MEASURES OF γ-DOSES AND GASEOUS DISPERSION FACTORS IN THE ENVIRONMENT OF A NUCLEAR FACILITY IN A TYPICAL MIDDLE-EUROPEAN SITE

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1. In the trajectories of the main wind directions at critical locations (e.g villages) in the environment of the nuclear facility in Wurenlingen (EIR) the γ-radiation level has been continously measured with very sensitive G.-M.detectors.
During a whole year (Dec.1975 - Nov.1976) the results have also been registrated graphically on appropriate recorders, thus allowing to determine simultaneously the local dose rates and their variations which is not possible with the also existing TLD (CaF_2:Dy) surveillance system. The network has been completed if necessary with a high pressure ionisation chamber (RSS-111) . It will be also possible to calculate the dispersion factors of the plume emitted by the heavy water reactor of the EIR which releases about 14-16 mCi Ar-41/sec into the atmosphere through a stack of 70m height.

   The detectors have been installed at 1,7 to 5 km from the Ar-41 source, so it was possible to consider the dispersion of the plume almost during weather conditions with adiabatic lapse rate when the plume reaches the ground not too far from the stack.

   In this paper only a few aspects have been considered such as to compare some results of these measurements with figures calculated with a computer program in order to test their validity in this region where relatively broad valleys alternate with hills of mean altitude (200-300 m above ground) as they are typical for all actual sites of nuclear plants in Switzerland and for many of them in Central Europe.

   The investigations were restricted to short-term emmissions (i.e. 1 hour) during atmospheric conditions of adiabatic lapse rate. More detailed results and long term diffusion calculations will be reported when the measures of the whole period will have been considered.

2. For a long term diffusion calculation such as annual dose calculations from the atmospheric emissions of radionuclides from a nuclear power plant the good agreement between measurement and calculation has been reported by J.A. Martin Jr. (ANS 20th Annual Meeting, 1974). The purpose of this experiment was to verify the short-term diffusion model through the measurement of γ-dose rates from the Ar-41 emissions.

   The computer code AIREM is used to calculate the atmospheric dispersion and diffusion. AIREM is based on sector averaged diffusion equation for long-term average calculations.

   The same code is used here for a short-term diffusion calculation considering the dispersion of the plume in a single 22,5^{o} sector. The cloud γ-

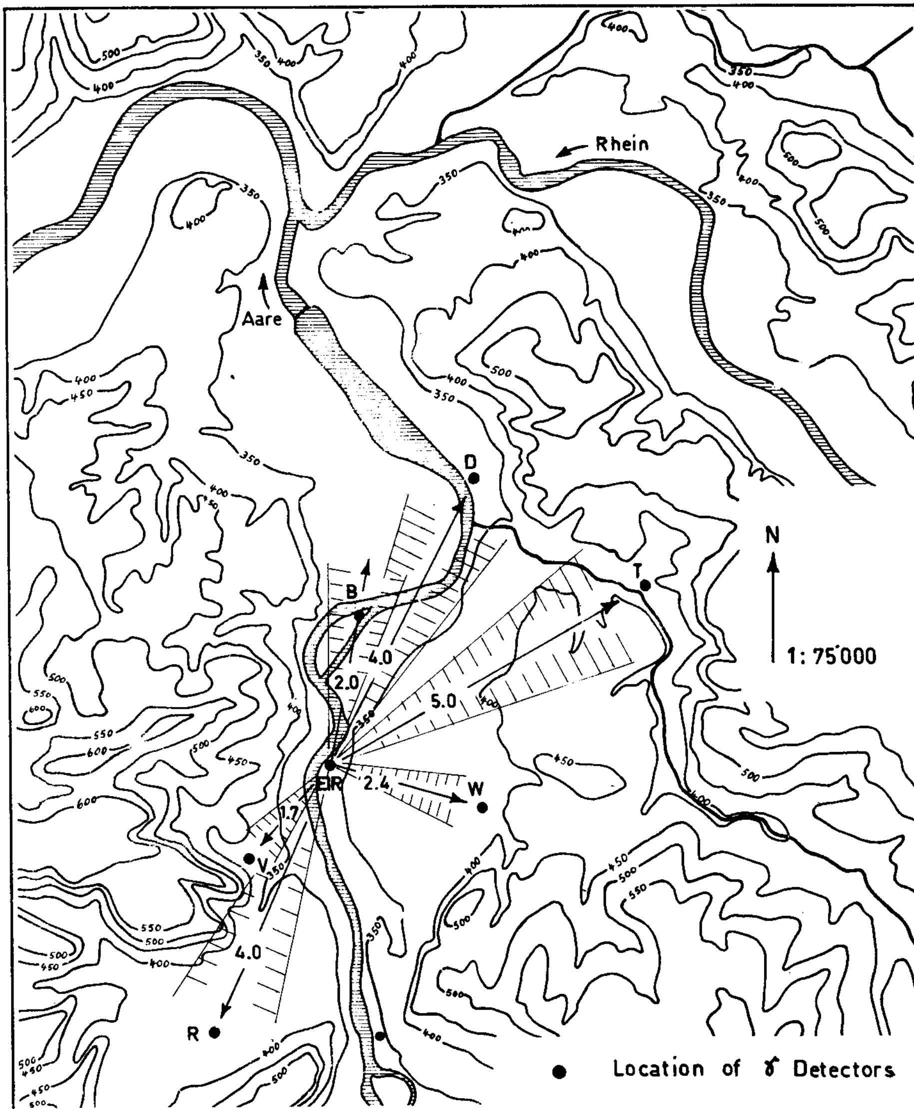

Fig. 1 Ar–41 Transport Directions and Sectors by Adiabatic Lapse Rate around EIR*

* S-SW, NNE-NE and WSW-WNW are the main wind directions during such atmospheric conditions.

dose rates were calculated using a model that considers the finite extent of the cloud, all decay γ-energies and dose buildup factors (computer code EGAD).

The ratios of the calculated to the measured dose rates at various points are shown in the following table :

Table 1
Ratios of calculated to measured dose rates (μrem/hour) in the environment of EIR for short-term emissions and during adiabatic lapse rate.

$\bar{u}$ m/sec	Point V 1,7 km	Point B 2 km	Point W 2,5 km	Point D 4 km	Point R 4 km	Point T 5 km
1,5 - 3,0	$\frac{47}{4} = 12$ $\frac{40}{14} = 2,8$ $\frac{34}{1} = 34$ $\frac{32}{1} = 32$	$\frac{48}{17} = 2,8$ $\frac{36}{21} = 1,7$ $\frac{36}{7} = 5,1$ $\frac{32}{10} = 3,2$ $\frac{29}{7} = 4,1$	$\frac{29}{2} = 14,5$ $\frac{30}{3} = 10$	$\frac{18}{2} = 9$ $\frac{16}{2} = 8$ $\frac{15}{2} = 7,5$ $\frac{14}{3} = 4,7$	$\frac{23}{5} = 4,6$ $\frac{20}{12} = 1,6$ $\frac{17}{4} = 4,2$ $\frac{16}{10} = 1,6$ $\frac{15}{8} = 1,9$	$\frac{12}{2} = 6$ $\frac{12}{1} = 12$
> 3,0 - 4,5	$\frac{21}{3} = 7$ $\frac{20}{2} = 10$ $\frac{19}{2} = 9,5$	$\frac{27}{12} = 2,2$ $\frac{27}{7} = 3,8$	$\frac{15}{4} = 3,7$	$\frac{13}{2} = 6,5$		$\frac{10}{\sim 1} = 10$ $\frac{8,5}{\sim 1} = 8,5$
> 4,5 - 7,5	$\frac{19}{3} = 6,3$ $\frac{19}{2} = 9,5$ $\frac{21}{3} = 7$	$\frac{16}{4} = 4$	$\frac{11}{1} = 11$	$\frac{8}{1} = 8$		$\frac{9}{\sim 1} = 9$ $\frac{6}{\sim 1} = 6$

For calculations the diffusion factor has been adapted to the effective height of release depending on prevailing wind velocities. The roughness of the ground has not been taken into account.

The figures in table 1 show that all calculated dose rates are higher than the measured ones. But the figures are not homogeneous.

If compared with the map of Fig.1 it is obvious that the best results (within a factor 2 - 4) would be obtained at locations situated in a quasi flat country as it is the case for point R in SSW and point B in N. Increasing factors (till a factor of 10) were calculated at locations where the plume rose in front of hills of 150 - 200m elevation e.g. Point V (NE-winds) W (WNW-winds), D (SSW-winds) or crossed a small valley (T, WSW-winds) those ground it only partly reached. Such plumes are known to overflow ridges quite directly during weather conditions of adiabatic lapse rate as those chosen for these calculations.

3. Due to the differences between the calculated and measured dose rates as shown in table 1, the short term diffusion factors to be used in the code should be reduced accordingly.

   For heights of release from 80 to 100 m as considered in this paper and for conditions as existing in the Points B (2 km) and R (4 km) values ranging between $2 \cdot 10^{-7}$ and $5 \cdot 10^{-7}$ sec/m^3 could be considered as reasonable.

4. A first approach shows a good agreement between the use of the model and the measurements (within a factor 2 - 4 in appropriate cases) and promises that the code AIREM can be used also for short-term diffusion calculations.