dose loads from radon and take measures to reduce them at different stages: 1) ventilation systems during construction; 2) commissioning of a gas heating system. To achieve this, uniform standards must be adopted based on research such as this work. In addition, the high dose rates presented in this work may be the reason for the increase in the level of malignant neoplasms in the localities in which these studies were conducted since the time of their gasification.

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Section

Applications of nuclear methods in science, technology, medicine and radioecology

Primary author: PETROVA, Kristina (M. K. Ammosov North-Eastern Federal University)

Co-author: MAMAEVA, Sargylana (North-Eastern Federal University named after M.K. Ammosov)

Presenter: PETROVA, Kristina (M. K. Ammosov North-Eastern Federal University)

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