GAMMA RADIATION AND RADON CONCENTRATION LEVELS AT THE RADIOACTIVE WASTE REPOSITORIES „RICHARD" AND „BRATRSTVÍ"

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1. Introduction

Disposal of radioactive wastes underground after appropriate conditioning is generally considered to be a feasible method of providing adequate protection for the population and the environment. In the Czech Republic most low and intermediate level radioactive wastes are deposited in two repository sites - abandoned mines - operated by the ARAO, Ltd., Prague, namely the Richard Repository near the town of Litoměřice and the Bratrství Repository located in the Jáchymov area [1].

2. Monitoring tasks

Although both repositories are routinely monitored in accordance with the requirements of the State Office for Nuclear Safety, some more detailed measurements were carried out inside and outside these waste disposal facilities. Primary attention was paid to the assessment of the gamma dose equivalent rate at selected places in the repositories and in their vicinity. Further measurements were focused on radon concentration monitoring, where some other parameters as air temperature, humidity and atmospheric pressure were also observed.

3. Instrumentation

A continuous monitor GammaTRACER [2] was used for dose equivalent rate measurements. The instrument is based on two energy compensated GM detectors whose signals are processed and evaluated by sophisticated electronics using custom-made hybrid chips. The monitor, which also measures temperature, has sufficient memory capacity to store results of dose equivalent rates and temperatures for several days or months depending on a set time interval. The data can be transferred easily, via a modem using infrared radiation, into a PC for display and for further evaluation of the dose rate time profile. The monitor is capable of detecting radiation levels in a wide range - from about 10 nSv/h to 10 Sv/h. A long-life lithium cell supports the operation for the minimum of 5 years.

Radon concentration was continuously measured by a portable radon monitor AlphaGUARD [3]. In addition to the radon concentration in the air, the instrument can also simultaneously measure and record ambient temperature, relative humidity and atmospheric pressure using special integrated sensors and its high storage capacity. The monitor incorporates a pulse-type ionisation chamber along with digital signal processing and evaluation. The range of measurable radon concentrations is between 2 Bq/m^3 and 2 MBq/m^3. This multiparameter instrument is characterised by its imperviousness to high humidity and its automatic data logging of all results, with a memory capacity sufficient for 21 days of continuous operation. Also in this case, the monitor can communicate with the PC, for which full software support with numerical and graphical presentation tools is available.

4. Results of measurements

The map of the repository structure and results of the measurements are illustrated in the attached figures.

Fig. 1 shows the labyrinth of the Richard Repository together with the values of the dose equivalent rate in nSv h^{-1} at the selected locations. The highest radiation levels were found near the stored barrels containing various low and intermediate radioactive waste.

As it was expected, inside the repository, the excessive radon concentrations in the air were observed (Fig. 2). The actual radon levels strongly depend on the ventilation (see Fig. 2, e.g., the interval F - where during working hours, the radon concentration was decreasing when the ventilation system was on).

In order to assess the dose equivalent due to the external gamma radiation, the measurement were carried out at some points at the height of 1m above the ground both within the boundary of the repository facilities and outside these boundaries, including the top of the air ventilation shafts (Fig. 3). Except elevated dose rates at some places close to the buildings, which some time ago were used as laboratories for the treatment of some wastes (these places show some residual contamination), the dose rate at other measuring points is comparable with the normal radiation background.

Due to much higher concentration of natural radionuclides, the situation in the Bratrství Repository (a former uranium mine in the Jáchymov region) is substantially different, especially as to the radon concentration. Its level can reach values as high as 400 kBq m^2 (Fig. 4). In addition, also the dose equivalent rate is showing levels exceeding several times radiation background typical in the Czech Republic (Fig. 5).

Fig. 1. Radiation levels at the Richard Repository

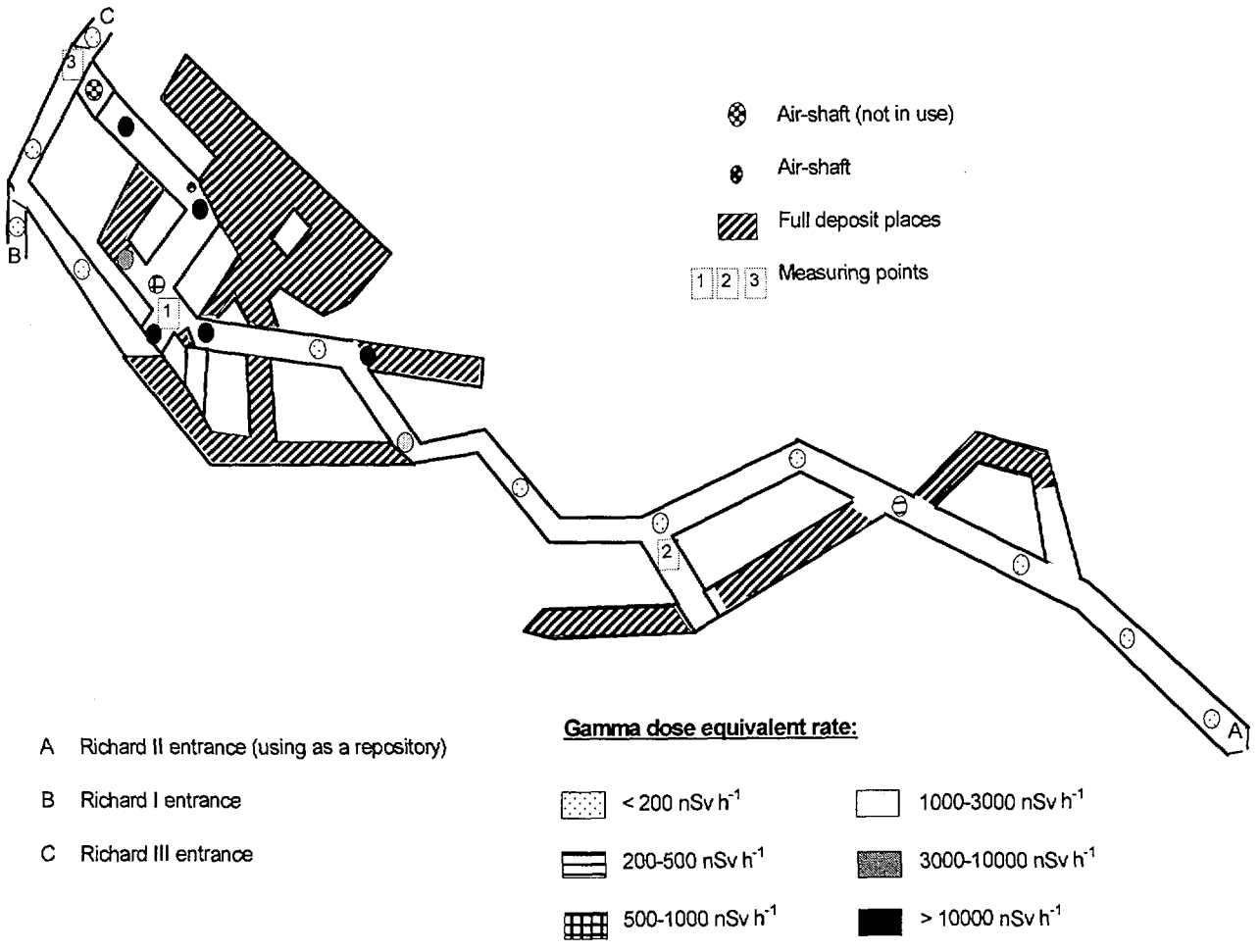
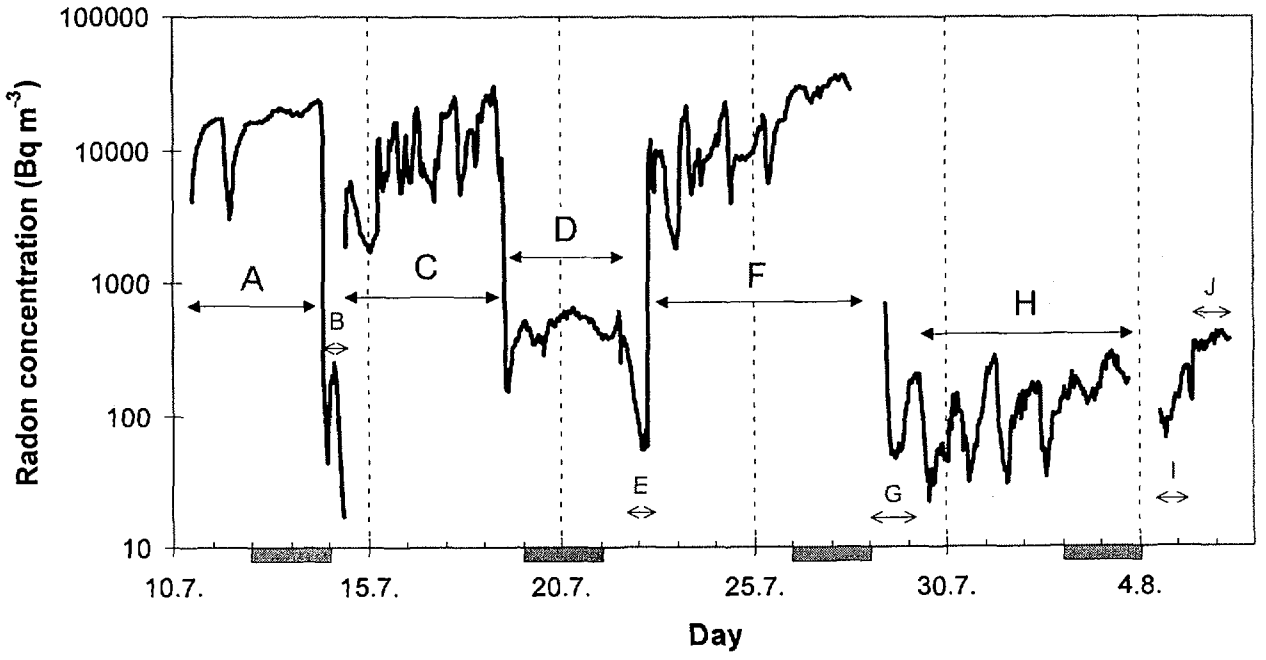


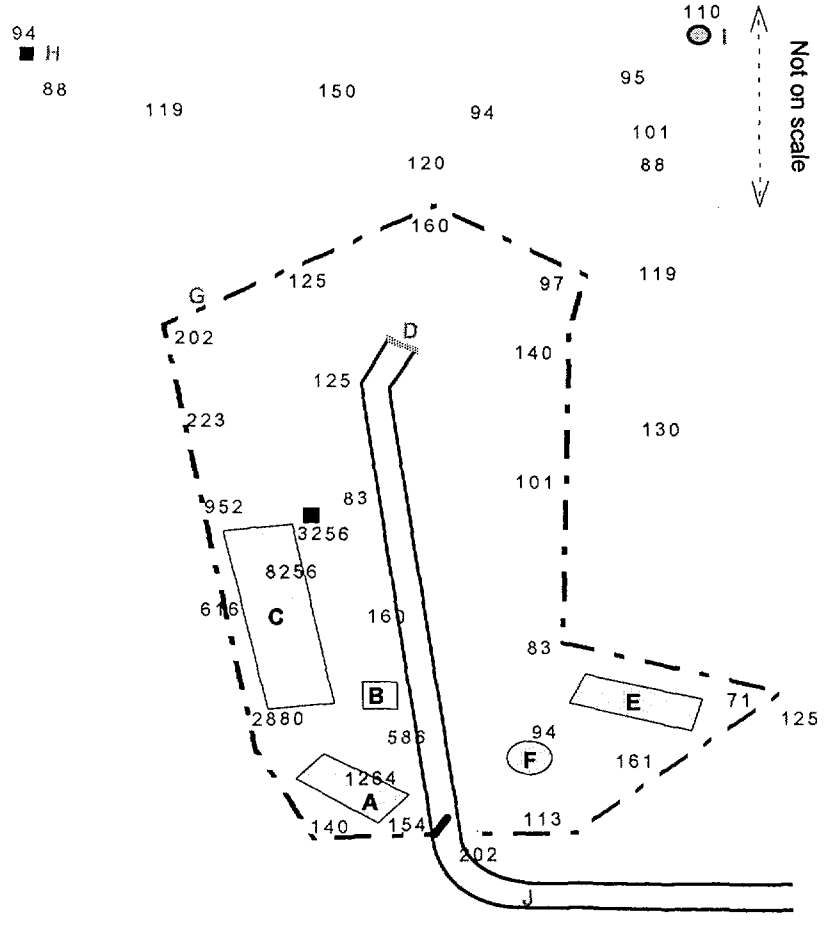
Fig. 2. Radon concentration at the selected places at the Richard Repository



A	Measuring point 1 (Fig. 1)	**B**	Guard-room
C	Measuring point 2 (Fig. 1)	**D**	Building (inside; air-shaft shut-down)
E,G,I	Building (inside; air-shaft shut-up)	**F**	Measuring point 2 (Fig. 1)
H	Workshop	**J**	Measuring point 3 (Fig. 1)

On the axis X weekend intervals are marked(ventilation off).

Fig. 3. Gamma radiation levels around the Richard Repository (nSv h^{-1})



A	Storage
B	Guard-room
C	Offices
D	Repository entrance
E	Storage
F	Test tower
G	Repository border
H,I	Air-shaft
J	Access roads

Fig. 4. Radon concentration at the Bratrství Repository

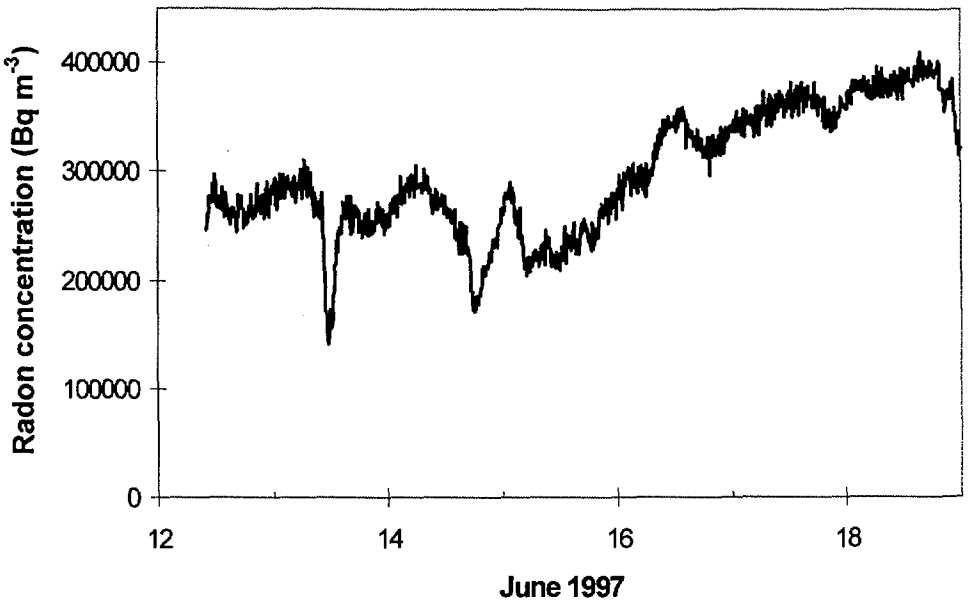
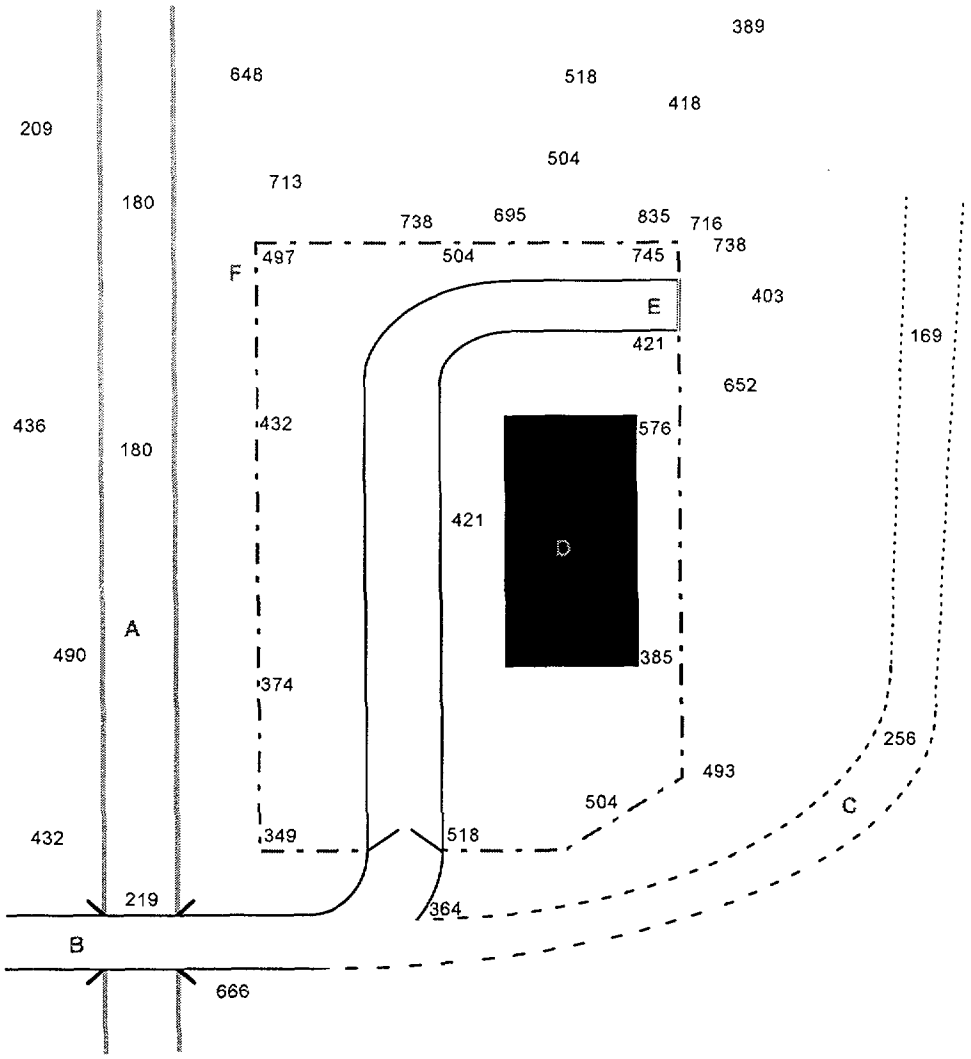


Fig. 5. Gamma radiation levels around the Bratrství Repository (nSv h^{-1})



A Creek **B** Access road
C Track **D** Office
E Repository entrance **F** Repository borders

5. Conclusion

The photon equivalent dose rates in the corridors in the Richard Repository due to the shielding against cosmic radiation are usually slightly lower than those outside. However, in places close to barrels containing radioactive wastes, the dose rate may reach the values as high as several tens of μSv/h. Because of high concentrations of natural radionuclides (in the soil - Jáchymov is a uranium mining area, and in the inside atmosphere - due to radon decay products), the dose rate in the repository Bratrství is generally much higher, in some places about 5 times that of normal background.

It has been found that radon concentration shows some specific time variations which are modified by ventilation. In the case of poor or no ventilation, extremely high radon concentrations were detected: up to 300 kBq m^{-3} and 30 kBq m^{-3} in Bratrství and Richard repositories, respectively.

The personal exposure of the workers depends on the total time spent underground and on the ventilation rate. While the contribution from the photons can easily be kept low enough to be well below the relevant limits, the radon related doses may be significant and even exceed the professional limits if no precautions are taken. The results presented can be useful for assessing the expected exposure levels and for the optimisation of radiation protection procedures.

5. Acknowledgement

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6. References

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