MANUSCRIPT CUT IN LENGTH !

FOR FURTHER INFORMATION PLEASE CONTACT AUTHOR

EVALUATION OF RADON DOSES OF THE POPULATION OF KARELIA AND COLA PENINSULA

F. I. Zuevich, A.V. Lazarev

Research Institute of Industrial and Marine Medicine, St. Petersburg, Russia

INTRODUCTION

In opinion of the experts of UNSCEAR, radon and radon irradiation are major components of a natural radiating background. The effective equivalent doze of the planet population irradiation by radon and its affiliated products makes not less than halves of total doze from all natural sources of radiation (up to 70 %).The inhaling of the air, containing 1 Bq m^{-3} of radon, by different literary sources creates an effective doze on lungs from 50 up to 150 μSv y^{-1} (1, 2).

The natural sources of radiation influence the people, both in municipal and industrial spheres.

The heaviest contribution to irradiation of the population introduce radon and its affiliated products, locating in air of premises. The separate groups of the population can receive at the expense of the inhaling of radon extremely high emergency dozes (thousand BER y^{-1} on lungs). On UNSCEAR data , from 20 up to 40 % of all lung cancers are stipulated by radon and its affiliated products.

Total for autumn- winter stages of the work 950 detectors were installed and 1310 instant measurements of radon and its daughters were conducted. It is surveyed 47 towns, from them in details Petrozavodsk, Murmansk, Vyartsila, Snezhnogorsk.

ANALYSIS OF DATA ON KARELIA

The geometrical means of radon concentration in Karelia for separate towns by results of integrated measurements of a "pure" radon(i.e. radon without its daughters products) are represented for 42 towns in a diagram on fig. 1. The analysis of all set of available materials permits to reveal some general laws, describing the contents of a radon in houses of Karelia: for the majority of towns a rather high similar average level of concentration of a pure radon is characteristic. Geometric mean (GM) on whole Karelia is 72 Bq m^{-3}, and expectation value for lognormal distribution is equal to Bq m^{-3}. The difference between maximum and minimum values does not exceed 2 - 4 times. Lower GM of radon concentration was found in Belomorsk and Kemm (up to 50 Bq m^{-3}). Probability of excess of allowable values of radon concentration, determined from parameters of lognormal distribution, makes for whole Karelia about 1 %. Thus, on a background relatively high stable year concentration of radon in air of premises for towns of surveyed regions as a whole, significant percent of buildings with extremely high its levels emerges. The analysis shows, that the highest levels are registered in small settlements, i.e. the design of buildings plays here the significant role. The analysis of the relationship of geology and radon levels with using geological data and data on Finland and Cola peninsula shows the following: - correlation of high radon levels with intrusion of rapakivy granite is doubtless.

In Finland the average concentration of radon in region with such geology lies within the limits of 200 - 300 Bq m^{-3}. The similar geological structure is present in Karelia on north-east coast of Ladoga lake. The least concentration of a radon (30 - 50 Bq m^{-3}) is marked in gneiss zones and in amphibolites of belomorsk series. The large part of Karelia, as a geological structure, belongs to regions with most ancient gneisses and oligoclases granitoids. For them it is possible to expect wide spreading of radon concentration, from 70 up to 400 Bq m^{-3}.

ANALYSIS OF DATA ON COLA PENINSULA

Results of integrated radon measurements are represented for 6 towns in the diagram on fig. 2. The analysis of set of available materials does not allowed to reveal general laws, describing the contents of a radon in houses of Murmansk area: in surveyed towns average levels of radon concentration (GM on all Cola peninsula is equal 29.6 Bq m^{-3}, and expectation value for lognormal distribution is equal 40.7 Bq m^{-3}) lie in a wide range from 20 up to 93 Bq m^{-3}. Lower GM of radon concentration was found in Murmansk and Kovdor (up to 25 Bq m^{-3}).

The analysis of measurements distributions shows, that, as well as in Karelia, wide spreading of radon levels from several ten up to thousand Bq m-3 is observed. Probabilities of excess of allowable levels of radon concentration, determined from parameters of lognormal distributions, equal for Murmansk - 0.001 %, for Kovdor - 0.01 %, for Kirovsk and Revda - 0.1 %

DETAILED INSPECTION OF PETROZAVODSK AND VYARTSILA

Measurements of radon were executed within the limits of 12 sites, located in regular intervals within the limits of Petrozavodsk. Total in Petrozavodsk more than 600 measurements were conducted. By results of

conducted research is established, that the background values of equivalent equilibrium volumetric activity of radon (EEVA) in buildings of various purpose change from the first units up to first dozens Bq m^{-3}.
On the majority of surveyed sites abnormal objects with volumetric activity of radon and its daughters products from the first hundreds up to thousands Bq m^{-3} (Center, Kukkovka, Peravalovka) are found out. Number of buildings with the abnormal content of radon, more than 100 Bq m^{-3}, is about 9 %.
However, using the complex approach to valuation radon danger of buildings (volumetric activity of radon and its daughters, specific flow of a radon), the total number of potentially radon dangerous buildings reaches 34 %. The accumulation EEVA in a premise and determination of radon flow, used in this work, are described in (3).

Attracts attention the fact, that objects with a high radon EEVA level were poorly found out at the survey. At the same time high levels of a "pure" radon are found out at low EEVA values, that specifies high receipt of radon and potential opportunity under other conditions of reception of very high EEVA values, down to dangerous levels.

The valuation additional deaths at the expense of irradiation by radon only at Petrozavodsk (calculations are made in conformity with ICRP 50 publication) makes of 60 cases per year.

In Vyartsila settlment, located directly on border with Finland, active construction both of industrial premises and residential fund was assumed within the framework of economic commonwealth. Provided emanation survey of the settlement territory differs from all spent early by direct measuring of radon flow from a soil surface, instead of measuring volumetric activity of radon in soil air . The measured flow of radon from a soil surface on different sites was in a range from 10-15 up to 300 Bq m^{-2} h^{-1} with average level equal to 40 Bq m^{-2} h^{-1}. The volumetric activity of a radon in soil air was from 20 up to 100 kBq m^{-3} at average 60 kBq m^{-3}. The maximum registered value was equal to 150 Bq m^{-3}, at average on surveyed premises equal to 30 Bq m^{-3}. Survey in Vyartsila settlement has clearly shown, that it is not enough to have knowledge only about the radon content in soil air. Accounts of the radon contents in the basements and radon flow very well correlate by average values.

THE DOSE LOADS ON THE POPULATION OF KARELIA

The average level of irradiation by the expense of availability of radon in air of premises (on average EER) makes for Karelia 4,5 mSv in a year. In separate settlements range of fluctuations from this average value is about 4 times decrease or increase (from 0.8 up to 14.3 mSv in a year). Annual ED of irradiation, were designed for the adult . With the children in age till 10 years they can be at 1.52 time above (1,2).These dozes make up in average about 0.3 from the accepted normative level. However with separate inhabitants, living in houses with high radon levels in air, the last value can be exceeded 23 times (as it is, for example, in Pudozhgorsky settlement). According to the available demographic data, there were 700000 persons in the Karelian republic in 1968 year, then the number of cases of the lung cancer (Qp) can make 60.0 cases in a year.

DOSE LOADS ON THE POPULATION OF COLA PENINSULA

The Murmansk region annual doze from a radon in air of premises is about 2,2 mSv. It should clearly see, that this value is enough rough valuation, owing to limited number of surveyed towns. On separate settlements a range of fluctuations from this average value is about 2 times decrease or increase (from 1.2 up to 3.7 mSv in a year). The excess number of the lung cancers for Murmansk region can be Qp= 27.8 cases per year.

CONCLUSIONS

1. The radiation conditions, formed by the expense of receipt of radon and its daughters products in the air of living accommodations and buildings of various purpose in settlements of Karelia and Cola peninsula, should be regarded as intense and creating for the population and its critical groups (in particular, the children) potential opportunity of irradiation higher then established normative limits.
2. Average annual ED of irradiation of population, stipulated by receipt from air of radon and its daughters, is for the inhabitants of various settlements 0.6 - 25 mSv in a year. These levels of irradiation change within the limits of 6- 120 % from value, considered by international organizations as not requiring fulfillment's of protective measures. At the same time, in the process of settlements survey separate houses are revealed, where according to results of measurements, radon concentrations 2 - 3 times exceeding national normative values are registered. The number of such houses in different settlements makes up 13 % from total number of buildings. In these cases protective measures should be accepted.
3. Annual mean ED value in surveyed towns of Karelia is 4.5 mSv, and for Cola peninsula - 2.2 mSv.
4. According to prognostic account, the possible lung cancer number, caused by the inhaling radon daughters, for the inhabitants of surveyed regions of Karelia, , makes up 9 persons on 100 000 of the population in a year, and for the inhabitants of Cola peninsula - 4 persons.

REFERENCES.

1. ICRP. The publication 50, (1991).

2. Ionizing radiation: Sources and biological effects. UNSCEAR Rep. General Assembly 1982; 773 p. United Nations, New York (1982).
3. F.I. Zuevich, Radiation conditions from radon dwellings of various purpose, IPRA 9 (1996).
4. Markov K.P., Riabov N.V., Stas K. H. Express - method of valuation of radiating danger, connected to availability in air of radon affiliated products .- ATOMNAYA ENERGIA, v.12, N.4, p.315-319 (1962).