RADIATION EXPOSURE POTENTIAL FROM COAL-FIRED POWER PLANTS IN ROMANIA

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INTRODUCTION

Thermoelectric power generated by coal represents about 30% of the electric power production in Romania (1). The combustion of coal results in release to environment of naturally occuring radionuclides. These are reasons for the research about the radiological impact of coal-fired power plants on the surrounding zones and population living there.

With that end in view we selected ten representative modern and older coal-fired power plants in Romania with a total installed capacity of 2.5 Gw.

MATERIALS AND METHODS

This work performed during 1984-1994, involved the measurement of activity concentrations of natural radionuclides in coal (235 samples) bottom and fly-ash (820 samples) originating from the power plants. Soil, vegetation and snow samples (910) have also been collected at 20 locations from the surroundings of each thermal power plant within a 5 Km radius from the stack. All the samples were counted for their natural radioactivity content using gamma ray spectrometry techniques and radiochemical methods (2,3).

RESULTS AND DISCUSSION

In the investigated power plants they burn brown coal, lignite and/or mixture of different kinds of coal : brown coal, lignite, pit coal, pitch coal, bituminous coal. The activity concentrations measured in the coal samples varied over two orders of magnitude (Table 1). The natural radionuclide concentrations in fly ash are significantly higher than the corresponding concentrations in the coal (Table 1).

The normalized discharged activities for the investigated power plants are much higher than those estimated in the UNSCEAR 1988 Report for typical old and modern plants (Table 2). Firstly, accounting for this is the low ash retention efficiency of the particulate control devices of power stations, especially for the older ones,and secondly,the high ash content of the coal: 26-60%. The low quality of coal leads to the higher coal consumption; thus the combustion of up to 20.10^9 Kg of coal is required to produce 1 Gwa of electrical energy.As a result,the activities of radon-222 and of radon-220 released per Gwa have been assessed at 25 to 770 GBq (2,3).

Table 1. Activity mass concentrations of natural radionuclides in coal and ash samples ($Bq.Kg^{-1}$)

Radio-nuclide	Brown coal	Lignite	Mixture of coal	Bottom ash	Collec-ted fly - ash	Escaping fly - ash
^{238}U	39[x]	41	30.6	38	71	80
	7-101[xx]	1.5-96	1.1-112	2 -160	3 -312	4 - 420
^{226}Ra	38	74	53.5	69	113	126
	1 -91	8 -152	4 -120	5 -237	4 -528	6 - 558
^{210}Pb	-	-	-	-	206	210
					10 -500	11-510
^{210}Po	-	-	-	-	240	260
					10 - 540	11-580
^{232}Th	30	25	16.5	49.5	59	62
	5 -45	10 - 35	1 - 43	1.5-147	2 - 170	2.2-170
^{228}Th	-	-	-	-	70	79
					1.2- 175	1.0-175
^{40}K	310	274	305	526	500	547
	230-590	182-490	30-615	158-1000	160-1200	160-1300

x - Arithmetic average ; xx - Range

Table 2. Estimates of annual atmospheric discharges per unit energy generated (GBq per Gwa)

Radionuclide	Coal - fired power plants (10)	
	Modern (7) [x]	Old (3) [xx]
^{238}U	0.19 - 50	28 - 281
^{226}Ra	0.07 - 47	28 - 201
^{210}Pb	0.17 - 86	52 - 300
^{210}Po	0.50 - 85	60 - 330
^{232}Th	0.04 - 17	10 - 65
^{228}Th	0.06 - 22	13 - 80
^{40}K	10.50 - 236	200 - 915

x - Fly-ash removal efficiency 96-99.5%
xx - Fly-ash removal efficiency 60-80 % ; in 1993,the worst of these plants was modernized.

Mesurements in soil, snow and vegetation had clearly shown the presence of increased concentrations of the natural radionuclides in the surroundings of the coal - fired thermal power plants,particularly for the oldest and most poorly controlled ones (Table 3).

Table 3. The average activity concentrations of natural radionuclides in soil,vegetation and snow (Bq kg^{-1})

Natural radionuclide	Soil (560 samples)		Vegetation	Snow
	the upper 5cm layer	the 5-15 cm layer	175 samples	175 samples
^{238}U	33 ± 30	26 ± 25	51 ± 46	$(4.2\pm3.1).10^{-3}$
^{226}Ra	38 ± 30	30 ± 27	30.8 ± 7.5	$(2.6\pm2.0).10^{-2}$
^{232}Th	36 ± 17	29 ± 16	83 ± 61	$(2.5\pm1.5).10^{-3}$
^{40}K	535 ±180	420 ±170	451 ±100	$(4.5\pm3.8).10^{-1}$

The resulting normalized collective effective doses (Table 4) have been estimated taking into account: the activity released per electrical energy unit; the population density; the wind rose and the deposition (dry and wet) velocity; the effective stack height (ranging from 55 m to 220m) (4,5).

Table 4. Estimates of normalized collective effective doses (manSv per Gwa)

Coal-fired power plants	Inhalation during the cloud passage	Irradiation due to deposited activity		Total
		Internal	External	
Modern	0.06-2.39	0.17-2.31	0.009-0.101	0.24 - 4.8
Old	10.4-34.5	7.2 -31.0	2.4 - 10.5	20 - 76

CONCLUSIONS

1. The population living in the neighbourhood of a inadequately controlled coal fired power plant is exposed to enhanced levels of natural irradiation.

2. The mass of $384x10^6$ Kg fly ash annually released to the atmosphere from ten coal - fired thermal power plants was considered to be the main cause of disturbance of natural radiation background and of enhancement of population doses.

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