RADIATION PROTECTION CONCEPT FOR THE PLANNED RADIOACTIVE WASTE REPOSITORY IN THE KONRAD MINE

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INTRODUCTION, BASES

It is intended to establish the planned repository in the former Konrad iron ore mine near Salzgitter-Bleckenstedt. With a dip of approx. 23°, the iron ore bed proposed for the deposition of radioactive waste is situated at a depth of approx. 1300 m to 800 m. The deposition cavities to be constructed during the operating phase form horizontal galleries with a cross section approx. 7 m in width and 6 m in heigth (Fig. 1). The different waste packages will be transported below ground with trackless diesel vehicles and stacked over the whole cross section of the gallery. The hollow spaces between the waste packages will then be backfilled.

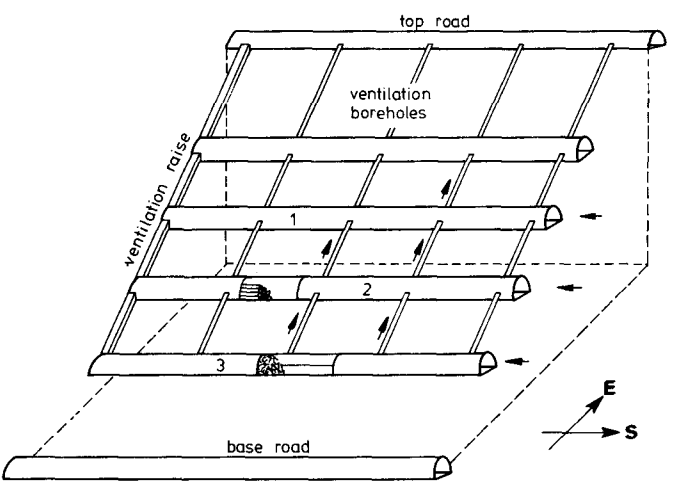

Fig. 1: Principle of a storage-field (Sectional area of the storage-rooms: 40 m²)

The planning bases relevant to radiation protection are in agreement with /1/:
- separation in space of the waste package and debris transports,
- parallel ventilation of the deposition and driving areas and, moreover, the supply of the waste transport roadways with fresh air,
- limitation to 5 mSv/a on an average of the exposure of the staff to direct and stray radiation which is largely unavoidable when handling and depositing the

waste; limitation of the largely avoidable exposure of the staff to radiation to the amount of a whole-body resp. effective dose of 0.5 mSv/a as a result of inhalation, submersion etc. of released radioactive substances or of detached, non-adhesive surface contamination (reference dose rate values taken as a basis of the planning work),
- limitation of the potential exposure to radiation in the surroundings as a result of a discharge of released radioactive substances, to values of approx. 20 % of the limiting values defined in § 45 of the Radiation Protection Ordinance /2/.

The causes of the staff's exposure to radiation are to be found on the one hand in the uranium/radium and thorium content of the iron ore and on the other, in the direct radiation of the waste as well as in the release of radioactive substances from the waste packages or their surfaces. The basic exposure (referred to 2000 working hours per year) is composed of the direct radiation in the individual galleries (additional dose up to 0.18 mSv/a as compared with the dose above ground), the inhalation of the iron ore dust (whole body dose 0.04 mSv/a) as well as the inhalation of radon-220/222, including their short-lived decay products (effective equivalent dose up to 12 mSv/a) /3, 4, 5/.

The radon exposure can be strongly influenced by the way of ventilation, in particular when allowing for goafs. It will be ensured that persons working below ground who do not belong to the staff exposed to radiation will get a basic exposure not exceeding a whole-body resp. effective dose of 5 mSv/a. For staff exposed to radiation, the basic exposure together with the radiation emanating from the waste form the professional exposure to radiation for which the limiting values defined in the Radiation Protection Ordinance are to be complied with.

To reach the objectives "compliance with the reference values of the exposure of staff and environment to radiation due to waste taken as a basis of the planning work" and to control the unavoidable effects, the radiation protection concept described in the following is applied /6/. The basis of the preparation of such a concept is formed by a detailed and complete description of the operational and technical sequences within a repository.

PRINCIPLES OF THE RADIATION PROTECTION CONCEPT

The paramount functional criteria of mine operation are the preponderantly "mobile activities"; here the transports between varying starting and final points are to be referred to in the main. The combination of conventional mine operation and handling of radioactive waste packages, the environmental conditions below ground which are unfavourable from the point of view of radiation protection (dust, distances to be covered, unfavourable surfaces) and influence to a high degree the character of the work and the technologies applied, were taken into account when defining the principles of the radiation protection concept set forth in the following.

The whole mine will be subdivided into a conventional and a nonconventional area. This subdivision refers not only to the whole mine structure but also to the technical operations (preparation, transport, deposition, supply, repair), the organizational services (executive services such as mining, electrotechnical, ventilation and radiation protection service) with their functional sequences and the equipment used with their respective locations. For practical reasons, it is recommended to declare the whole non-conventional area including the upcast ventilation shaft and the above ground installations for the handling of waste packages to be a controlled area in the sense of radiation protection. All overlapping activities are to be restricted to a minimum and monitored.

Another principle of the radiation protection concept results from the fact that - in contrast to other nuclear installations in which the handling of radioactive substances determines the planning and sequence of operations to a large extent - the conditions below ground and the mining requirements determine the character of plant and operation of a mine used as a repository. This means that without abandoning radiation protection principles, the radiation protection measures are to be adapted to the largest possible extent to the operating conditions. This objective can be reached best by decentralized radiation protection.

A continuous feedback between radiation protection and operation will be of fundamental importance. "Special" and "long-term supervision programmes" will therefore be practised in a well-defined way in order to profit from the experience gained by reducing too rigorous radiation protection measures delaying mine operation and by analyzing all points and sequences of operation relevant to radiation protection so that long-term non-conventional operating disorders (such as, for example, the slow contamination of a major gallery section) can be prevented.

The last principle to be set forth is that of how to act in the case of an incident. Incidents in a mine used as a repository are subdivided into incidents with mechanical, with thermal and with mechanical and subsequent thermal impact. The incidents themselves and their effects are characterized by the considerable size of the mine, the resulting diversity of the places where an incident can take place, the passive nature of the barriers and the large number of staff members potentially involved, due to the "open ventilation" (no activity inclusion using progressively lower pressure). The largest complex of problems resulting from a release of activity due to an incident comprises the intervention in the actual ventilation with a view to limiting the propagation of the activity. This can be achieved technically by sealing off the zone where the incident has taken place from the rest of the mine structure by establishing a sufficient number of ventilation doors ("ventilation barriers").

TASKS AND PERFORMANCE OF RADIATION PROTECTION

In the following the main criteria of the most important measurement tasks and control measures will be set forth.

The general examination of persons for contamination will be carried out in a decentralized way, the persons working in the mine being examined below ground. All accesses to the controlled area are provided with monitored contamination detectors. Should a contamination be ascertained, the contaminated persons will be decontaminated - in dependence upon the extent of the contamination - either locally by means of a decontamination vehicle or - after appropriate isolating measures have been taken - above ground in the decontamination room for persons. Equipment and working areas are monitored for contamination as well, particular importance being attached to operating points with increased dust exposure and sealed storage chambers.

The monitoring of the repository for radiation is made by measuring the local dose in the whole installation with thermoluminescence dosimeters and the local dose rate with stationary (above ground), temporarily stationary (chambers, transport roadways) and mobile (radiation protection missions) devices. The storage chambers are an essential source of radiation to which the staff is exposed. At a distance of 10 m, a stack of packages filling the whole cross section causes a dose rate of up to 0.1 mSv/h, the component of the radiation scattered at the rock being of the order of almost 50 % /7/. Without additional shielding, a person staying here only for approx. 50 hours would already receive the mean annual dose of 5 mSv/a which serves as a reference value for the planning. The storing machines and vehicles are therefore equipped with shielding systems. For the control of the persons exposed to radiation, official and self-reading personal dosimeters are used. Incorporation

controls depend upon the actually measured concentrations of the activity in the ventilation and ambient air and will be carried out only in special cases.

The kind and extent of the air activity and emission control will be determined substantially by the expected - though small-scale - release of volatile nuclides from the waste packages. The radionuclides H-3, C-14, traces of J-129 as well as Rn-220/222 (from iron ore and waste) require special control methods. In addition, aerosol traces from released surface activity are expected. The activity concentrations at the workplaces will be substantially determined in a discontinuous way, whereas the discharge via the exhaust air and the sewage/residual water path (decontamination waters, mine waters) will be determined continuously.

The environmental control programme is characterized by an emission spectrum differing from that of nuclear power plants and by a low emission level. The measurement programme which is to be established in agreement with the plan approval authority will therefore refer mainly to the operating site as well as to the immediate environment.

REALIZATION OF THE CONCEPT

Within the scope of the preparation of documents for the plan approval procedure, the mine, the operating conditions and the waste packages are submitted to a safety analysis /8/. The following criteria are allowed for in the analysis as parameters which are characteristic of the Konrad mine and relevant to radiation protection: relatively high radiological basic exposure (radon), accumulation of mine waters (approx. 15000 m^3/a) which are pumped above ground and discharged in a controlled way (water path), "open ventilation", size of the mine (some kilometers), as well as dust. Up to the plan approval decision which can be taken in the year 1987 at the earliest, the final quantitative requirements on the mine, operating conditions and waste packages will be defined iteratively /8/. The realization of the final radiation protection concept can thus be commenced in 1987 at the earliest. In the course of the "change-over" of the Konrad mine into a repository which is proposed to be carried out in 1987 to 1989, the radiation protection requirements on the technical installations and equipment must be complied with and the organizational and administrative preconditions for the carrying out of the radiation protection tasks provided.

/1/ Sicherheitskriterien für die Endlagerung radioaktiver Abfälle in einem Bergwerk. Bundesanzeiger, Jahrgang 35, Nummer 2, 05. Januar 1983.
/2/ Verordnung über den Schutz vor Schäden durch ionisierende Strahlen. (Strahlenschutzverordnung - StrlSchV) vom 13.10.1976, BGBl. I, S. 2905.
/3/ Gesellschaft für Strahlen- und Umweltforschung, München: Abschlußbericht Eignungsprüfung der Schachtanlage Konrad für die Endlagerung radioaktiver Abfälle. GSF - T 136, Juni 1982.
/4/ Physikalisch-Technische Bundesanstalt, Braunschweig: Radon-Messungen in der Grube Konrad. Aktenvermerk Eh/Ko vom 02.03.1983.
/5/ Gesellschaft für Strahlen- und Umweltforschung, München: Durchführung von Beweissicherungsmaßnahmen: Radon- und Thoron-Aktivitätskonzentration im Grubengebäude Schachtanlage Konrad.
/6/ Gesellschaft für Umweltüberwachung mbH, Aldenhoven, 1981: Strahlenschutzkonzept für die zu errichtende Anlage des Bundes zur Endlagerung radioaktiver Abfälle. Abschlußbericht, GUW - 0780-01.
/7/ D. Ehrlich et al.: Dose Planning and Calculations for Radioactive Waste Repository Plants in Mines. Proc. of the Sixth Internat. Conf. on Radiation Shielding, Tokyo, May 16-20, 1983.
/8/ E. Warnecke et al., in R. Odoj, E. Merz (Hrsg.): Proceedings of the International Seminar on Chemistry and Process Engineering for High-Level Liquid Waste Solidification. Jul-Conf-42 (Vol.2) 792-815 (1981).