RADIATION EXPOSURE OF THE POPULATION IN THE VICINITY OF COAL-FIRED POWER PLANTS

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ABSTRACT

Our investigation included 4 coal-fired power plants (CPP). All 4 CPPs are located near inhabited places and the depots of ash and slag are 2-5 km away from the CPPs. The measuring of the exposition dose rate was performed using the highly sensitive ionizing chamber under high pressure "in situ" 1 m above ground and termoluminescent (TLD) dosimeters on 4 measuring points (2-5 km in front of the CPP, on the ground of the CPP, at the depots of ash and slag and 2-5 km behind the CPP). The average annual radiation dose on 5 locations in the surroundings of the CPPs is approximately 1 mSv.

INTRODUCTION

It is known that all types of coal contain at least 1-2 ppm uranium and 3-4 ppm thorium which correspond to 12.2-24.4 Bq/kg uranium-238 and 12.21-16.8 Bq/kg thorium-232 as well as the products formed by their radioactive decay (1, 2). These concentrations are somewhat less in comparison to the content of natural radionuclides in the earth's crust (3). However, some types of coal contain considerably higher amounts of natural radionuclides (hard coal). Besides this, combustion of coal in CPPs leads to the concentration of natural radionuclides, during which the enrichment factor for ash and slag can amount from 5 to 10 (4-6). It was therefore interesting to examine the contribution and influence of CPP on the environment and total irradiation dose of the population (7-9).

MATERIAL AND METHODS

Exposition dose rates of gamma radiation were measured "in situ" at 1 m above the plain surface of ground. Measurements were made at four locations (2-5 km in front of the CPPs along the most frequent wind direction, on the grounds of CPPs, at the depots of ash and slag and 2-5 km behind the CPPs along the most frequent wind direction).

Three instruments were used for measuring exposition doses of gamma radiation:
- highly sensitive, pressurized ionization chamber (0.35 MPa argone + 1.4 MPa nitrogen), with low detection limit of 0.258 nC/kgh and resolution of 0.00258 nC/kg, manufactured by "SILENA",
- termoluminescent dosimeters (TLD) from the Institute for Nuclear Science, Vinca (each box contained 3 TLD tablets).

RESULTS AND DISCUSSION

A comparison of gamma radiation exposure dose rates at four locations for all the CPPs examined is given in Table 1 and 2. Table 1 shows that the highest values for CPP 1 were detected on depots of ash and slag (11.44 E-4 nC/kgs), while the other three locations had almost identical values. Exposition doses of gamma radiation in CPP 2 showed approximately equal values in all locations, while the highest exposition dose was measured 3-5 km behind the CPP and amounted to 8.60 E-4 nC/kgs. Approximately equal values were detected in all locations measured in CPP 3. The exposition dose rates for CPP 4 ranged from 7.17 E-4 (depot) to 9.13 E-4 nC/kgs (3-5 km behind the CPP).

Table 1. Radiation doses measured by anionizing chamber in the vicinity of coal-fired power plants

Locality	Dose (nC/kg s)			
	1.	2.	3.	4.
3-5 km in front of CPP*	9.55E-4	7.17E-4	7.62E-4	7.70E-4
On the grounds of CPP	9.14E-4	7.17E-4	7.71E-4	9.10E-4
3-5 km behind CPP*	9.13E-4	8.60E-4	7.54E-4	9.13E-4
Depot of ash and slag	11.44E-4	7.51E-4	7.65E-4	7.17E-4

*along the most frequent wind direction

Table 2. Radiation doses measured with TL-dosymeters in the vicinity of coal-fired power plants

Locality	Measuring period	Dose (mSv/3 month)			
		1.	2.	3.	4.
3-5 km in front of CPP*	jan.-march	-	0.31	0.31	0.33
	apr.-june	0.16	0.16	0.17	0.19
	july-sept.	0.46	0.22	0.24	0.23
	okt.-dec.	0.23	0.20	0.24	0.17
	Annual dose:	-	0.89	0.96	0.94
On the grounds of CPP	jan.-march	0.30	0.33	0.42	0.29
	apr.-june	0.17	0.25	0.19	0.16
	july-sept.	0.22	-	0.32	0.27
	okt.-dec.	0.21	0.19	0.22	0.25
	Annual dose:	0.90	-	1.15	0.97
Close to electrofilter	jan.-march	0.29	0.27	0.25	0.20
	apr.-june	0.17	0.17	0.17	0.18
	july-sept.	0.21	0.19	0.18	-
	okt.-dec.	0.21	0.22	0.21	0.27
	Annual dose:	0.88	0.85	0.81	-
On the depot	jan.-march	0.30	0.29	0.27	0.34
	apr.-june	-	0.22	0.19	0.18
	july-sept.	-	0.20	0.19	0.29
	okt.-dec.	0.18	0.19	0.20	0.22
	Annual dose:	-	0.90	0.85	1.03

Table 2. Radiation doses measured with TL-dosymeters in the vicinity of coal-fired power plants (continued)

Locality	Measuring period	Dose (mSv/3 month)			
		1.	2.	3.	4.
3-5 km behind CPP*	jan.-mart	0.29	0.32	0.30	0.32
	apr.-juni	0.16	0.19	0.19	0.16
	juli-sept.	0.24	0.24	0.23	0.25
	okt.-dec.	0.24	0.21	0.24	0.24
	Annual dose:	0.93	0.96	0.96	0.97

*along the most frequent wind direction

An analysis of results indicates that the highest irradiation doses for all CPPs were measured during the period from January to March, while the lowest from March to June. It was obvious that the doses on depots of ash and slag as well as on the grounds and behind CPPs, in the direction of winds, were higher than at other locations. The total annual doses were highest at locations 3-5 km behind CPPs (except for CPP 3, where the highest annual dose was detected on the grounds of the CPP). The relatively lower doses detected close to the electrofilters are probably due to the absorption of radiation from metal constructions located between the dosimeters and the electrofilter contents, because it was not technically possible to set the dosimeters into the electrofilters.

Differences in values of doses detected between the spring-summer and autumn-winter seasons are most probably a consequence of a difference in the intensity of production of CPPs and repair work usually carried out in the spring-summer period. Table 2 gives a comparison of the exposition dose rates of gamma radiation at four locations measured for all the CPPs examined.

CONCLUSION

The basic problem of technologically induced increase of natural radioactivity caused by CPPs is the increase of the basic radiation rate in the surrounding area and higher exposure of the local population to radiation.

For coal with elevated or high uranium contents, a question is raised whether such depots should be considered as uranium strip mines or not. The potential for the discovery and application of coal with higher natural radioactivity is increasing as well as the need for coal. Therefore, it is necessary to devote much more attention to environmental pollution with radioactive material from coal-fired power plants in both research and scientific work as well as to legally regulate the technologically induced increase of natural radioactivity.

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