THE ADDITIONAL EXPOSURE DUE TO THE USE OF UNCOMMON BUILDING MATERIALS IN ROMANIA

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INTRODUCTION

Beginning with 1981, the district ionizing radiation hygiene laboratories, charged by the Ministry of Health with the surveillance of the work places and the environment, have signaled the attempt of the industry to introduce new highly radioactive materials in the building products. Phosphogypsum, by products of the phosphate fertilizer industry, and slag and ash, wastes of the coal-fired power plants, are the most important of them.

In order to establish radioactivity levels and limits for the building materials and the exposure due to their use, some studies have been elaborated by the specialized laboratories of the Ministry of Health. As a result, admissible limits for the building material radioactivity have been chosen the maximum values obtained for the building materials commonly used, are presented in Table 1.

The additional exposure and fly ashes have been assessed by two ways:

1) The measurements of the potential alpha energy concentrations, PAEC (mWL) and equilibrium equivalent concentrations (Bq/m^3) for radon level were carried out in a flat with internal walls of phosphogypsum. The measurement results were compared both with those obtained for the flat without internal walls and those obtained for the houses from Romania (50% of the country).

2) For the same flat of the experimental house, annual effective dose were calculated.

MATERIALS, METHODS AND RESULTS

Samples of phosphogypsum obtained from the main producers of phosphate fertilizers and samples of the fly ashes collected on filters came from 18 coal-fired power plants were analysed by the high resolution gammaspectrometry method using a 4096 MCA Canberra systems equipped with Ge(li) detectors. Results are presented in Table 2.

An experimental detached house (basement, ground floor, garret) was built with usual building materials (concrete 15 cm thick and aerated concrete bricks 30-35 cm thick for walls, concrete 20 cm thick for floor and ceiling, the flat of ground floor having the internal walls of phosphogypsum (7 cm thick).

In order to estimate the contribution of the Rn level in the flat, PAEC or EEC levels were determined by Nazaroff's method [1] occasionnally doubled by Sima's method [2]. The annual effective dose given by the building materials have been estimated on the basis of the data delivered by UNSCEAR Reports 1982 and 1993 [3,4] and W van Dijk [5].

The results are presented in Table 3. The exposure generated by the phosphogypsum only partly used in a flat is very high compared to both ground floor values (4-5 times higher) and the mean value obtained for the houses in Romania (2-3 times higher).

CONCLUSIONS

As a result of these studies, the Ministry of Health included two articles regarding the use of the building materials in the "Regulations concerning the radioprotection of the population and environment"

a) "The natural radioactive elements in building materials should correspond to the raw materials from which are derived, the intentional addition of the natural and artificial radioactive elements being prohibited"

b) "The use as building materials of the sterile, slag and by-products of the fertilizer industry, with a natural or artificial content higher than the value of the products commonly used in the building industry is forbidden"

The use of phosphogypsum as building material for social dwellings was banned in any way (no mass proportion was addmitted). In the case of the potential building materials containing fly ash, each solution should be analysed and licensed by the Ministry of Health on the basis of the Ra-226, Th-232 and K-40 radionuclide concentrations of the products and dose assessements.

Table 1. Concenrations of the ^{226}Ra, ^{232}Th, ^{40}K radionuclides in the building materials commonly used in Romania (Bq/kg)

Type of material	No. of samples	^{226}Ra		^{232}Th		^{40}K	
		Arithmetic mean	Max.	Arithmetic mean	Max.	Arithmetic mean	Max.
Red brick	32	35.9	**100.0**	32.2	**53.3**	493	**833**
Cement	25	33.9	**66.3**	17.8	**97.0**	152	**504**
Natural gypsum	14	17.8	**43.0**	9.6	**27.0**	103	**277**
Lime	8	13.3	**41.0**	8.2	**18.5**	68	**167**
Concrete	16	27.8	**78.5**	20.0	**38.5**	201	**452**
Mortar	4	5.9	**7.8**	5.9	**12.2**	426	**611**
Aerated concrete brick	7	16.7	**32.2**	15.6	**36.7**	163	**277**
Sand, gravel	14	7.8	**30.0**	27.4	**91.7**	557	**870**
Various rocks	11	25.2	**63.0**	21.5	**75.9**	434	**1370**
Clay	3	24.8	**30.4**	49.3	**66.7**	861	**1140**

Table 2. Concentrations of the ^{226}Ra, ^{232}Th, ^{40}K radionuclides in the phosphogypsum and fly ash (Bq/kg)

Type of material	No. of samples	^{226}Ra		^{232}Th		^{40}K	
		Range	Arithmetic mean	Range	Arithmetic mean	Range	Arithmetic mean
Phospho-gypsum	54	237-970	702	11.1-42.2	22.6	60-167	113
Internal walls of the experimental house (phospho-gypsum)	10	554-809	659	6.7-32.2	13.1	15-43	18
Fly ash	18	64.4-218.5	154.6	73.6-125.9	88.8	277-945	569

Table 3. Additional exposure for the flat with internal walls of phosphogypsum.

	Houses in Romania	Flat without internal walls from phospho-gypsum	Flatwith internal walls from phospho-gypsum	Ratio		Additional exposure (mSv/year)	
	1	2	3	3/1	3/2	3-1	3-2
EEC(radon) Bq/m^3 measured	a=21.6 g=17.2	a=11.7 g=10.1	a=54.0 g=48.5	4.6 4.8	2.6 2,8	-	-
Total effective dose (mSv/y)	1.4	0.9	4.2	3	2.1	2.8	3.3

REFERENCES

1. W.Nazaroff - "An improved technique for measuring working levels of Radon daughters in residences" - Health Physics, vol.39 (October 1980), pp.683-686

2. O.Sima ,S.Sonoc, C.Dovlete - "Critical analysis of the least square method applied to the determination of the environmental Radon and Thoron daughters", Studii si cercetari de Fizica, nr.38, 1986

3. Ionizing Radiation: SOurces and biological effects - UNSCEAR Report 1982.

4. Sources and effects of ionizing radiation - UNSCEAR Report 1993.

5. W.van Dijk, P.de Jong - "Determining the ^{222}Rn exhalation rate of the building materials using liquid scintilation counting" - Health Physics, vol.61, no.4, 1991.