The Israeli Model for Calculating the Radioactivity Indexes

Dr. Yair Shamai

Radiation Safety Division

Soreq NRC

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Aim:

- **Find the coefficients for the following equation:**
- **$[Th]/A_{Th}+[Ra](1-e)/A_{Ra}+[^{40}K]/A_{40K} + e[Ra]/A_{Rn}< 1$***
- [j] are the actual activity concentrations in the walls.
- A_j are the indexes, which are the concentrations which lead to the total dose to be exhausted by radioactivity of the single contributor j.
- e is the fraction of Rn that escapes from the walls
- The total dose is defined by the existing dose + the permitted addition, which was decided to be 0.3mSv

- * The factor "1" can be reduced for special cases like ceramic tiling

External dose calculation

- Our model includes a numerical integration (summation) on voxels of any desired size, on all 6 faces of any room (standard 3x3x2.7 m^3). Each voxel acts as a point source with the activity of all of the NORM, and attenuation + build-up is calculated to any defined point inside the room (the center).
- The summation runs over all voxels, over all gamma lines (BR>1% E>20keV), taking into account the slant passage through the walls, including half of the voxel. This gets us the dose (air Kerma) per unit act.
- Multiplication by 0.7 converts air Kerma to effective dose.

Radon

- The concentration of Rn (from the walls) is governed by [Ra] and the amount of material (in the 6 sides of the room) S·d·ρ, the fraction of the gas that escapes from the walls (e), the dimensions of the room (S-surface, V-volume, d-thickness of the wall), and the air exchange rate (vent) (in ach: air exchanges per hour)
- $[Rn]=S/V\cdot[Ra]\cdot e\cdot\lambda\cdot\rho\cdot d/2\cdot vent^{-1}$ (true as long as $\lambda << vent^{-1}$)
- To get the dose [Rn] is mult. by the dose convention 0.017mSv/(Bq/m3) (which needs to be changed due to recent recommendations) $D_{Rn}=\{6.46E\text{-}5\cdot S/V\cdot\rho\cdot d\cdot vent^{-1}\}\cdot e\cdot[Ra]$ thus dependent on the dimensions, on vent and on e

- λ(h-1)*0.017(mSv/Bqm^{-3} for 7000h/year)/2=7.6E-3*0.017/2 = 6.46E-5

The reference dose

- The γ dose inside the standard room, which stems from all the walls, was calculated with this model for an average local concentration of NORM. (0.94 cov. factor)
- The Rn conc. was taken as 50Bq/m^3 from a survey made in home-shelters in high-rise buildings
- Thus we got the ref. doses for the standard room prior to the change of building technology.
- In a concrete room the annual doses were found to be 0.25mSv for γ + 0.85Sv for Rn = 1.1mSv, and some smaller numbers for lighter materials. These values are input to the model.

The value of the indexes

- $A\gamma$ = Dtot/D_γ(1Bq/kg) for all γ emitters
- A_{Rn} depends on d, e, vent. So it was calculated for d=20cm, e=1 and for a vent value of 0.5 ach.

- (It should be noted that the factor of 2 between the measured lab emanation to the room emanation is embedded in the factor A_{Rn}).

- **$[Th]/A_{Th}+[Ra](1-e)/A_{Ra}+[40K]/A_{40K} + e[Ra]/A_{Rn} < 1$**

Thank you