RADIATION EXPOSURE DUE TO RADON IN DRINKING WATER IN REGIONS WITH HIGH TERRESTRIC ACTIVITY

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INTRODUCTION

We performed investigations to evaluate the radiation exposure due to the private use of drinking water in the region of the German Fichtelgebirge (300 km North Munich near the Czech border), where the content of Radon in ground water is very high. Besides the drinking water pathway the different practices in the household were investigated such as taking showers, stay in a hairdressing salon, operating a washing machine.

RADON CONTENT IN WATER

In water Radon concentrations from less than 0,1 mBq/l up to more than 5 kBq/l are to be found. In Germany the mean concentration of tap-water is 7,2 Bq Rn 222 per litre [3].

In table 1 there are listed the results of our measurements in the German Fichtelgebirge (300 km North Munich near the Czech border).

Location		C(Rn-222) [Bq/l]
Swimming pool Hof	Upstream charcoal filter	250
	Downstream charcoal filter	6
	Pool, waterfall	6
	Non swimming pool	8
	Whirl pool	3
	Sauna, pool	6
Shower, Weißenstadt*	Run in, bath	685
Inn, Ochsenkopf, private well	Run in (mainstream), cellar	836
Hotel, Fahrenbühl	Run in, bath	320
	Run in, kitchen	301
	Run in, swimming pool	283
Farm house, Fahrenbühl	Run in, bath	281
	Well, backyard	114
Hairdresser, Kirchenlamitz	Run in, washbasin	397
Inn, Girgelstein, private well	Run in, washing machine	920
	Run in, dish-washer	798
	Run in, bath	710
	Run in (mainstream), cellar	898

*- Drinking water treatment facility of Municipal Water Supply, City of Hof

Table 1: Rn-222 concentration in drinking water, emanation free taken

RADIATION EXPOSURE DUE TO CONSUMPTION OF DRINKING WATER

Following [2] we assumed equilibrium between Rn 222 and his short lived daughter nuclides Po 218, Pb 214, Bi 214 and Po 214. For Rn 222 concentrations above 100 Bq/l we assumed Pb 210, Bi 210 and Po 210 concentrations of 5 mBq/l due to Radon. These nuclides are negligible for Rn 222 concentrations below 100 Bq/l. These assumptions arise from the results given in [2].

There are 3 pathways to distinguish:

- Intake of freshly taken drinking water (concentration of Rn 222, short and long lived daughter nuclides as measured, see above)
- Consumption of drinks made of heated up drinking water such as tea, coffee (Rn 222 completely off, short and long lived daughter nuclides as above)
- Use of drinking water for cooking of liquid foodstuff (duration $\geq$ 1 hour; Rn 222 completely off, short lived daughter nuclides 25% of freshly taken water, long lived daughter nuclides as above)

Based on the highest measured Radon concentration of about 1000 Bq/l for freshly taken water, assuming an average consumption rate of 400 l drinking water per year [1] and the distribution of the total consumption as 1 : 3 : 2 (70 l : 200 l : 130 l per year) into the above mentioned three pathways an effective dose of 1,5 mSv per year has been estimated. For the German average Rn 222 concentration in freshly taken water of about 5 Bq/l the effective dose yields to 7 µSv per year. In both cases the main part (about 95%) of the estimated effective dose results from the intake of freshly taken drinking water.

RADIATION EXPOSURE DUE TO TAKING SHOWERS

Figure 1 shows the measured concentration of Rn 222 and his daughter nuclides during taking showers for a measured Rn 222 concentration in water of 685 Bq/l. The maximum values of Rn 222 concentration in air and EER respectively are 21.350 Bq/m³ and 5.860 Bq/m³. A 1 hour shower taking of a family was simulated. After taking the shower a 20 minute stay in the bathroom was assumed for hair drying, e. g. As expected the air concentration is lower leaving the window ajar (approximately by a factor of 3). Assuming a stay of 20 minutes per day at the most unfavourable time the integration of EER given in figure 1 yields to an exposure of 1 WLM and hence an effective dose of 4 mSv per year using the dose conversion convention 4 mSv per WLM according to ICRP 65.

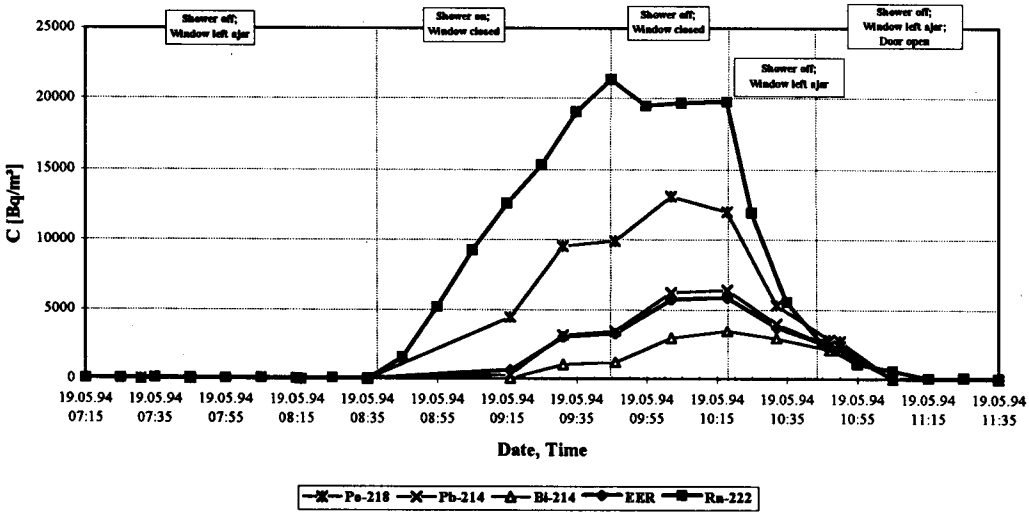

Figure 1 ***Rn-222- and Rn-222 Daughter Nuclides Concentration in Air while Taking Showers (Volume 11,25 m³; Rn 222 concentration in Water 685 Bq/l; 9 °C; 15 - 18 l/min)***

RADIATION EXPOSURE DUE TO OPERATING A WASHING MACHINE AND FOR STAY IN A HAIRDRESSING SALON

Concerning the radiation exposure due to the Radon concentration in water for a stay in a hairdressing salon and for operating a washing machine the same investigations have been conducted.

The washing machine has been running with a Rn 222 concentration in water of 280 Bq/l. The maximum values of Rn 222 concentration in air and EER respectively (volume 31,2 m^3) are 925 Bq/m^3 and 85 Bq/m^3. Assuming a 20 minutes stay in the room per week after finishing the machine operation the integration of EER yields to an exposure of 0,002 WLM and hence an effective dose of 8 µSv per year using the dose conversion convention 4 mSv per WLM according to ICRP 65.

The water used in the hairdressing salon had a Rn 222 concentration of 400 Bq/l. The maximum values of Rn 222 concentration in air and EER respectively were 285 Bq/m^3 and 120 Bq/m^3. Assuming a 2 hours stay in the hairdressing salon per month the integration of EER yields to an exposure of 0,002 WLM and hence an effective dose of 8 µSv per year using the dose conversion convention 4 mSv per WLM according to ICRP 65.

References

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