NATURAL RADIOACTIVITY AROUND THE COAL-FIRED POWER PLANT

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ABSTRACT

By far the greatest part of the radiation received by the world's population comes from natural sources. In some situations the exposure to natural radiation sources is enhanced as a result of technological developments. Burning of coal is one source of enhanced radiation exposure to naturally occurring elements, particularly radium, thorium and uranium. Extensive investigations have been performed in the coal-fired power plant (CFPP) Plomin in Croatia, using an anthracite coal with a higher than usual uranium content and normal thorium content. A network of TL dosimeters (TLD), working levels (WL) measurements, air pollution monitoring and monitoring of waste pile were organized. Some of the measurements have been repeated, and the results have shown decreased contamination.

INTRODUCTION

One of the first sources of uranium and thorium which were detected not being connected with the nuclear industry, was found during energy production using fossil fuels [1,2]. Coal is burned in CFPP at about 1700 °C, and the activity is redistributed from the underground (where the impact on humanity is nill) and liberated into the environment. Most of the radioactive substances are concentrated in the ash and slag, which are heavy and drop to the bottom of a furnace. Lighter fly ash is carried up the chimney and irradiates the environment. The bottom ash and slag are usually deposited to the waste pile, from where some activity may leach into aquifer, or be dispersed by wind.

METHODS

Air samples for determination of total alpha activity were collected on Schneider-Poelman filters with the aid of an air pump.

At the same sampling stations, the fallout samples were collected. One litre from the monthly sample was evaporated to dryness for determination of total alpha activity.

Determination of total alpha activity was performed by using a surface barrier Si detector and 1 K analysing system [3,4].

To obtain the monthly mean concentrations of gamma emitters in surface air, the airborne particles were collected on glass fibre filters (with a normal collection efficiency of 99.9 % for 0.3 μm particles) by means of a high-volume air sampler at a flow rate of 2000 m^3 in 24 hours.

The activities of natural radionuclides were measured by use of Ge(Li) detector jointed to 4 K channel analysing system and connected on line with the computer [3,4].

Radiation surveys of the working area inside the CFPP were made with a Victoreen Thyac III gamma-beta survey meter, with a detector held one metre above the surface. Later on a network of TL dosimeters was organized.

Our investigations on WL measurements, at the beginning were performed using the Holmgren's method [5], but later on we find more convenient the field method developed by Scott [6].

RESULTS AND DISCUSSION

Monthly mean values of total alpha activities in surface air showed fluctuations through the year. The maximum value was obtained in winter (2.4 E-5 $Bq \cdot m^{-3}$) at the location 1.5 km far from CFPP, SEE direction. The lowest values were in summer (less than 3.0 E-6 Bq·m^{-3}, with the maximum of 2.4 E-6 Bq·m^{-3}).

The maximum value of total alpha activity was determined in monthly fallout sample from September (2.7 E+1 Bq·m^{-3}), what was in direct connection with the amount of rain.

Specific activities of ^{238}U, ^{226}Ra and ^{40}K in surface air samples are presented in Table 1.

	^{238}U	^{226}Ra	^{40}K
Around CFPP	4.0 E-6	2.8 E-7	6.2 E-7
Northern Hemisphere	2.6 E-8	3.0 E-9	3.1 E-5 [7]

Table 1: Specific Activities in Surface Air (Bq·m^{-3}).

It is obvious that the activity levels around the CFPP exceed the values in Northern Hemisphere by factors of hundred.

The external level of natural radiation around working places at the time of measurement varied from 13 to 39 nC·kg^{-1}·h^{-1}. The highest value was 129 nC·kg^{-1}·h^{-1}, obtained on one occasion under the ash hopper. The background of the surrounding countryside showed fluctuations between 1 - 2 nC·kg^{-1}·h^{-1}.

Five different workplaces inside the CFPP were chosen for WL measurements. The highest data were obtained at fresh waste pile and beside the bottom ash (83 mWL). The work places listed according to decreasing contamination, calculated on the bases of 170 working hours per month were:

Fresh waste pile (13.6 WLM) ➤ **Below the ash hopper (10.2 WLM)** ➤ **Coal conveyor belt (2.6 WLM)** ➤ **Steam generator building (1.0 WLM)** ➤ **Under the stack (0.9 WLM)**

On site places with good ventilation had 0.9 - 2.6 WLM.

WLM data did not differ from two measurement points - one 500 m distance from the CFPP (office building) and the other 10 km SW from the CFPP. On both locations we measured 0.5 WLM.

More recently some of the measurements were repeated, and all the results have shown decreased contamination. The reason for that probably is use of the coal with low concentration of uranium. The old waste pile has been covered with 0.5 m thick level of soil and grass was sawed on, so that is another reason for decreased contamination at surrounding area.

CONCLUSION

It seems that covering the waste pile with soil was good solution for reducing radioactive contamination in the environment and to keep the possible risk to the surrounding population under permanent control. However, it is necessary to control the radioactivity of coal used for combustion, slag and ashes deposited on new waste pile. WL measurements should be conducted at least once a year.

REFERENCES

1. M.Eisenbud, H.G.Petrow: Radioactivity in the Atmospheric Effluents of Power Plants that use Fossil Fuel. Science 144 (1964) 288.
2. H.L.Beck, et.al.: Perturbations on the Natural Radiation Environment due to the Utilization of Coal as an Energy Source. In: Natural Radiation Environment III. CONF-780422, 2 (1980) 1521.
3. HASL-300, EML Procedures Manual (Ed. J.H.Harley), U.S. Atomic Energy Commission, N.Y. (1971).
4. IAEA, Measurements of Radionuclides in Food and the Environment, Tech.Rep.Ser. No. 295, Vienna (1989).
5. R.M.Holmgren: Working Levels of Radon Daughters in Air Determined from Measurements of RaB+RaC. Health Phys. 27 (1974) 141.
6. A.G.Scott: A Field Method for Measurement of Radon Daughters in Air. Health Phys. 41 1981) 403.
7. UNSCEAR, Ionizing Radiation Sources and Biological Effects. UN., N.Y. (1982).