ON THE USE OF TRAJECTORY MODELS FOR EVALUATION OF THE DISPERSION OF AIRBORNE RADIOACTIVITY IN NUCLEAR POWER PLANT ACCIDENT SITUATIONS

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1. INTRODUCTION

Commonly, there are diagrams constructed in advance for calculating the dispersion of radioactive matter in an accident situation. Wind and stability values observed from some point (e.g. tower) near the plant, are used as meteorological input data. These values are then assumed to be valid for the dispersion up to several hundred kilometers from the plant. However, in most cases the orography and synoptic situation influence the dispersion so that this definitely cannot be described by data from a single observation point alone. The dispersion calculation should therefore be based on analysis of the wind and stability conditions over the whole dispersion area. To be of use in an accident situation, the method must be fast and simple to apply even on relatively small computers or calculators. The following describes the method developed at the Finnish Meteorological Institute for use as a complement to the diagram safety system.

2. CALCULATION OF THE DISPERSION TRAJECTORIES

Regular synoptic wind observations in the area surrounding the plant are used for calculating the dispersion trajectories. The wind analysis for each point required is performed by the relatively sophisticated "optimum interpolation" method introduced in meteorology by L.Gandin (1). The use of this method near the ground and in mesoscale has been discussed earlier (2).

3. ESTIMATION OF THE HORIZONTAL AND VERTICAL EXTENSION OF THE RADIOACTIVE CLOUD

For calculating the horizontal spread perpendicular to the trajectory, σ_y-values are used, as is usual in gaussian plume models. In order to get enough broad risk zones, the uncertainity of the trajectory computation should be added to the σ_y-estimate of the horizontal spread.

The vertical spread is simulated according to a K-teori approach:

$$\frac{\partial C}{\partial t} = \frac{\partial}{\partial z}\left(K_z \frac{\partial C}{\partial z}\right),$$

where C is concentration and K_z the vertical eddy diffusion coefficient. For the determination of the important K_z-values the planetary boundary layer (0-1000 m) is divided into three layers: a ground layer (0-1 m) in which the vertical spread only depends or the deposition velocity v_d, a surface layer (1-100 m) where K_z grows with increasing height according to

$$K_z = u_* z \, f\left(\frac{z}{L}\right),$$

and a transition layer in which K_z is constant to the inversion. For the stability characteristics u_* and L (see e.g. (3)) values are given in advance for different synoptic situations.

4. THE RELEASE INFORMATION AND THE OUTPUT

The above described dispersion calculation method does not include any procedures for estimating the amount and type of release. This information should be obtained in another way, as accurately as possible. The initial release height and the plume rise should also be estimated separately.

The trajectory is plotted on a map and for the distances 2^n (n= 1,2,..,8)km values for the horizontal extension of the radioactive cloud and the ground level axial concentration C_o are tabulated. Further rough estimates of the corresponding time integrated β and γ submersion doses and the inhalation dose will be included in the output.

REFERENCES

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