ASSESSING THE RISK OF RADON PROGENY ACCEPTABLE LEVEL EXCEEDING IN LIVING QUARTERS

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Close attention is paid in the world over last decades to the effect of radon isotopes and radon progenies (RP) on population health. RP concentration of the air is mostly measured in the units of "working level", but in Russia and Kazakhstan "equivalent equilibrium volume activity" (EEVA) is used defined as weighted sum of short-lived radon and thoron progenies: $EEVA_{Rn}(^{222}Rn) = 0.10A_{Po\text{-}218} + 0.52A_{Pb\text{-}214} + 0.38A_{Bi\text{-}214}$ and $EEVA_{Tn}(^{220}Rn) = 0.91A_{Pb\text{-}212} + 0.09A_{Bi\text{-}212}$. The acceptable level ($\beta$) is EEVA average annual of radon isotopes: $EEVA_{Rn} + 4.6\ EEVA_{Tn}$. For instance, this value being measured in the exploited living quarter air must not exceed 200 Bq/m^3. Such an approach supposes carrying out long-term and expensive measurements of radon EEVA average annual values using integrating measuring methods.

Assuming instant RP measurements in human settlements are described by a smooth distribution function, preliminary survey can be restricted by assessment of the risk of β

exceeding. Since in this case indoor radon temporal variations are not so important, immediate RP measurements can be used thus enabling to reduce essentially the cost of survey.

Presenting all possible RP values in a human settlement as a continuous variate X, risk R_β is probability P of β exceeding $R_\beta = P(X > \beta) = \int_\beta^{\infty} f(x)dx < 1$, where $f(x)$ is a differential distribution function. If only RP are measured, thoron progeny contribution can be accounted according to mean world statistical data: $EEVA_{Tn} = 0.1\ EEVA_{Rn}$. In this case the acceptable level of radon isotope EEVA 200 Bq/m³ corresponds to the measured RP value of 137 Bq/m³.

Risk assessment was made by the results of instant RP measurements ("TN-IR-21", Thomson&Nielson Electronics Ltd.) in the course of sample radiation survey of the living quarters in human settlements of four Kazakhstan oblasts in summer period, 2002-2007. Radon EEVA distributions were approximated by lognormal, exponential and, Weibull functions. Approximation quality by the first two was checked with the help of non-parametric Kolmogorov-Smirnov test, by the last one – using standard "probability-probability" plots. R_β values corresponding three $f(x)$ types were calculated in STATISTICA 6.0, StatSoft, Inc.

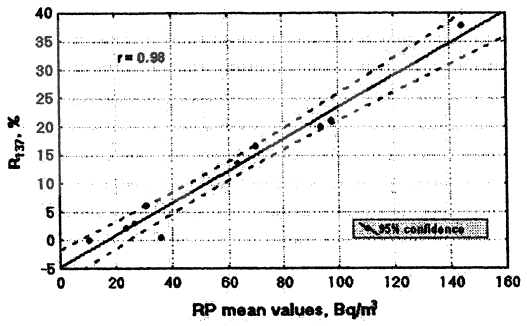


Fig. Dependence between RP mean values and risk assessments (%)

Stochastic dependences between risk assessments and some parameters of RP empirical distributions (mean, geometric mean, median) were revealed. With ^{222}Rn mean values not greater than 150-200 Bq/m³ these dependences can be assumed as linear ones confirmed by high correlation coefficients ≥ 0.94. The closest relationship is observed between mean values of radon EEVA and R_β values calculated with $f(x)$ approximation by lognormal function (Fig.). This dependence is of a certain practical importance allowing high-reliable risk assessment using the results of indoor RP instant measurements. The suggested approach does not require protracted measuring and thus can be recommended in the course of preliminary radiation survey of human settlements.