PROBLEMS OF ESTABLISHING NATIONAL REFERENCE LEVEL FOR RADON

Michael Zhukovsky, Ilia Yarmoshenko,
Alexandra Onishchenko

Institute of Industrial Ecology UB RAS
Ekaterinburg, Russia

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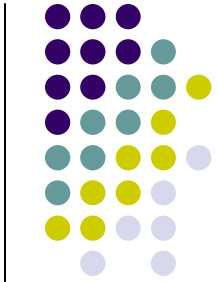
EXISTING APPROACH TO RADIATION PROTECTION AGAINST RADON



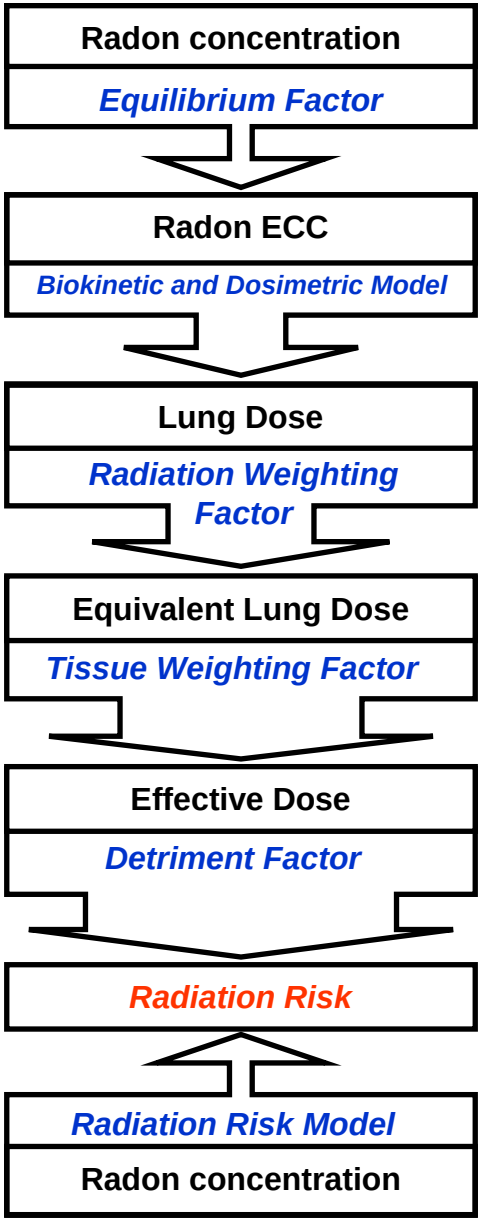
ICRP recommends to base the policy on protection against radon on a level of annual effective dose of 10 mSv from radon.

The Reference level (RL) for radon is recommended to be expressed in activity concentration with upper value 300 Bq/m^3.

Russian Radiation Safety Standards have two levels in regulation of the indoor radon and use the equilibrium equivalent concentration (EEC) of radon and thoron daughters (EEC ^{222}Rn + 4.6 EEC ^{220}Rn):

200 Bq/m^3 for exploited residential and public buildings
100 Bq/m^3 must be provided in future buildings

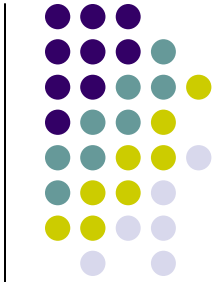
CHOOSING QUANTITY TO SET RL



Radon exposure can be characterized by several quantities, conversion between which is associated with considerable uncertainties.

The total uncertainty of conversion from radon concentration to radiation risk by calculating the effective dose is much higher than the direct risk estimation.

CHOOSING QUANTITY TO SET RL



Radon concentration or radon EEC?

Important advantage of the radon concentration is possibility to conduct its direct measurements

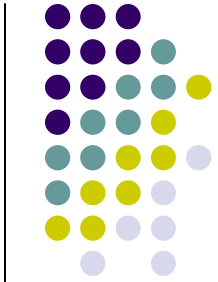
The advantage of using radon EEC is converting to lung dose without consideration unknown equilibrium shift between radon and daughter products.

Disadvantage of radon EEC: annual average EEC of radon progeny can not be directly measured by common methods. In this case, uncertainty associated with the seasonal variations of indoor radon appears.

In Russia, measurements of the radon concentrations using different methods prevail over radon EEC measurements.

The conversion between the measured radon concentration and radon ECC is carried out through a fixed value of the coefficient of equilibrium, which is proposed to be 0.4 or 0.5 in various official guidelines.

CHOOSING QUANTITY TO SET RL



Should thoron be accounted in RL?

There are requirements on restriction of population exposure due to decay products of thoron (radon-220) in Russia.

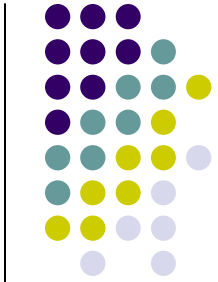
Disadvantages:

- the annual average thoron ECC is associated with a number of unresolved technical and metrological problems
- the doses due to thoron decay products usually are not significant in comparison with radon exposure

Controlling ^{232}Th content in building materials is likely provide the optimisation of radiological protection against thoron and its progeny.

Therefore, to establish RL for radon, the indoor radon concentration is preferable quantity. The conditions, under which this quantity is applied, such as occupancy, value of equilibrium factor and dose coefficients, should be specified.

CHOOSING RL VALUE



600 →	400→	300→	100
ICRP 65	Rus RSS	ICRP 115	WHO

Optimization of protection of population against the radon can not be achieved if national RL is established on the level above maximum indoor radon concentration in dwellings.

If the radon concentration exceeds RL in considerable amounts of dwellings, the expenses to reduce radon exposure will be economically unjustified. Therefore, when establishing national RL for radon, actual data, characterizing overall indoor radon situation in country, should be considered.

CHOOSING RL VALUE

To choose the RL value, certain percentile of distribution of radon in dwellings can be used. For this purpose, such parameters of indoor radon concentration distribution as average and dispersion have to be estimated within representative national radon survey.

Unfortunately, such survey hasn't been performed in Russia yet.

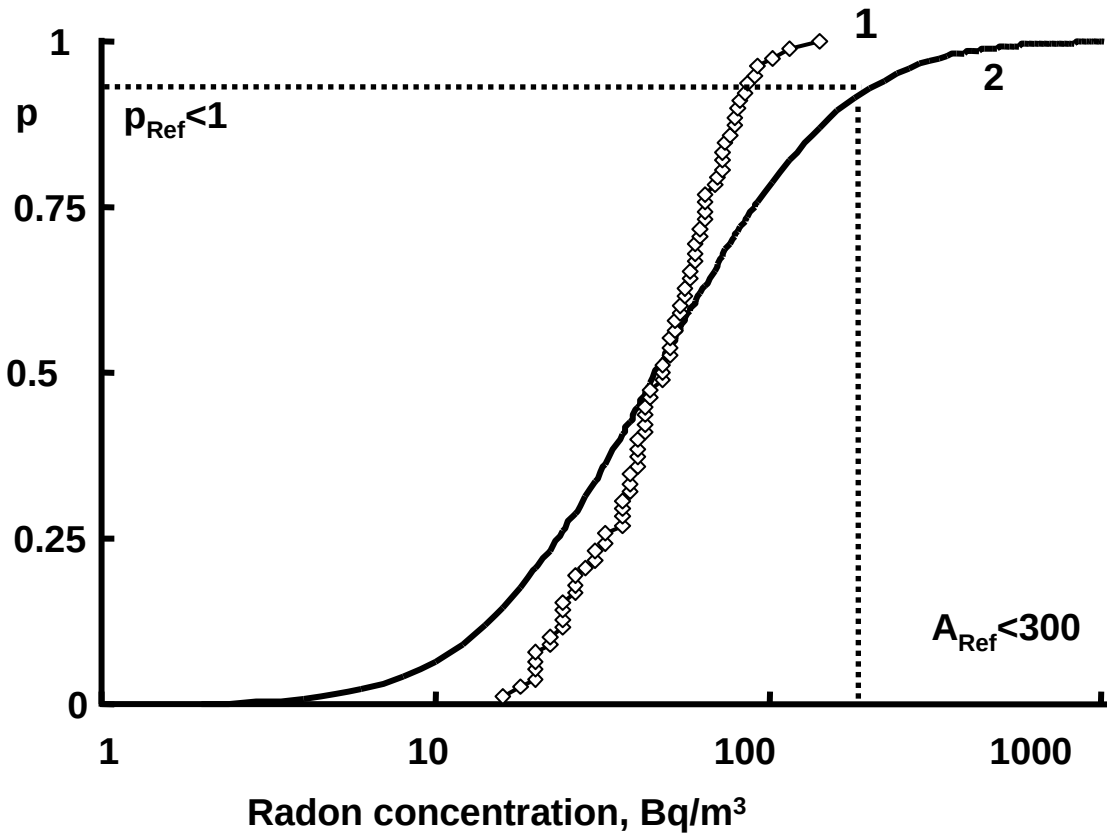
78 regional radiation-hygienic passports (2009 year):
the average regional indoor radon concentration is 52 Bq/m^3,
geometric standard deviation (GSD) is 1.62 in urban dwellings.

Obtained regional average radon concentration can be accepted as rough assessment of country average value.
Considering that the variance of the group mean is always less than variance of the sample, GSD of radon concentration in dwellings must be greater than 1.62. The GSD≈exp(1) have to be expected for large scale indoor radon surveys.

CHOOSING RL VALUE

Value of national RL, A_{Ref}, may be chosen using the conditions as follow:

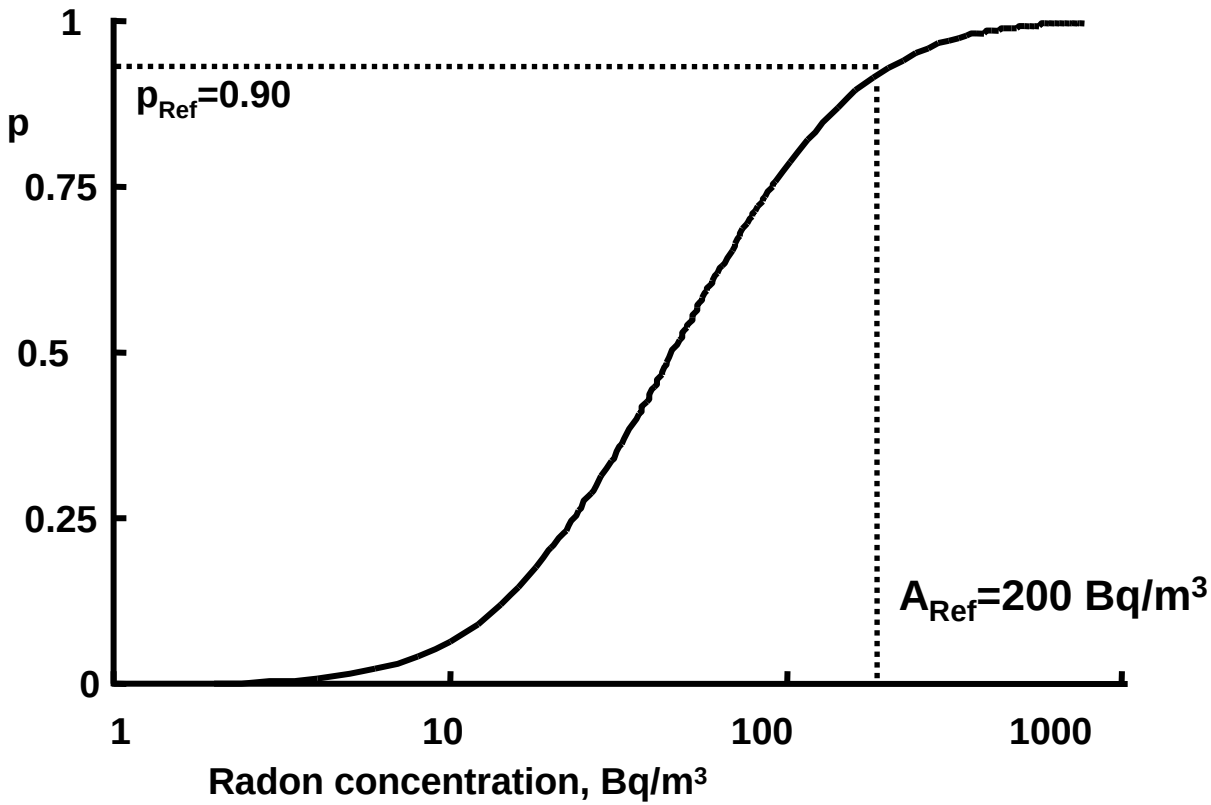
A_{Ref}< 300 Bq/m³ and *p* (A_{Rn}=A_{Ref})<1



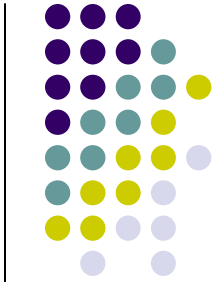
1 – integral distribution of regional average radon concentrations, GSD=1.62;
2 – estimated distribution of radon concentration in dwellings, GSD=2.7.

CHOOSING RL VALUE

Given mean radon concentration 52 Bq/m^3, and GSD=2.7 in urban dwellings, 90-th percentile of distribution corresponds to radon concentration 160 Bq/m^3. Considering one-storey rural houses where indoor radon concentration is usually higher, the 90-th percentile in all types of buildings amounts to approximately 200 Bq/m^3.



CHOOSING RL VALUE



Two levels of RL or single one?

During considerable period passed since establishing two stage norms of indoor radon concentration in Russia, substantial amount of residential and public buildings were constructed meeting the requirements to new buildings. Generally in such buildings, the annual indoor radon concentration is ensured to be below 200 Bq/m^3. When setting new RL, it is not feasible to decline the achieved degree of radiation protection.

Finally, for Russia, single stage national RL expressed by annual radon concentration A_{Ref}=200 Bq/m^3 is appropriate.

RL IMPLEMENTATION PROBLEMS

For optimisation of protection purposes, besides establishing RL value, coefficient K could be introduced.

When measured indoor radon concentration $C_{Rn} > K \cdot A_{Ref}$, corrective measures are considered obligatory.

Under condition $C_{Rn} < A_{Ref}/K$, no measures against radon should be planned in the dwelling.

Within the range of indoor radon concentration $A_{Ref}/K < C_{Rn} < K \cdot A_{Ref}$, decision on the corrective measures has to be made taking to account principle of optimization. The number of individuals under exposure, their ages, technical capability and cost of the corrective measures etc. should be considered.

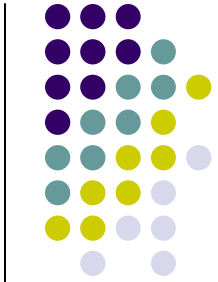
Value of K may lie in the interval 1.5-2.

RL IMPLEMENTATION PROBLEMS

Regions of Russia with regional radon concentration above country average value 52 Bq/m^3

Establishing sub-national regional RL for radon along with the national RL is reasonable in such big countries as Russia. Taking to account economical and social factors the regional RL may be set at a level both below and above national RL, but within the the range from A_{Ref}/K to $K \cdot A_{Ref}$.

CONCLUSIONS



- **The experience with regulation the indoor radon exposure applying ECC of radon and thoron daughters as central quantity of control was generally successful. Nevertheless for future optimization of radiation protection, distinct RL expressed by the annual indoor radon concentration should be now established in Russia. Then thoron exposure has to be considered in the frames of radiation control of building materials**

- **Single stage national RL should be set at value of annual radon concentration A_{Ref}=200 Bq/m^3**

- **Establishing regional RL for radon along with the national RL allows future optimisation of protection against radon in Russia**

Thank you for attention